Volume **2** | Appendices A-L

EIS

Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska

April 2005

United States Department of Commerce
National Oceanic and Atmospheric Administration

National Marine Fisheries Service
Alaska Region

Appendix A
Essential Fish Habitat
Final Scoping Report

Prepared by

National Marine Fisheries Service
and Tetra Tech EC

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ACRONYMS AND ABBREVIATIONS

ANCSA	Alaska Native Claims Settlement Act
BSAI	Bering Sea and Aleutian Islands
Council	North Pacific Fishery Management Council
CPUE	catch per unit effort
DPSEIS	Draft Programmatic Supplemental Environmental Impact Statement
EAs	environmental assessments
EFH	essential fish habitat
FCMA	Fishery Conservation and Management Act
FMP	Fishery Management Plan
GOA	Gulf of Alaska
HAPC	habitat areas of particular concern
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MPA	marine protected area
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
OP	Observer Program
SCA	Sea lion conservation area

1.0 INTRODUCTION

In the 1996 Magnuson-Stevens Act Fishery Conservation and Management Act (Magnuson-Stevens Act) reauthorization, Congress recognized that one of the most significant long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. To ensure that habitat considerations receive increased attention for the conservation and management of fishery resources, the amended Magnuson-Stevens Act included new essential fish habitat (EFH) requirements. As such, each fishery management plan (FMP) must describe and identify EFH for the fishery, minimize adverse effects on EFH caused by fishing to the extent practicable, and identify other actions to encourage the conservation and enhancement of EFH. EFH is defined in the Magnuson-Stevens Act as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.”

In June 1998, the North Pacific Fishery Management Council (Council) adopted Amendments 55/55/8/5/5 to the Bering Sea and Aleutian Islands (BSAI) Groundfish FMP, the Gulf of Alaska (GOA) Groundfish FMP, the BSAI Crab FMP, the Scallop FMP, and the Salmon FMP, respectively, and submitted them for review by the Secretary. These amendments were approved by the Secretary on January 20, 1999 (64 FR 20216; April 26, 1999), in accordance with Section 304(a) of the Magnuson-Stevens Act.

In 1999, a coalition of several environmental groups brought suit challenging the agency’s approval of the EFH FMP amendments prepared by the Gulf of Mexico, Caribbean, New England, North Pacific, and Pacific Fishery Management Councils (*American Oceans Campaign [AOC] et al. v. Daley et al.*, Civil Action No. 99-982(GK)(D.D.C. September 14, 2000). The court found that the agency’s decisions on the EFH amendments were in accordance with the Magnuson-Stevens Act, but held that the environmental assessments (EAs) on the amendments were in violation of the National Environmental Policy Act (NEPA) and ordered the National Marine Fisheries Service (NMFS) to complete new, more thorough NEPA analyses for each EFH amendment in question. Because the court did not limit its criticism of the EAs only to efforts to minimize adverse fishing effects on EFH, NMFS decided that the scope of these new analyses should address all required EFH components as described in Section 303(a)(7) of the Magnuson-Stevens Act. Further, NMFS determined that the agency’s prior actions regarding EFH should not predetermine any conclusions in the EIS.

This action is designed to determine whether and how to amend the Council FMPs pursuant to Section 303(a)(7) of the Magnuson-Stevens Act and based on the EFH Final Rule in 50 CFR, part 600 subpart J. More specifically, the three-part purpose of this action is to analyze a range of potential alternatives for each fishery to 1) describe and identify EFH for the fishery, 2) identify other actions to encourage the conservation and enhancement of EFH, and 3) identify measures to minimize the adverse effects of fishing on EFH to the extent practicable. In addition to these three actions, the scope of the EIS will cover all of the required EFH components of FMPs described in the Final Rule, as well as a description of a process to identify habitat areas of particular concern (HAPCs).

2.0 SCOPING PERIOD, PUBLIC SCOPING MEETINGS, AND ISSUES

On June 6, 2001, NMFS published in the Federal Register a Notice of Intent (NOI) to prepare this EIS. The NOI solicited written comments to determine the issues of concern and the appropriate range of management alternatives to be addressed in the EIS and included notification regarding noticed seven scoping meetings in six communities in Alaska and Washington State (66 FR 30396).

2.1 Summary of Scoping Meetings

The public scoping meeting were held as follows:

Kodiak, AK – Monday, June 4, 2001 - Kodiak - from 7:00 to 9:00 p.m., at the Fishery Industrial Technology Center, 118 Trident Way, Kodiak, AK.

The members of the public in attendance included Gordon Blue, Al Burch, Wayne Donaldson, Ben Enticknap, John Gauvin, Albert Geiser, Dave Fraser, Erin Harrington, John Henderschedt, Terry Leitzell, Paul MacGregor, Trevor McCabe, Brent Paine, Alan Parks, Glenn Reed, Michelle Ridgway, Scott Smiley, Beth Stewart, and Jay Stinson.

The NMFS staff members in attendance included Steve Davis (Analytical Team), Matthew Eagleton (Habitat Conservation Division [HCD]), Cindy Hartmann (HCD), and Michael Payne (HCD).

The Kodiak scoping meeting was held in conjunction with a Council meeting that was scheduled from June 4 to 11, 2001. The EFH scoping meeting was included on the Council's meeting agenda. Special efforts were made to contact Native community leaders in Kodiak and give them notice of the meeting. Native organizations that were contacted included Koniag, Inc., Afognak Native Corporation, Natives of Kodiak, Inc., Kodiak Area Native Association, and Kodiak Tribal Council. In addition, EFH materials available at the meeting were sent to all these organizations.

Unalaska, AK – Friday, June 8, 2001 - Unalaska - City Hall, Council Chambers, 245 Raven Way, 4:00 to 8:00 p.m., Unalaska, AK.

The members of the public in attendance included Emil Berikeff Sr., Gregg Hanson, Aimee Kniaziowski, Rick Kniaziowski, Mark Lashua, Greg Moyer, and Dave Willmore.

The NMFS staff members in attendance included Cindy Hartmann (HCD), Mike Mchaffey (Enforcement), Troy Martin (Observer Program [OP]), Ernie Soper (Enforcement), and Chuck Raterman (Enforcement).

Anchorage, AK – Monday, June 11, 2001 - Anchorage - Z. J. Loussac Library, public conference room, level 1, 3600 Denali Street, 2:30 to 6:30 p.m., Anchorage, AK.

The members of the public in attendance included Dave Cline, Diana Evans, Brian Fedorko, Jon Isaacs, Wesley Loy (Anchorage Daily News), Charles Edison McKee, Dana Olson, Bob Pawlowski, Carl Portman, Russell Seither, and Jennifer Watson.

The NMFS staff members in attendance included Matthew Eagleton (HCD), Jeanne Hanson (HCD), Cindy Hartmann (HCD), Pete Risse (OP), Russell Seither (OP), and Jennifer Watson (OP).

Seattle, WA – Tuesday, June 19, 2001 - Seattle - Alaska Fisheries Science Center, room 2079, 7600 Sand Point Way NE, 1:30 to 5:30 p.m., Seattle, WA.

The members of the public in attendance included Dave Benson, William P. Chace, Jr., Christian Gebhardt, Paul H. Burney Hill, MacGregor, Donna Parker, Glenn Reed, Susan Robinson, and Thorn Smith.

The NMFS staff members in attendance included Cindy Hartmann (NMFS, HCD).

Juneau, AK – Wednesday, June 20, 2001 - Juneau - Federal Building, room 445, 709 W. 9th Street, 2 to 5:30 p.m. and Centennial Hall Convention Center, Egan Room, 101 Egan Drive, 7 to 9 p.m., Juneau, AK.

The members of the public in attendance included the following:

- Afternoon Meeting: Randy Bates, Clancy DeSmet, Tom Gemmell, Heather McCarty, Janet Hall Schempf, and Bob Tkacz (Alaska Fishermans Journal).
- Evening Meeting: Beverly Agler, Tom Gemmell, Dale Kelley, Heather McCarty, Michelle Ridgway, Janet Smoker, and Paula Terrel.

The agency staff members in attendance included Cindy Hartmann (HCD) and Michael Payne (HCD)**.**

Sitka, AK – Thursday, June 21, 2001 - Sitka - Harrigan Centennial Hall, Maksoutoff Room, 330 Harbor Drive, 2 to 5:30 and 7 to 9 p.m., Sitka, AK.

The members of the public in attendance included Molly Ahlgren, Linda Behnken, Liz Brown, Page Else, Jay Erie, Shannon Haugland (Daily Sitka Sentinel), Pat Veessart, and Steve Will.

The agency staff members in attendance included Cindy Hartmann (HCD).

2.2 Format of Scoping Meetings and Information Presented and Available

NMFS staff presented a Power Point® presentation with relevant overview information including the following:

- Magnuson-Stevens Act EFH provisions overview
- EFH FMP amendments review
- EFH litigation brief
- NEPA overview
- EFH EIS relationship to the Programmatic Groundfish EIS
- Scoping process overview
- EFH EIS process, including alternatives for EFH description and identification HAPC identification, and minimizing the effects of fishing
- Public involvement and public input
- EIS time line
- Scoping meeting schedule
- Where to go for further information

The Power Point® presentation was given and NMFS staff answered questions. The public attendees were asked to sign in. Comment forms were available so that people could write their comments at the meeting or send them in at a later date. Reference materials available at the meetings included the EFH EA, dated January 1999, and the EFH Habitat Assessment Reports. Handouts available for the public provided relevant information and background information.

Available handouts included the following:

- Paper copies of the Power Point® presentation.
- Comment form with NMFS mailing address and contact numbers
- Federal Register Notice with the Notice of Intent (66 FR 30396, June 6, 2001)
- EFH Interim Final Rule (50 CFR Part 600) (62 FR 66531, December 19, 1997)

- Memorandum from William T. Hogarth to Regional Administrators, dated January 22, 2001, "Guidance for Developing Environmental Impact Statements for Essential Fish Habitat per the *AOC v. Daley* Court Order"
- U.S. District Court for the District of Columbia, Opinion by Gladys Kessler, Decided September 13, 2000
- Copies of a litigation summary Power Point® presentation
- Draft time line for the EFH EIS
- Alaska Region EFH web sites and NOAA Fisheries/Headquarters EFH seb sites

2.3 Comment Letters and Issues

Written comments were accepted from June 6 to July 21, 2001. NMFS received letters from 27 commenters (Table A-1). Individual comments were delineated within the letters and grouped into similar issue categories, resulting in 147 unique comments and 236 total comments (Table A-2). This report provides a summary of public scoping comments for the EIS and identifies significant and non-significant issues.

Table A-1. Comment Letters Received During the Scoping Period

Letter Number	Source
1	Minerals Management Service; John Goll, Regional Director
2	Arctic Storm, Inc.; Donna Parker
3	Perkins Cole, LLP; Guy Martin
4	Alaska Longline Fishermen's Association; Linda Behnken
5	A. Geiser, F/V Hazel Lorraine; Albert Geiser (2 Letters)
6	Alaska Marine Conservation Council; Nancy Lord
7	Resource Development Council; Carl Portman, Deputy Director
8	Alaska Miners Association, Inc.; Steve Borell, Executive Director
9	Lynden, Inc.; David Haugen, Vice President
10	Bill Rotecki
11	Raven Environmental Services; Paul C. Rusanowski
12	Pacific Fishing, Inc.; Patricia Phillips
13	Trisha Herminghaus
14	Word Wildlife Fund; David Cline, Director
15	Alaska Marine Conservation Council; Ben Enticknap, Fisheries Project Coordinator
16	Kodiak Fish Company; Nancy Hillstrand
17	Alaska Forest Association; Owen Graham, Executive Director
18	Coal Point Seafood Co.; Nancy Hillstrand
19	Chugach Alaska Corporation; Rick Rogers, Vice President
20	Sealaska; Ronald Wolfe, Corporate Forester
21	Marine Conservation Alliance; Heather McCarty for the Board of Directors
22	High Seas Catcher's Co-op; Dave Fraser
23	American Oceans Campaign; Chris Zeman and Phil Kline
24	Dana Olson
25	J.M. Erie
26	Groundfish Forum; John Gauvin, Director (No comments, endorsement of Letter 21)
27	North Pacific Longline Association; Thorn Smith

Table A-2. Summary Count of Comments within Comment Categories

Issue	Number of Comments	Number of Unique Comments
Significant Issues That Suggest Alternative Actions		
Criteria for Description and Identification of EFH	24	15
Suggested Alternative for Salmon EFH	4	1
Alternatives to Minimize the Adverse Effects of Fishing on EFH	36	30
HAPC	7	6
Scientific Information, Research, and Uncertainty	13	7
Significant Issues to be Analyzed in the EIS		
Effects on Non-fishing Interests of EFH Definition and Identification	19	5
Effects of Fishing on EFH and Need for Mitigation Measures	13	11
Economics/Socioeconomics	16	6
Ecosystem, Wildlife, and Other Non-targeted Marine Species	13	13
Regulatory Compliance	8	3
Other Issues to be Considered in the EIS		
General Comments	13	13
NEPA Document and Process	20	10
Scientific Information/Research	11	11
Issues Not Considered in the EIS		
Regulatory Compliance and Duplication	11	2
General Comments	6	4
NEPA Document and Process	18	6
Scientific Information/Research	2	2
Economics/Socioeconomics	2	2
Total	**236**	**147**

A principal objective of the scoping and public involvement process is to identify a reasonable range of management alternatives that, with adequate analysis, will delineate critical issues and provide a clear basis for distinguishing between those alternatives and selecting a preferred alternative.

NEPA requires that only significant issues need to be analyzed in depth for environmental effects, formulating alternatives, and prescribing mitigation measures. The term “significance,” has a different meaning under NEPA than statistical “significance” as generally used in scientific documents. Following guidance by the Council on Environmental Quality implementing regulations for NEPA, determinations of significance require consideration of both the context and the intensity of the issue (40 CFR 1508.27).

This scoping report describes issues in three subsections. The first subsection describes significant issues that suggest alternative actions. The second subsection describes significant issues that require in-depth analysis within the EIS, but that do not drive development of alternatives. The final subsection describes non-significant issues. Table A-3 at the end of this appendix is a matrix that identifies which comments were used in the development of specific issue statements.

3.0 SIGNIFICANT ISSUES THAT SUGGEST ALTERNATIVE ACTIONS

The following significant issues provided guidance in formulating the alternatives in the EIS.

3.1 Criteria for Description and Identification of Essential Fish Habitat

One action to be addressed in the EIS is to "identify and describe EFH." Commenters were concerned about how the description and identification of EFH would affect the balance between fish and non-fish interests and achieve an appropriate level of protection for fish habitat. Many commenters were concerned about what criteria would be used to define "essential." They wanted only truly essential components of fish habitat to be considered.

Several commenters were concerned about the level of economic and environmental risk that would be acceptable when designating EFH, especially considering the quantity and quality of available scientific information. One commenter suggested that any approach that includes zero risk of adversely affecting fish habitat is inappropriate. Other commenters suggested taking a precautionary approach that would preserve a diverse marine environment and EFH.

Many commenters were concerned about the scope of EFH description and identification. Some commenters suggested that EFH should be specific locations. In contrast, other commenters suggested that EFH should be broadly defined and might include both the general distribution and the core habitat areas for managed species. Others suggested that broad EFH descriptions should be further refined to include more specific habitat types within EFH so that management strategies might be more appropriately applied.

Suggested habitat types included the following:

- Nurseries and rearing grounds
- Spawning beds
- Feeding areas
- Freshwater tributaries and estuaries
- Kelp beds
- Upwelling zones
- Prey habitat

One commenter suggested that EFH defined as the geographic location where a species is merely known to occur is too broad. Several commenters suggested that the current EFH definitions are adequate and should not be changed without supporting scientific information and analysis.

Many commenters suggested considering an ecosystem approach within the EIS. Some commenters were primarily concerned with diverse fish communities beyond those targeted by the fishing industry, while others were concerned with a broad ecosystem approach that would also include non-fish species. One commenter suggested that a precautionary approach be taken to protect marine ecosystems. One commenter suggested that bycatch be considered in the determination of EFH. One commenter suggested that water quality be considered in developing EFH description and identification.

3.2 Suggested Alternative for Salmon EFH

Commenters were concerned about how inclusion of freshwater as EFH for salmon would affect non-fishing interests. Several commenters with non-fishing interests suggested that EFH for salmon be limited to marine and estuarine waters within the Exclusive Economic Zone (EEZ).

3.3 Alternatives to Minimize the Adverse Effects of Fishing on EFH

Another action to be addressed in the EIS is to “minimize, to the extent practicable, adverse effects on EFH caused by fishing.” The EIS identifies and analyzes several alternative approaches to minimize adverse effects. Thus, comments recommending various EFH fishing impact minimization measures are addressed as alternative actions or minimization alternatives.

Several commenters suggested that marine protected areas (MPAs) and reserves should be used as EFH fishing impact minimization measures to protect EFH, biological diversity, and sustainable fisheries. Some commenters suggested that these include major representative habitats in coastal and offshore areas, including pelagic habitats. Several commenters recommended specific areas for added protection, including the World Wildlife Fund’s priority areas for biodiversity conservation in the Bering Sea, the Council’s Southeast Alaska trawl closure area, and the Sitka pinnacles.

Some commenters suggested that artificial reefs be considered for habitat enhancement. One commenter recommended habitat restoration as a EFH fishing impact minimization measure.

Many commenters suggested that EFH fishing impact minimization measures include monitoring, gear restrictions and modifications, and partial-to-complete area and timing restrictions. Another commenter suggested specific modifications to trawl gear to reduce adverse effects to habitat (e.g., size limits on rockhopper and roller gear). Some commenters suggested that low-impact fishing gears replace high-impact fishing gears. One commenter suggested that incentives be investigated for voluntary switching from high- to low-impact gear types. Several commenters wanted few gear modifications and asked that timing restrictions and year-round area closures be considered actions of last resort. Another commenter suggested an aggressive implementation of EFH fishing impact minimization measures. One commenter suggested a reduction in the trawl fleet, targeting the large and powerful trawlers.

Several commenters suggested that one alternative include no additional EFH fishing impact minimization measures. Other commenters implied that adequate scientific information is not currently available to support implementation of additional EFH fishing impact minimization measures. One commenter suggested that the alternatives should range from a reduction in the amount of area currently closed to trawling to maintaining the status quo (i.e., no increase in areas closed to trawling). Several commenters suggested that if the distribution of areas closed to trawling was redefined, the total area should not exceed 20 percent of the GOA and BSAI fishing grounds. One commenter suggested that areas currently closed to trawling be analyzed for fish habitat (depth and environment).

One commenter suggested that “a reasonable and fair standard of precaution” be used when assessing options for minimizing the effects of fishing on habitat and stated that the analysis should be focused on habitat protection rather than on gear allocation issues. Another commenter cautioned that poorly conceived EFH fishing impact minimization measures might have an adverse effect on EFH, rather than providing the intended protection.

3.4 Habitat Areas of Particular Concern

A third action to be addressed in the EIS is to identify HAPC within EFH. The EFH Final Rule, 50 CFR, part 600.815(a)(8), encourages identification of HAPCs, but does not require identification of HAPCs. The Final Rule states the following:

> “FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations: (I) The importance of the ecological function provided by the habitat. (ii) The extent to which the

> habitat is sensitive to human-induced environmental degradation. (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type. (iv) The rarity of the habitat type."

Scoping comments did not provide a sharp definition of HAPC-related issues. Several commenters suggested specific areas to be considered as HAPC or criteria for considering areas as HAPC. The comments concerning HAPC suggest the major issue is how HAPC identification may affect fishing restrictions.

Several commenters were concerned that pelagic habitat be included in HAPC identifications. Some commenters recommended that specific areas be included as HAPCs, including the World Wildlife Fund's priority areas for biodiversity conservation in the Bering Sea, the Council's Southeast Alaska trawl closure area, and Sitka pinnacles. These areas were also suggested for consideration as mitigation measures. Another commenter suggested that a HAPC be identified near Knik, Alaska, to protect existing fisheries threatened by proposed and existing activities. Several commenters suggested that some HAPCs be designated as MPAs.

One commenter suggested that HAPCs be used as tools for the protection of EFH.

One commenter suggested that HAPCs be identified as areas that contained the highest historical abundance of a particular stock. Another commenter suggested that HAPC identification consider vulnerability and resilience to disturbance, as well as ecological function and rarity or uniqueness.

3.5 Scientific Information, Research, and Uncertainty

Many letters included comments about the uncertainty of existing scientific information and the need for additional research. These comments reflected a concern about how scientific uncertainty would affect description and identification of EFH and HAPC, assessment of the effects of fishing on EFH, and the selection of measures to minimize the effects of fishing on EFH. Although not explicitly stated, these comments suggest an approach commonly termed "adaptive management."

One commenter suggested that the EIS address the limitations of the available data and indicate if and when such data may be available. Several commenters suggested that additional EFH fishing impact minimization measures that could have an adverse effect on fishery economics should not be implemented until scientific research has been completed that shows that such measures are necessary.

Several commenters suggested that additional research is needed. Suggested areas of research included the following:

- Improvement of stock assessment techniques
- Understanding of fish habitat and behavior
- General fisheries management
- Effects of fishing on EFH
- Measures to minimize the effects of fishing

One commenter suggested that scientific information is adequate for justifying the development of marine reserves as a way to preserve EFH. Another commenter suggested that a network of habitat research areas should be developed.

Several commenters suggested that measures to minimize the adverse effects of fishing on EFH incorporate experimental designs and controls that would increase scientific understanding of fishery management.

4.0 OTHER SIGNIFICANT ISSUES TO BE ANALYZED IN THE EIS

The following issues are considered significant, but do not suggest alternative actions. These issues are addressed by analysis within the EIS.

4.1 Effects on Non-fishing Interests of EFH Description and Identification

Many commenters were concerned about how the description and identification of EFH would affect non-fishing interests. They suggested that all non-fishing activities that might be affected by description and identification of EFH be identified in the EIS. They also suggested that only non-fishing activities that have significant effects on EFH be analyzed in the EIS.

4.2 Effects of Fishing on EFH and Need for Mitigation Measures

Several commenters were concerned about the uncertainty of scientific information related to the effects of fishing on fish habitat and species diversity. They suggested that uncertainty should be quantified and that thresholds should be developed for weighing the tradeoffs between economic and ecological costs. Several commenters suggested that fixed-gear impacts have not been adequately researched. Two commenters were concerned about the scientific information available to determine the relative adverse effects of fixed and mobile fishing gear. They stated that limited information should not be used to assume low adverse effects from one gear type, but high adverse effects from another. One commenter said that it is important to consider both differences between various gear types and the intensity of fishing effort.

Two commenters suggested that the analysis of gear effects include direct, indirect, and cumulative adverse effects of physical, biological, and chemical disturbances. One commenter suggested that adverse effects from foreign fleet fishing be included in the cumulative effects analysis.

Many commenters were concerned about the level of precaution needed for the protection of EFH. One commenter was concerned about how the concept of “adequate precaution” would be used in the analysis of fishing effects on EFH. Several commenters suggested that the level of precaution needed to protect EFH must be reasonable and warranted based upon the available scientific information and that mitigation measures not be overly precautionary.

4.3 Effects on Economics and Socioeconomics

Many commenters were concerned about the tradeoffs between economic costs and EFH protection. Also, many commenters were concerned that mitigation measures would result in reallocation of catch among gear types.

Many commenters were concerned about the potential adverse effects of the alternative actions on the human relationship to the fishery resource. Several commenters suggested that all alternatives analyzed in the EIS should minimize the potential adverse effects on the human relationship to the fishery resource. One commenter suggested that these effects be evaluated in the EIS.

Many commenters suggested that the cost of conducting EFH consultations be included in the economic analysis.

4.4 Effects on Ecosystems, Wildlife, and Other Non-targeted Marine Species

Several commenters were concerned about a variety of non-targeted species potentially affected by fisheries. These included Steller sea lions, northern fur seals, whales, albatross and other seabirds, herring, kelp beds, sea grasses, and gorgonian coral.

4.5 Regulatory Compliance

Several commenters were concerned that EFH amendments comply with requirements in the Magnuson-Stevens Act and other federal laws such as the Alaska Native Claims Settlement Act (ANCSA). Several commenters suggested that the preferred alternative in the EIS should meet the national standards identified in Section 301 of the Magnuson-Stevens Act.

One commenter was concerned that EFH description and identification could have an adverse effect on energy supply. It was suggested that a "Statement of Energy Effects" be prepared, as required by Presidential Executive Order (May 18, 2001).

5.0 OTHER ISSUES

Several commenters did not suggest an alternative, an effects analysis, or EFH fishing impact minimization measure. Their comments, therefore, are considered non-significant according to the NEPA definition of significance. Some of the following non-significant issues are, however, incorporated into the EIS (Section 5.1), whereas others are not (Section 5.2).

5.1 Other Issues to be Considered in the EIS

Several commenters did not suggest an alternative, an effects analysis, or a measure to minimize the effects of fishing, but their comments are, nevertheless, reflected in the EIS.

5.1.1 General Comments

Several commenters suggested that a full range of alternatives be considered in the EIS.

Several commenters suggested that specific types of information such as observer data, habitat data, gear impact information, ecosystem health, socioeconomic information, and specific reports or theses be included in the EIS.

One commenter requested that Senator Frank Murkowski's testimony to Congress on May 4, 2001, and a five-part series, from the Sacramento Bee, beginning April 22, 2001, be included as scoping comments. The series from the Sacramento Bee, which was quoted in Senator Murkowki's testimony, suggested that environmental advocacy groups slow down legitimate conservation efforts by focusing agency resources on litigation rather than biology.

5.1.2 NEPA Document and Process

Several commenters expressed a preference for either NMFS or the Council to lead the EIS process. Several commenters suggested that objective and unbiased scientists prepare the EIS analysis and management options. One commenter suggested that the following specific fields of expertise be included: biology, ecology, oceanography, and fisheries biology. Another commenter suggested that the EIS analysis not rely heavily on prior EFH and NEPA analyses and that conclusions be based upon the best scientific information available.

Several commenters wanted knowledge and experience from fishermen and local area managers to be included in the EIS. Several commenters were also concerned that all potentially affected parties, including both direct and indirect stakeholders, be provided with an opportunity to participate in the NEPA process.

5.1.3 Scientific Information/Research

One commenter suggested that the definition of EFH be backed with good science. Several commenters expressed concern about the data used for developing EFH descriptions. One commenter suggested that catch per unit effort (CPUE) data are inappropriate to use for developing EFH descriptions because the data may be confounded by regulations, bottom characteristics, and temporary aggregations that might not reflect essential habitat characteristics. Another commenter suggested that catch data from foreign fleets be used in the analysis. One other commenter suggested that bycatch data be considered in the determination of EFH.

5.2 Issues Not Considered in the EIS

The following issues are not considered within the EIS for one or more of the following reasons:

- The issue is outside the scope of the proposed action.
- The issue is irrelevant to the decision to be made.
- The issue suggests analysis at an inappropriate level of detail.
- The issue is conjectural and is not supported by scientific evidence.
- The issue suggests an approach that would be contrary to federal regulations.
- The issue is already decided by law, regulation, or a higher level decision.

5.2.1 Regulatory Compliance and Duplication

Several commenters were concerned that EFH descriptions would duplicate current laws and regulations, such as the following:

- The Endangered Species Act
- Clean Water Act
- State and local forest practices
- Mining, land use, and agricultural laws and regulations
- The Coastal Zone Management Act

Various laws and regulations (including the above) may be interrelated with requirements of the Magnuson-Stevens Act, and are discussed in the EIS insofar as they are relevant to the actions covered. Several commenters suggested that EFH descriptions should be made only to supplement existing regulations. Describing and identifying EFH is required by law, however, and potential duplication of laws was considered an issue that would not be addressed in the EIS.

5.2.2 General Comments

One commenter suggested that alternatives be limited to past actions considered by the Council. This approach would be contrary to federal regulations.

5.2.3 NEPA Document and Process

Many commenters were concerned about the type of NEPA document to be prepared and the process used to prepare the document and analysis. Several commenters suggested that the proposed EIS document was inappropriate. Several commenters suggested that an EA should be adequate and that the previously prepared EA could be used as the basis for preparing a new EA. One commenter suggested that an EIS was the appropriate document to prepare.

Several commenters suggested that the NEPA process should be delayed until the EFH guidelines are finalized.

Several commenters were concerned that NMFS was conducting private negotiations with the plaintiffs and circumventing the public NEPA process. Several commenters were concerned that the public and specific stakeholders and communities be included in the NEPA process. Several commenters were concerned about what roles the Council and NMFS would play in guiding the NEPA process.

5.2.4 Scientific Information/Research

One commenter suggested that the observer program and coverage be modified to include habitat monitoring. The structure of the observer program is outside the scope of this analysis, although habitat monitoring is discussed in the EIS.

5.2.5 Economic/Socioeconomics

One commenter suggested that subsistence use continue in MPAs.

One commenter suggested that the analysis specifically include the community of Knik, Alaska.

6.0 DETAILED SUMMARY OF COMMENTS AND ISSUES ADDRESSED IN WRITTEN COMMENTS RECEIVED DURING SCOPING

On August 13 and 14, 2001, the Council's EFH EIS Committee met to analyze and review the comments received on the scoping process for developing alternatives for the determination of EFH and the effects of fishing analyses on EFH. The Committee reviewed all the comments received and identified the key issues raised in each of the comments. In some cases the committee made a call as to whether they thought the issue was significant (yes/no).

Significant issues are used to formulate alternatives, develop measures to minimize the adverse effects of fishing on EFH, or analyze environmental effects. Issues are considered significant based on the extent, duration, magnitude, or intensity of the effect. The extent is the geographic distribution of the effects. The duration is the length of time the effect is likely to occur. The magnitude or intensity is the value of the effect relative to acceptable values and/or the intensity of interest or resource conflict.

In this section of the report the public comments are grouped into somewhat different categories than in Table A-2. The comments are grouped into the following four areas: comments regarding the identification, description, and characterization of EFH (Section 6.1); comments on the effects of fishing on EFH and measures to be considered to protect EFH and HAPC (Section 6.2); comments on the process by which NMFS is reconsidering EFH and conducting a NEPA analysis to examine the effects of fishing on EFH (Section 6.3); and summary of suggested alternatives that were received in scoping comments (Section 6.4). Public comments are described in detail within these four areas.

6.1 Comments Regarding the Identification, Description, and Characterization of Essential Fish Habitat

6.1.1 General Comments

Several commenters stated that the identification and protection of EFH should be focused on promoting ecosystem health and enhancing sustainable fisheries. They believe that these two objectives are fundamental to the Magnuson-Stevens Act and specific to the EFH provisions of the Sustainable Fisheries Act.

Several commenters referred back to the amendments to the Magnuson-Stevens Act in 1996. They cited the integral link between habitat, healthy fish populations, and sustainable fisheries, and indicated that Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." In addition to laying the congressional framework for EFH, the Magnuson-Stevens Act also mandates that the regional councils take action to ensure the conservation and enhancement of EFH. They further stated that the EIS must advance the description and identification of EFH as well as examine options to minimize the deleterious effects of fishing on EFH.

Many commenters agreed that the EIS should also include existing information on habitat types in the North Pacific and Bering Sea; gear impact assessments from published literature; the status of ecosystem health in various Gulf, Bering Sea, and Aleutian Island regions; and socioeconomic data on industry sectors and fishing communities

Several commenters believed that the support and enhancement of sustainable fisheries and the promotion of ecosystem health should be fundamental to the EFH process. They further stated that the Agency [NMFS] should focus on identifying a broad range of alternatives for protecting habitat, determining the need for additional fishing restrictions by evaluating the health and diversity of the surrounding ecosystem. The EIS for EFH should incorporate all existing information on habitat types and fishing gear habitat impacts (differentiating between various gear types and including information from the Groundfish DPSEIS). Additionally, the EIS management alternatives should be designed to accomplish specific objectives with a meaningful resolution of scale and at minimum cost to the industry. Finally, they continued to support the active involvement of fishermen and fishery managers in the HAPC/EFH process to ensure that management actions are well informed by local knowledge.

Some commenters specifically favored a stakeholder process whereby local input was provided throughout the development of the EIS.

Other commenters supported an ecosystem approach to the identification of EFH to further the scientific knowledge of managed fish species, benthic and pelagic habitats, and their ecological relationships.

The precautionary principle was mentioned many times. Most commenters indicated that NMFS must evaluate the effects of fishing on habitat, and take precautionary measures to protect sensitive habitat areas. They further stated that NMFS should move beyond single species management by looking at whole ecological marine communities and their long-term benefits for productive and diverse fisheries.

Many commenters thought NMFS should consider a management approach that uses tools such as MPAs, HAPCs, gear conversion, and spatial and temporal fishing closures, in conjunction with good science and community input.

6.1.2 The EFH Definition is Too Broad

Many commenters believed that the criteria for description and identification of EFH is overly broad. They recommended that, whatever criteria is used for identification of EFH, recognition be given to habitat that plays a "truly essential" role in fish populations and that sufficient scientific justification exists to allow meaningful analysis.

One commenter believed that the most important issue is the definition of EFH and urged the agency to adopt a definition of EFH that can be applied to specific geographic locations that are critical to the survival and reproduction of a target species.

Several commenters expressed concern regarding modifications to or "working definitions" of the current definition of EFH. Recognizing the broad language in the section of the Magnuson-Stevens Act that defines EFH, the commenters stated that there will undoubtedly be consideration of the establishment of a working definition of EFH. This was, in part, already attempted when the Council and NMFS developed a plan amendment to consider protection for certain areas referred to as "habitat areas of particular concern" (hereafter HAPC). While there may be a legitimate need to create a working definition of EFH, and some of the existing work on HAPC may be useful, commenters are concerned that proceeding down this path is not without significant pitfalls that should be recognized up front. While impractical to some extent, the current broad definition of EFH accurately reflects the lack of scientific data and information of how fish use habitat and how to prioritize habitat types and features in terms of meaningful concepts such as productivity, etc.

Given the existing Magnuson-Stevens Act definition of EFH, many commenters indicated that it is difficult to dismiss any marine habitat from the description and identification of EFH. They continued that "quite likely, every part of the ocean contributes to the spawning, rearing, or feeding of marine fish species." They further stated that clearly other strategies for designating EFH could be entertained (such as a habitat-based, rather than a fishery-based approach), but the actual description seems less important than the management decisions made in response to the description.

Several commenters indicated that, given the broad interpretation of EFH by NMFS (i.e, if all habitat is considered "essential"), then further criteria must be developed to discriminate between various habitat types to dictate appropriate management strategies. Although this level of discrimination may be more appropriate at the HAPC level, considering habitat categories as an alternative to the existing EFH description could provide a useful exercise and result in a more meaningful use of the EFH term.

Many commenters focused on the issue of limiting EFH to those areas that are "truly essential" to fish stocks and to activities that directly affect marine or estuarine environments within the purview of the FMPs. Land-based development, wetlands dredge and fill permits, upstream discharges governed by the Clean Water Act, and all other non-marine and estuarine activities should be excluded from NMFS' review. These commenters further stated that Congress intended this program to be a streamlined, voluntary, information-sharing process focused only on the most important fish habitat. Instead, it has evolved into a confusing, prescriptive regulatory program that encompasses all marine, coastal, estuarine, and significant inland waters.

Similarly, one commenter stated that each alternative should include explanations of why each area has been identified as EFH. This would include a detailed evaluation of marine habitat within the EEZ to see if it meets a test of being truly essential.

Several other commenters stated that the description of EFH should include the identification of all managed species' general distribution and core habitat areas.

Several commenters stated that areas should be ranked according to importance and priority [for protection] in the identification of EFH. However, these areas should not be exceed 20 percent of the fishing grounds.

6.1.3 EFH Should Focus on Marine Habitats Only

Many commenters representing non-fishing concerns stated that the EIS must identify and describe EFH through specific criteria that limit its extent to offshore marine or estuarine environments that are truly essential for fish the interim final regulations consider all habitat capable of sustaining fish as EFH, including inland waters far from the ocean). They further stated that the EIS must identify and describe EFH through specific criteria that limit the extent of the program to marine or estuarine environments within the EEZ. An overly broad approach on EFH unnecessarily impacts a wide range of fishing and non-fishing entities and activities with NMFS consultation.

6.1.4 Do Not Rely Solely on CPUE Data as Description and Identification Criteria

Many comments focused on the sole use of CPUE data to identify EFH. Generally, they agreed with the comments of the SSC (June 2001, Council meeting) that "using fishery dependent CPUE data to define which habitats constitute EFH is inappropriate because areas of high CPUE may reflect regulations, availability, fishable bottom, temporary aggregations, etc., rather than habitat critical to particular life stages." The commenters concurred with the SSC that "technical and scientific expertise is needed in developing new concepts for defining EFH and defining what habitats are essential to each species and in determining the effects of fishing on these habitats, including effects of gear types other than bottom trawls."

6.1.5 Alternatives for Describing and Identifying EFH and Mitigating Impacts Should be Non-allocative

Several commenters indicated that only non-allocative alternatives should be considered. They further stated that there is a very public effort by some to favor some fishing gears over others. The commenters believed that alternatives should be designed to minimize reallocative gains to existing participants. The most effective and fair way to accomplish this is to consider reallocation in the context of a rights-based fishery where an individual's historical catch rights would be retained, and would be able to be fished by vessels with allowable gear. This would make consideration of alternatives more allocation-neutral and would allow for fair treatment for those forced to exit or reduce participation in the fishery because of gear specific closures.

Another comment also emphasized that only "non-allocative" alternatives should be considered when determining alternatives for minimizing impacts to EFH or for designating EFH.

One commenter stated that "the EFH EIS process is an open invitation to gear wars in which the industry will attempt to reallocate access to the resource through claimed environmental salubrity, real or imagined."

6.1.6 Status Quo EFH Description is Adequate

One commenter supported the status quo, Council approach in designating EFH for its groundfish species. They suggested that this is a precautionary approach that is consistent with the EFH Interim Final Rule and has been approved by NMFS. Existing EFH descriptions should not be significantly modified unless the best scientific information available supports such a modification. Presently, it is unclear whether NMFS and the Council have obtained additional data to refine these EFH descriptions, consistent with the process outlined in the EFH Interim Final Rule. They further stated that significant modification of EFH would take considerable time and resources and would divert the Council from addressing the primary reason for the preparation of these EISs—to assess the effects of fishing on fish habitat and the marine environment and identify and implement measures to minimize these effects.

Another commenter favored the status quo on any EFH description until impacts of and changes can be considered.

A couple of commenters believed that we should remain at status quo until we have better management tools, or a research program that would direct us to a different description of EFH than that already in place.

Several commenters recommended a range of alternatives based on a different interpretation of the scientific baseline about what is known about trawling and the applicability of existing information to the trawl fisheries off Alaska than the one used for Section 3.2 of the draft groundfish Programmatic Supplemental Environmental Impact Statement (DPSEIS). We [commenters] feel that there is no deficiency in the status quo measures to protect EFH off Alaska.

Another commenter took a different approach and disagreed with previous commenters on “status quo” stating that “in the past [i.e., status quo], NMFS and the Council have not taken a precautionary approach in its management of these fisheries toward protection of the marine environment or the protection of fish habitat. Instead, both NMFS and the Council have repeatedly delayed taking anticipatory conservation action claiming inadequate science of a casual relationship between fishing practices, habitat damage or destruction, and effects on a commercially-managed fish species.” The commenter continued also stated that the Council and NMFS failed to properly analyze and fully disclose known and predictable environmental effects of proposed actions and reasonable alternatives, in both required environmental analyses under NEPA or in FMP amendments. Rarely, has NMFS or the Council properly considered or implemented measures for the primary purpose of habitat protection. They further stated that management measures, like harvest incentives to low-impact gears, gear modifications to reduce the ability of gears to access sensitive habitats, and area-based gear management to protect important habitats from other gears, seem intuitive, but, as yet, still remain to be implemented. Such an approach, combined with the present policy of allowing fishing to occur throughout state and federal waters (with the exception of effort and bycatch limitations), is the antithesis of precautionary and poses a serious risk to EFH and the marine environment.

6.1.7 Ecosystem Approach to Describing and Identifying EFH

Many commenters advocated an ecosystem approach to describing and identifying EFH. One commenter recommended that NMFS examine the document entitled “Ecoregion-Based Conservation in the Bering Sea: Identifying Important Areas for Biodiversity Conservation” and consider protecting the areas cited in that document as unique ecoregions within the region.

These commenters continued by stating their belief that humans have to be included in the Ecosystem Formula Genuine ecosystem-based management must incorporate people as a legitimate part of the ecosystem. As required under NEPA, the environmental impacts on the relationship of humans to the resource must be included in the EIS. Neither NMFS nor the Council may simply ignore issues such as sustained participation of fishing communities or the goal of achieving optimal yield. After all, one of the purposes of the Magnuson-Stevens Act’s conservation mandate is to sustain long-term harvests of fisheries resources. The commenter(s) support the inclusion of the “human relationship to the resource” as part of the EIS.

Several comments focused on ecosystem links and the protection of food webs. One commenter stated that “sealions are linked to a stable and growing herring stock. All efforts must be quickly organized to sustain and enhance this vital link of the ocean ecosystem.” NMFS assumes that the comment supports the analyses of a ecosystem-food web approach to protecting EFH.

Several commenters generally did not support the inclusion of alternatives that, on their face, do not seek to minimize the potential adverse effects on the human relationship to the resource as required under NEPA and the Magnuson-Stevens Act. They further stated that alternatives that do not meet this test are a waste of time for both the analysts and the public.

Many commenters favored an ecosystem approach to defining EFH that identified habitat associations, species distribution and ecosystem mechanics, accounting for the species’ various life stages and habitat requirements for reproduction, growth, dispersal, adult distribution, and trophic interactions. However, they recognized that, in many cases, present scientific knowledge is not advanced enough to detail all these components. This is not a minimum standard to ascertain before EFH description and identification, but a goal to strive toward. It is necessary to further biological research while using the best current information to identify EFH. As the scientific understanding of habitat associations and species distributions progresses, EFH can be reassessed.

6.1.8 Zero-Risk Approach to EFH Description and Identification and Managing Effects of Fisheries on EFH

Several commenters did not support a zero-risk approach to EFH description and identification or to fisheries management. They stated that under that approach, the burden of proof would shift to the fisheries management system to prove that fishing activities do not have adverse impacts on the resource or the ecosystem before they could be authorized.

6.2 Comments on the Effects of Fishing on EFH and Measures to be Considered to Protect Essential Fish Habitat and HAPC

6.2.1 General Comments

Several comments focused on general recommendations for a gear impact assessment on EFH stating that the Magnuson-Stevens Act and the EFH Interim Final Rule require that fishery management councils and NMFS minimize adverse effects on EFH from fishing activities to the extent practicable. The commenter stated that according to the EFH Interim Final Rule, “adverse effect” means “any impact which reduces quality and/or quantity of EFH. Adverse effects may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.” They continued that it states that “fishing activities that adversely affect EFH may include “physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem.” The commenter concluded by stating that the Councils should minimize adverse effects if there is evidence that a fishing practice is having an identifiable adverse effect on the EFH.

One commenter stated that “in no way will an EFH assessment alone address the requirements of NEPA, as NEPA requires a much broader analysis of the effects of fishing on the marine environment.” Consistent with these requirements, the commenters urged NMFS and the Council to include a full analysis of the effects of fishing on EFH and the environment and not rely heavily on prior EFH analyses and NEPA analyses. They stated that prior environmental and EFH analyses are inadequate. This assessment must include a full and objective analysis of both environmental and EFH impacts for each gear used in these fisheries and must be based on the best scientific information available. Most important, the analysis should focus mainly on applying existing scientific data to predict the short- and long-term effects of each fishing gear on EFH in the affected area of each fishery. Where data are limited, the EIS must evaluate whether that information can be obtained and how long it may take to obtain necessary information. More important, the EIS must evaluate the risk of environmental harm caused by continuing existing fishing practices until that information is available.

6.2.2 Effects of Specific Gear Types on EFH and Gear Conversion, Gear Modification, and Gear Incentives as Means to Minimize the Effects of Gear on EFH

Several commenters focused on gear modification or conversion as a means to reduce effects of gears on habitat. They suggested that rockhopper and roller maximum-diameter size restrictions be evaluated by NMFS and the Council gear and a maximum-diameter size limit on rockhopper and roller gear in the groundfish fisheries be implemented to prevent trawling in the most complex habitats.

Parallel components to the identification of EFH are research on the effects of fishing gear on habitat and mitigation of those effects in sensitive habitat areas. Several comments focused on the mitigation of the effects of fishing gear. They stated that this should include habitat restoration and protection, but emphasized that habitat protection does not require a prohibition on all fishing. Rather, it means a prohibition or modification of fishing practices that harm EFH.

Several commenters suggested that once EFH and HAPCs are identified, steps should be taken to protect these sites from damaging fishing practices. In areas identified to exhibit ecosystem stress or direct and lasting damage to EFH from fishing practices, measures must be taken to alleviate these effects. Alternatives to consider for the protection of EFH are status quo or no net increase in fishing effort, gear modification, gear restrictions/allocations to promote gear conversion, closures to all or a significant amount of bottom fishing (for the protection of benthic habitat), or full area closures (for the protection of pelagic and benthic habitats).

One commenter referenced Alternative 5 in the DPSEIS which focuses explicitly on reducing the adverse effects of bottom trawling on benthic habitats through the use of area restrictions, gear allocations, gear restrictions, and gear modifications. The DPSEIS predicts dramatic declines in the catch of coral and sponges under Alternative 5, but an increase in the catch of anemones, sea pens, and sea whips, due primarily to increased effort by the use of longline gear (DPSEIS 4.7 to 14; 4.7 to 24).

One commenter recommended that NMFS develop an alternative in the EFH EIS, similar to Alternative 5 in the DPSEIS; i.e., the agency should weigh the potential benefits of increasing gear conversion to pots. This may alleviate some unintended increases of the bycatch of HAPC biota as predicted with longline gear. They stated that a shift to pelagic trawls may alleviate damage to benthic habitats, but it is important to consider that pelagic trawls often contact the seafloor, damaging habitat with dragging footropes. They also stated that unobserved habitat damage and species mortality have to be considered when assessing gear impacts. For example, gear impact analysis should evaluate practices that reduce habitat complexity, unobserved mortality of both commercially viable species and other marine life valuable to the ecosystem, and damage to habitat and epifaunal species from sediment suspension and distribution.

Several commenters recognized that it is important to delineate between various gear types and intensity of effort. This includes consideration of the degrees of impact within a gear type (fishing methods and gear modifications) and the impacts of different gear types, from jigs and trolling to bottom trawling and dredging. Several commenters suggested that some habitat areas cannot sustain healthy fish populations with certain fishing practices and intensities, but can sustain gear types that have less impact.

One commenter was particularly concerned about the adverse effects of mobile gear on sea floor habitats and stated that the effects of bottom trawling include direct damage to sensitive habitat areas by crushing corals and sponges, overturning boulders, or introducing suspended sediments, toxins, and nutrients into the water column by plowing and scraping the sea floor. Commenters stated that the protection of EFH from fishing impacts must consider the direct and indirect impacts on marine communities by both benthic and pelagic trawls.

One commenter stated that NMFS should analyze the impact that foreign longlining and trawling had on all identified EFH and HAPC in the GOA and BSAI.

Several commenters stated that the trawl fleet has to be reduced and more controlled. The comment(s) targeted a reduction of the larger, more powerful, vessels.

One commenter focused on crab populations stating that it is important to recognize that major crab populations in the EBS and GOA have collapsed (red king crab, bairdi tanner, and opilio crab). Therefore, the EFH EIS must look closely at the effects of bottom trawling on crab habitat. The commenter continued on by stating that the Bristol Bay pot sanctuary was closed to trawling from 1959 until the early 1980s. This sanctuary protected important habitat for red king crab, as well as halibut. The development of the domestic trawl fleet for cod and other bottomfish may have played a role in the inability of red king crab to recover to precollapse levels. The EFH EIS must look at near-term, long-term, direct, indirect, and cumulative effects of bottom trawling on crab habitat.

Another commenter stated that both fisheries [groundfish fisheries] continue to rely predominately on bottom-tending mobile gears that dramatically disturb and alter tens of thousands of square nautical miles of seafloor habitats annually off the coast of Alaska. Certain EFH, like Pacific cod EFH and rockfish EFH, is clearly being adversely affected. Allowing such fishing practices throughout federal and state waters exposes many other EFH to adverse effects by these fishing practices. This commenter continued by stating that "as required by both NEPA and the Magnuson-Stevens Act, NMFS must identify a full range of alternatives to minimize the effects of these fisheries on EFH and the environment. NMFS and the Council must identify and implement a full range of measures to sufficiently protect EFH from the effects of fishing gears."

One commenter focused on harvest incentives for low-impact gear use, emphasizing the distinction between mobile gears (high-impact) and fixed gears (low-impact). Commenters believe that NMFS and the Council must reexamine their dependence on bottom-tending mobile gears and use existing fishing practices that have low impacts on EFH and the environment. For species like rockfish and Pacific cod where fixed fishing gear is an alternative to bottom-tending mobile gear, trawl gear should be prohibited from targeting those species. In cases where there are no alternatives to using trawl gear, trawl gear must not be permitted to use rockhopper gear, large roller gear, or chafing gear, as these gear modifications allow trawlers to target and destroy important complex habitats. The commenter also believed that the Council should analyze the use of incentives such as allowing exemptions in sensitive habitat areas if a particular fishing practice or gear type is shown not to be detrimental to habitat. Further, the Council should create incentives for fishermen to switch voluntarily from habitat-disrupting gears to more low-impact gears, such as hook and line and pots.

Other commenters also recommended a conversion from bottom trawling to lower impact gears to lessen the footprint on the ecosystem.

One commenter stated that, given the size of the Bering Sea pollock fishery and importance of squid to protected marine mammals (northern fur seal, sperm whale), as well as the endangered short-tailed albatross and other non-breeding albatrosses that forage in these waters, a year-round pelagic trawl closure area would provide effective protection to squid and benefit other pollock predators that converge on these variable but predictable “hotspots” of high productivity in areas of strong, persistent upwelling over the continental slope or shelf break, at the boundaries of different water masses, and at the heads of marine canyons or edges of gullies.

6.2.3 Habitat Areas of Particular Concern

Many comments focused on the identification of HAPCs. One commenter stated that in categorizing habitat and identifying HAPCs, the following factors have to be taken into consideration: vulnerability or resilience to disturbance, ecological function, and rarity or uniqueness. The commenter further stated that these three categories follow the HAPC guidelines currently under development by the Council. Examples of each habitat type include gorgonian corals (recognized as highly vulnerable to disturbance), the EBS ice edge (an ecologically productive area critical to the productivity of a large geographic region), and the Sitka Sound Pinnacles.

Two commenters offered opinions on approaches to managing HAPCs by stating that once an area is identified as a HAPC, management alternatives should be evaluated in the context of ecosystem health and diversity under current fishing practices. If the ecosystem within and immediately surrounding a HAPC is robust, management alternatives should be limited to status quo or a policy of no net increase in impacts (from fishing gear or other sources) until additional information indicates the need for more precautionary measures. If signs of ecosystem stress are apparent, either in targeted fish species or other ecosystem components, then alternatives should include gear modifications (e.g., limits on pot lifts, net size and longline sets, reduced frequency of impact, prohibition of on-bottom trawling, etc.), gear zones (e.g., Alternative 5, DPSEIS: restricting high impact gear to less vulnerable habitat), and closures to all groundfish or bottom fishing. Where negative impacts of a certain gear type are known, and alternative gear types are available to harvest a given species in a HAPC, management measures should mandate either an immediate or a phased-in transition to the lower-impact gear.

Several comments supported the creation of a systematic and effective HAPC identification process. They stated that it is likely that habitats exist in each region that meet at least one of the criteria for HAPC identification: 1) the habitat provides an important ecological function; 2) the habitat is sensitive to human-induced environmental degradation; 3) development activities are, or will be, stressing the habitat type; or 4) the type of habitat is rare. The commenter further stated that the Councils should be required to identify HAPCs in its EFH amendment or, at least, provide proposed research measures that the Council will take that are necessary to identify areas as HAPC.

One commenter suggested that designating a habitat type as HAPC will call attention to the important properties and functions of such habitats and will also include a minimum set of protections to protect these sensitive habitat types. Commenters stated that the Council should identify HAPCs for all groundfish, even though many EFH descriptions remain based on Level 1 data—distribution and abundance. They stated that one approach the Council can take is to identify those areas within a species’ EFH that have historically contained the highest abundance levels of a particular stock as HAPCs. High abundance of fish in these areas provides sufficient evidence to meet the first HAPC criteria on: these habitats provide some important ecological benefits. Such areas likely represent core range areas for a particular species and likely contain those habitat characteristics that provide maximum value for a fish species.

One commenter supported efforts to identify HAPC in a precautionary manner. Of course, adequate measures must be implemented along with the HAPC identification to ensure they actually protect the sensitive habitat within the HAPC.

One commenter recommended that HAPCs be used as an additional tool for the protection and identification of EFH. HAPCs are areas of EFH that require added protection from deleterious effects. The commenter emphasized that HAPCs are not stand-alone measures to protect habitat and species associations, but a component of a much larger area that is carefully managed for EFH and a healthy, diverse ecosystem.

One commenter emphasized that HAPCs should be subsets of the total essential habitat needed to support healthy fish populations and should not be considered all that is required for EFH.

One commenter requested HAPC identification for the Knik area, stating that proposed activities in the upper inlet pose risks greater than can be accommodated with mitigation measures.

One commenter indicated that one issue of concern that had to be brought to the attention of NMFS was the resolution of scale in designing HAPC areas and management measures appropriate to those areas. The technology exists to define habitat areas in very specific terms, outlining canyons or pinnacles where corals exist, or specific shell hash beds essential to juvenile crab. The commenter and others stated that they cannot accept closing 20 nautical mile blocks because a corner of that block contains coral when the technology exists to accomplish habitat protection with far less disruption to the industry. Facilitating enforcement is poor rationale for imposing unnecessary costs on the industry. HAPC areas should be designed to accomplish clearly defined habitat objectives with the least disruption to local fishing fleets.

6.2.4 The Use of the Precautionary Principle and Uncertainty in Habitat Management

Many comments focused on the issue of precautionary management. One general comment indicated that fisheries managers in the North Pacific face the obstacle of uncertainty when assessing stock biomass and assigning catch limits. The use of precautionary management has generally been applied to reducing fishing mortality. Now fisheries managers must expand precautionary management to incorporate the uncertainties of managing for the ecological relationships of target species and their habitat requirements. This will entail incorporating the biological requirements of not only target species, but those of associated species as well, including upper and lower trophic animals. Precautionary habitat management should be viewed in an ecosystem context that considers species interactions, environmental changes, and scientific uncertainty.

One commenter stated that to develop a means for assessing habitat in the face of uncertainty, it will be wise to use inferential information regarding habitat value. Habitat value can be inferred from species diversity, abundance or rarity, physical structures, sediment types, depth and temperature gradients, and physical processes such as ocean currents, gyres, and upwelling. EFH must be analyzed beyond presence/absence data from trawl surveys and catch data.

One commenter stated that it is clear that a precautionary strategy for habitat management is needed as researchers study the effects of fishing on EFH. The commenter stated that “to avoid making errors that may cause long-term damage to habitat or a decline in species abundance and diversity, managers must take heightened precaution to ensure protection of habitat and species assemblages. To do this, quantitative thresholds of uncertainty should be implemented that weigh potential economic and ecological costs against present understanding of the effects of fishing on habitat and species diversity.” For example, when considering a fisheries plan to allow trawling for flatfish in the Bering Sea, managers have to consider lost economic opportunities that may occur due to the breakdown of ecological functions of damaged habitat, or future regulations that would limit fishing due to the decline of another target species, such as tanner crab. The impact of one fishery may adversely affect other fisheries by damaging habitat or endangering other target species.

With regard to uncertainty, one commenter stated that determining the levels of uncertainty should not be arbitrary, but should have clear and quantifiable standards for assessing fishing impacts, current scientific knowledge of the target species, and knowledge of other ecosystem components that may be affected by the fishery.

One comment stated that the Council should develop a precautionary management approach to protecting EFH in Groundfish Amendment 10 and Scallop Amendment 13.

One comment stated that a precautionary management approach to protecting EFH in both groundfish fishery management plans is consistent with the prevalent themes of sustainability and risk-averse management in the Magnuson-Stevens Act in protecting EFH, preventing overfishing, and achieving optimum yield. The commenter also stated that "it is consistent with the requirements of the EFH Interim Final Rule. As NMFS has stated in its response to comments on the Interim Final Rule, "care should be exercised in the face of inadequate information or overfished stocks to guard against habitat losses or alterations that may prove significant to the long-term productivity of the species."

One comment stated that a precautionary approach is also consistent with sound conservation principles adopted by the United States in signing the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea (U.N. Agreement) relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

One commenter stated that a precautionary approach should include the following four components: (1) preventative action to protect habitats should be taken in advance of scientific proof of causality; (2) the proponent of an activity, rather than the public, should bear the burden of proof of showing that a fishing practice or gear will not result in environmental harm; (3) a reasonable range of alternatives, including a no-action alternative (for new activities) should be considered when there may be evidence of harm caused by an activity (required already under NEPA); and (4) for decision-making to be precautionary, it must be open, informed, and democratic and must include all potentially affected parties, including indirect stakeholders. The commenter stated that such an approach has been adopted by the U.S. and numerous individual states in their regulation of practices where data are limited as to effects on the environment.

One commenter stated that the Council should also adopt a precautionary management approach toward EFH management in both the groundfish and scallop FMPs.

Several commenters indicated that the precautionary approach would 1) minimize adverse effects to EFH and the environment via timely implementation of protective measures rather than exacerbate environmental harm by delaying necessary conservation measures, 2) reduce the risk of serious or irreversible harm to certain habitats, and 3) foster innovation among resource users which would likely lead toward lower-impact fishing practices and reduced waste.

One commenter stated that the draft groundfish DPSEIS admits there is currently a lack of scientific information on the link between potential or observed habitat effects off Alaska and ecosystem function and fisheries productivity. Page 4.7-39 of the DPSEIS states as follows:

> "In conclusion, the linkage between fishing and habitat characteristics is not known with great precision for Alaskan fisheries. The absence of fish stocks below their minimum stock size thresholds (Section 4.4) implies that the status quo fishery has not had significant impacts on the productivity of stocks in the BSAI and GOA (SPEIS page 4.7-39)."

The commenter suggests that this admission reflects the fact that there is no real evidence that there is a problem with the current measures in place to protect EFH in the North Pacific. It is undoubtedly true that all fishing gears that tend bottom somehow modify benthic habitat, and in some cases the effects have been described. That some sorts of changes associated with fishing can be detected off Alaska does not mean the changes are necessarily "big" or "bad" for the ecosystem. For example, it is not clear whether the observed small differences between unfished and heavily fished areas in the EBS (as cited in McConnaughey et al. 2000) are ecologically significant. Furthermore, it may ultimately be more important to estimate effect sizes and use these to determine the levels of fishing intensity that may be sustainable for a given habitat. For this reason, we [commenters] are concerned about taking steps that may not be warranted. Further, we are concerned that there is no scientifically credible way to correlate observed or hypothetical effects with the resulting potential downstream reduction in ecosystem function or fishery productivity. The commenters recommended that NMFS proceed cautiously with the process of considering changes in the existing management regime to protect EFH off Alaska. This caution is also recognized in the Magnuson-Stevens Act's requirement to minimize effects of fishing on EFH "to the extent practicable." Poorly conceived measures may actually concentrate fishing effort, possibly creating problems that did not exist before. This precaution has to be explicitly built into proposed management measures, particularly where the health of fish stocks does not suggest any deficiency in the existing habitat protections in the groundfish fisheries off Alaska. Further, if it is deemed that additional measures must be considered for implementation and experimental designs and controls should be incorporated to gain information on the efficacy of such measures, therein avoiding some of the problems encountered in dealing with the sea lion issue.

Similarly, a commenter stated that "due to the absence of scientific research off Alaska or anywhere else, comparative studies of effects of different fishing gears on fish habitat are not available." This fact is clearly acknowledged in the draft groundfish DPSEIS. Despite this, some environmental groups and a few industry groups are likely to recommend analysis of proposals based on the supposed "differential impacts" of fixed gears relative to mobile fishing gears. If such differential impacts have not been evaluated scientifically, this analytical process has to employ safeguards to prevent arbitrary determinations and unjustified actions. This matter is of great concern because we have observed a double standard in the DPSEIS when it comes to application of a precautionary approach. For instance, the DPSEIS proposes options to greatly restrict trawling, and much of the rationale for taking this action revolves around what may or may not be known about trawl effects. In this situation, the precautionary approach is used as an argument to impose extensive restrictions on trawling in order to be "risk averse." By comparison, the DPSEIS openly admits that scientific studies on the effects of fixed gears are not available and no studies of comparative effects have ever been undertaken. Despite this, the DPSEIS somewhat arbitrarily proposes options to increase fishing allocations to fixed gears with virtually no recognition of the unknowns or adherence to the need to be precautionary in face of limitations in scientific information. In consideration of available evidence, we feel that a reasonable and fair standard has to be applied for the use of the precautionary approach regarding effects of all types of fishing gear. Given the path taken in the DPSEIS, we would like to avoid making the same mistakes for this action. Commenters further recommended that "until a better scientific foundation is available, a reasonable and fair standard of precaution should be adopted to evaluate effects of all options and all bottom tending fishing gears. Such a standard promotes fairness in this process, keeps the process focused on habitat protection rather than allocation, and is the most scientifically defensible course of action. Further, the mandate to minimize habitat effects of fishing gear to the extent practicable implies that a balance between economic and social concerns and habitat benefits must be made in the application of an approach to being precautionary. The practicable test is particularly important for the fisheries off Alaska because fish stocks are healthy and there is no evidence of a habitat problem."

6.2.5 NMFS Should Review and Analyze Existing Measures Taken to Protect Habitat

One commenter was concerned that once-productive and diverse marine habitat areas are now so altered that the original species complex no longer exists in its former abundance. This emphasizes the need for a baseline when considering an effects analyses.

Several commenters indicated that the Council has had a comprehensive policy on habitat protection since 1988, long before passage of EFH requirements. The objectives of this policy are to maintain the current quantity and productive capability of habitats and to restore and rehabilitate habitats previously degraded. Consistent with that policy the Council has taken several measures to protect habitat, including measures to protect crab habitat and other habitat protections that have resulted in the year-round closure of approximately 20 percent of the BSAI and GOA fishing grounds to trawling. Some of these commenters further stated that, in addition, the Council has implemented seasonal fishing restrictions to protect herring, crab, and salmon and has prohibited the commercial sale of sponges and coral and closed the Cape Edgecomb pinnacles to all fishing.

Another commenter reemphasized this point by stating that several comments stated that the Council, in conjunction with NMFS, has taken a number of actions over the years to protect habitat, for example, the implementation in 1998 of a no trawl zone east of long. 140° W. The Southeast Alaska trawl closure was enacted 1) to protect sensitive habitat from the impact of trawling and, 2) to protect and enhance fishing opportunities for the community-based fisheries of Southeast Alaska. The commenter maintained that the health of the Southeast ecosystem and the socioeconomic health of the southeast fisheries bear testimony to the effectiveness of this closure. A second closure to all bottom fishing on the Sitka Pinnacles was also designed to achieve a very specific objective and excluded only those gear types necessary to achieve the management objective. Of perhaps most importance was the statement that, in the above cases, the management actions were successful because they both relied on clearly defined objectives, good data, appropriate resolution of scale, involvement of local stakeholders, and differentiation between gear types. The commenter strongly recommended that these guidelines be adopted by NMFS for future HAPC actions.

One commenter stated that for purposes of mitigation [NMFS should] identify all current areas that are closed to trawling, to be analyzed [as actions already taken to protect EFH].

Several commenters recommended that NMFS include all protective measures now in place when determining whether more measures have to be taken to protect habitat.

One commenter suggested that existing protected areas were developed for a variety of purposes. They protect some species some of the time and by default protect some habitat types. Scientific analysis and peer review are needed to determine the extent and effectiveness of current protection.

Another commenter stated that status quo and past management efforts focused on effort reductions and protected species bycatch, not on habitat protection. While effort controls implemented during this time may have some incidental benefit to habitat, it is unlikely to expect that they "minimize EFH impacts" because existing management measures were neither designed for habitat protection, nor for minimizing a particular threat to habitat. The commenter continued by stating that the lack of a focused management effort to reduce impacts by fishing to habitat is seen in both fishery management plans by 1) no comprehensive approach to protect adequate portions of all marine habitat types, 2) minimal use of area-based gear restrictions and restriction on gear modifications for the purpose of protecting fish habitat, 3) minimal use of incentives to promote low-impact fixed gears, 4) a continued "open-ocean" policy for trawling in areas known to contain complex habitats and/or sensitive benthic megafauna like sponges and deep-sea corals, and 5) a lack of any protections to offshore marine habitats and deep-sea canyons.

The commenter continued by stating that, in passing the 1996 Sustainable Fisheries Act, Congress agreed that fishery managers must make protecting marine habitats from fishing and non-fishing activities a priority in their management of fisheries nationwide. The commenter continued by stating that both NMFS and the Council have continued to take minimal steps to protect EFH in the North Pacific from fishing practices occurring in both groundfish fisheries. The commenter continued to state that NMFS, therefore, must take sufficient action in both of its groundfish fisheries to ensure that these fisheries are managed properly to minimize their potential negative effects on EFH and the marine environment. NMFS must take an aggressive approach to protect EFH and the marine environment by implementing measures including no-take marine reserves, area-based gear restrictions, and other gear modifications to effectively accomplish this goal. The commenter continued by stating that the Council has taken numerous actions in the past that promoted expansion of bottom trawling into areas that were previously closed prior to the 1980s. These actions, while promoting the growth of American fleets, had significant impacts on sensitive habitats, known to be essential to crab, salmon, and other groundfish species. Furthermore, the Council has continuously postponed taking action based on existing scientific evidence of significant disturbance to habitats by bottom-tending mobile gears with claims that more scientific research was necessary. When new technologies developed that potentially threatened marine habitats, i.e., rockhopper gear, chafing gear, or rock chains, the Council took little to no action to restrict these developments.

Several commenters believed that relying solely on existing measures [measures in place] is unlikely to minimize fishing effects to EFH. They urged NMFS and the Council to identify and analyze the environmental benefits of a broad range of alternatives to minimize the effects of fishing gears on EFH.

6.2.6 Marine Protected Areas, Marine Reserves and Marine Refugia as a Means to Protect EFH

One commenter stated that marine protected areas (MPAs) are becoming increasingly mentioned as a valuable management tool to protect marine areas from damaging fishing practices, pollution, or development. In addition to protecting species and habitat within the designated area, MPAs can have positive ecological effects outside of their boundaries by acting as productive nurseries and fueling species distribution at juvenile and larval life stages. Permitted activities within the MPA may also benefit from ecological conservation measures.

One commenter stated that the identification of MPAs should be considered both as a means to protect EFH and HAPCs from damaging fishing practices and as a way to sustain commercial fishing. They further stated that the waters off the coast of Alaska already have a number of places that meet the definition of an MPA. The places range from the Bristol Bay Red King Crab Savings Area to the large Southeast Alaska trawl closure, the Sitka Pinnacles, and Steller sea lion critical habitat areas. With the exception of the Southeast Alaska trawl closure, current year round closures do not include a wide range of habitat types and depths necessary to protect the range of managed species. Proposed MPAs for the conservation of EFH and HAPCs should be established with explicit objectives on an appropriate scale, using the best available data.

Another commenter believed that there is strong scientific justification for protecting key EFH in a network of marine reserves. The commenter paraphrased a 1998 report to Congress [the Ecosystem Principles Advisory Panel to NMFS] recommending that fishery managers consider and evaluate the potential benefits of marine protected areas for promoting ecosystem-based management. The panel pointed out that such protected areas can range in size and degrees of protection. Prohibitions in some areas may remain in effect year-round, while in others they could restrict activity only during certain times, for example, when fish are spawning.

The same commenter stated that there “is compelling scientific evidence that marine reserves conserve both biodiversity and fisheries, and could help replenish the seas” and “marine reserves work and they work fast. It is no longer a question of whether to set aside fully protected areas in the ocean, but where to establish them.” They cited the results of a 3-year study which underscored the effectiveness of marine reserves in protecting not only fish, but also fisheries. The study showed that after just 2 years of protection, marine reserves produced results that were both startling and consistent. Among the findings are the following: fish population densities were an average 91 percent higher; biomass was 192 percent higher; average size of organisms was 31 percent higher; and species diversity was 23 percent higher. Furthermore, the size and abundance of exploited species increased in areas adjacent to the reserves because “reserves serve as natural hatcheries, replenishing populations regionally by larval spillover beyond reserve boundaries.”

One commenter recommended that NMFS establish a timely process for identification of a network of marine reserves in the EBS. The same commenter stated that, unfortunately, fully protected marine reserves are often perceived by the fishing community as locking up the seas and limiting fishing opportunities. Thus, they are often vigorously resisted. The commenter concluded, however, by stating that “protection of EFH in a network of marine reserves will be essential to achievement of the most worthy goal in marine conservation.”

One commenter stated that the only pelagic areas in the North Pacific currently afforded some level of protection from groundfish fisheries are portions of the designated Steller sea lion at-sea foraging habitats in the Shelikof Strait and parts of the sea lion conservation area (SCA) off the eastern Aleutian Islands. Both areas are major pollock spawning grounds. The commenter further states that NMFS’ current DPSEIS acknowledges that existing trawl closure areas do not encompass pelagic habitats. The commenter states that there are generally no area restrictions in the deeper waters that encompass the outer continental shelf and upper slope of the central and western GOA and BSAI.

One commenter stated that the “Horseshoe” area near Unimak Pass, Pribilof Canyon (south of St. George Island), and Zhemchug Canyon (northwest of St. Paul Island) would make ideal pelagic MPAs. The productive upwelling zones contain shelf-break bathymetry and are major fishery target areas, as well as areas of high squid bycatch. These are also foraging areas for albatross, murres, kittiwakes, puffins, auklets, etc. They further stated that the area encompassing the Horseshoe near Unimak Pass is also in designated Steller sea lion aquatic foraging habitat and is a major migratory route and foraging ground for many species of marine mammals and birds. Pribilof Canyon, south and west of the Pribilof Islands, is prime northern fur seal and seabird foraging habitat. The commenter concluded by stating that pelagic protection zones would accomplish multiple goals for mammal, seabird, and fish habitat conservation and would reduce bycatch of species such as squid which occur primarily in these areas.

One commenter supported the development of marine wilderness areas. As described, the commenter would support the identification of a network of marine refuges that encompass the major representative habitats found in coastal and offshore areas off the North Pacific coast. The commenter stated that presently, no such extensive network of marine reserves exist in the North Pacific or nationwide; they are long overdue, and managers should quickly proceed to develop them in all major habitat types. Such areas are necessary for the protection of overexploited rockfish stocks, sensitive habitats, and marine diversity and regional ecosystem processes, as well as acting as a buffer against significant environmental damage due to commercial fishing and other fishing practices. Marine refuges can also be used for baseline areas for comparative habitat and marine diversity studies.

One commenter cited a study that noted that concentration[s] of fishing fleets in patchy, relatively discrete areas of enhanced productivity concentrates the associated ecological impacts of fishing; e.g., localized depletion, bycatch, lost gear, discard wastes, disturbance, and ship strikes. Given the persistent and predictable features of upwelling zones over shelf breaks, submarine canyons, seamounts, gullies, boundaries of water masses, etc., the commenter, therefore, supported creation of pelagic no-fishing marine reserves for these areas as a tool to ensure conservation of pelagic species and fishery resources.

One commenter suggested designing artificial reefs to enhance habitat.

One commenter indicated that "the strong concordance between nekton species assemblages and water column properties provides an effective foundation for the design of large-scale dynamic MPAs defined by water column properties."

Several commenters stated that year-round closures should be considered actions of last resort.

Concerns were expressed in at least two comments regarding the ecosystem effects of harvesting of kelp and herring on trophic webs and prey availability, especially salmon.

6.2.7 The Need for Better and More Complete Observer Coverage

One commenter stated that nearly 1,000 species are caught as bycatch in the North Pacific, many of which are poorly documented, and their ecological value is poorly understood. Observer coverage could be modified to more closely monitor habitat identification. It is, however, crucial to recognize that although bycatch may be a strong indicator of habitat damage, many other fishing gear effects are not observed from the deck of a ship.

6.3 Comments on the Process by which NMFS is Reconsidering EFH and Conducting a NEPA Analysis to Examine the Effects of Fishing on EFH

6.3.1 Involve Stakeholders in the Process

Some commenters supported an active involvement of coastal community stakeholders to identify measures that have a direct economic benefit to individuals and businesses that are dependent on the fishing fleet. They further stated that community-based involvement recognizes the diverse interests and high expectations of all participants, such as harvesters, processors, residents, and consumers.

Hold stakeholder meetings when designating EFH.

EFH regulations should encourage the Council to continue stakeholder meetings to identify HAPCs. The commenter recommended that conservation efforts in localized areas involve open discussion between fisheries managers, scientists, and community citizens. We [commenter] support the continuation of stakeholder meetings as described in the Council discussion paper, "The Stakeholder Process and Identification of Habitat Areas of Particular Concern" (dated May 31, 2001).

One commenter stated that the EIS should incorporate the knowledge and experience of both fishermen and local area managers, establishing a process to ensure that local stakeholders participate fully in the identification and design of management alternatives for EFH and HAPC.

6.3.2 Research Recommendations and the Need for an Expanded Research Effort

Several commenters simply stated that better research is needed to provide and improve stock assessments, fish habitat, and behavior research.

One commenter was also concerned with the use of survey trawls for assessing species composition and abundance. Although this sampling methodology has proven successful for determining species presence, it inadvertently damages sensitive habitats. They encouraged greater use of alternative methods to identify habitat such as research submersibles, sonar, and benthic sleds.

One commenter recommended the establishment of habitat research areas. The commenter supported efforts to implement a system of habitat research areas to further knowledge of the effects of fishing on EFH. Habitat research areas can facilitate research necessary for 1) quantifying the value of protected areas to recovering fish stocks, 2) assessing the benefits of protected areas for fish and fisheries, 3) identifying other ecosystem functions, and 4) establishing baselines for fished and unfished areas. Habitat research areas can also provide information on recovery rates of various benthic habitats from mobile fishing gear. The commenter cited the EFH IFR which specifically recognized the benefits of research areas and suggested that Councils consider creating such research areas to provide necessary information for habitat protection. Also, the EFH Interim Final Rule recommends the creation of research closure areas and other measures to assess the effects of fishing equipment on EFH. The commenter conclude by stating that it is essential that the environmental effects of a network of habitat research areas are fully evaluated in this proposed EIS, and immediate measures are taken to implement such areas in both groundfish FMPs.

Another commenter stated that, given that there is a lack of data for Alaska fisheries, the EIS should include recommendations to increase scientific research/data in support of the fishery management requirements of the Fishery Conservation Management Act (FCMA).

Many general comments indicated that conservation measures must be based on the best scientific information.

Other commenters also supported the idea that the EIS should include recommendations to increase scientific research/data in support of the fishery management requirements of the FCMA. There are numerous problems associated with attempting to prioritize protections for certain types of habitat without guidance based on a body of scientific information to help apply systematic criteria for which types of protections to prioritize and what form protections should take. The Council's SSC has attempted to point out the potential problems here in their February 2000 minutes which state "The SSC is concerned that the current document is focusing on isolated habitat concerns without any strong connections drawn to resultant fish productivity." They go on to stress, among other concerns, the need for "process oriented research that establishes the connections between habitat and fish production." We [the commenters] would like to echo these concerns and make sure that the analysis properly addresses the lack of an established scientific foundation regarding the ways in which fish use habitat, how much habitat is needed, the degree to which it can be modified before productivity is affected, and what types of protections make the most sense. Lacking this information, we certainly run the risk of protecting the substrates and fauna that we like the most or feel the most connection to when the productivity of fish species may not be best addressed by that approach.

The process should be required to incorporate experimental designs and controls into any measures to protect EFH that may flow from a redefinition of EFH, or into any further measures to minimize, to the extent practicable, effects of fishing gear on EFH. If such measures had been explicitly incorporated into the existing fish habitat protections by the Council, we would probably be a lot closer to knowing what types of measures are beneficial and what measures have little or no effect and why.

6.3.3 The EIS Should Look at Impacts from Non-fishing Entities when Examining Effects of Action

One commenter stated that the EIS should examine the direct and indirect economic and social effects of EFH description and identification on non-fishing entities as well as on the fishing industry and Alaska Natives and should specifically ensure conformity with ANSCA Section 2(b) which requires maximum participation of Alaska Natives in decision-making affecting their rights and property.

The EIS must limit conservation measures recommended for fishing and non-fishing entities to those truly necessary to supplement stipulations already in place under existing regulatory controls to protect EFH. The EIS must list all existing regulatory mechanisms that are already available to protect habitat and explain in detail why EFH regulations do not duplicate each.

Several commenters stated that habitat needed protection from chemical, physical, and biological alteration of water quality from land-based industry; dissolved oxygen depletion; physical obstructions; impediments due to chemical or mineral nutrient movement (like silica); cases of excessive siltation, or scouring; concentrated dumping of organic or inorganic substances causing putrification, suffocation, or toxicity; and damaging fishing methods or equipment like benthic trawling.

One commenter stated that the EIS must limit identification of non-fishing activities to those with direct and significant effects on EFH. The commenter stated that the current approach considers a universe of activities throughout a broad spectrum of inland areas that may threaten EFH, and that this approach goes beyond the original intent of Congress.

The EIS must identify and evaluate in detail all non-fishing activities that may be affected by EFH. Only activities with significant and direct identifiable effects on EFH should fall under scrutiny. The current approach identifies a broad spectrum of inland areas as EFH and considers a wide range of activities in those areas as actions that may threaten EFH. This approach oversteps the bounds of reasonable regulation and is inconsistent with the intent of Congress.

The EIS must limit conservation measures recommended for fishing and non-fishing activities to those truly necessary to supplement requirements already in place under existing regulatory controls to protect EFH.

One commenter focused on the impact EFH regulations could have on non-fishing entities, given their application to inland areas far from the ocean and an overly broad definition that considers all habitat capable of sustaining fish as EFH. All activities in the vicinity of such waters could be impacted by the broad scope of the emerging EFH program. However, we are looking to the EIS process to address our concerns and refocus the program on marine waters and habitat that is truly "essential."

6.3.4 Questions Regarding NEPA Process, EIS v. EA, and Transparency of Process

Many commenters focused on their concerns regarding the process of development of an analysis for this action. One commenter stated the following:

> "Just as in the Steller sea lion legal debacle, NMFS is once again trying to reach a settlement with the plaintiffs while at the same time trying to conduct a public process and analysis that complies with the Magnuson-Stevens Act and NEPA. This seriously undermines the legitimacy of the process for development of the analysis. At a minimum, ongoing private negotiation between NMFS and the plaintiffs creates an uneven playing field for the public who deserve a thorough, scientifically balanced, and

> equitable process for an analysis. In the worst case scenario, it jeopardizes an industry, which is dependent on the resource for its livelihood. As NMFS has demonstrated with sea lions, the agency sometimes appears willing to propose just about any solution to settle a lawsuit, even if the scientific foundation is weak and even though it may involve near total economic destruction of the fishing industry."

The commenters recommended that NMFS discontinue all negotiations with plaintiffs, deal directly with the judge on all issues (including timing for completion of the analysis), and concentrate solely on addressing the NEPA deficiencies in the analysis for its original EFH plan.

Regarding the NEPA process and the development of an EIS versus an EA for EFH, several commenters believe that NMFS is overreacting to the decision in *AOC v. Daley*. NMFS should revise the EA and not draft an EIS. According to the commenter, great amounts of scientific data are lacking and unlikely to become available in near future.

One commenter supported the idea that NMFS should reconsider its NEPA process. Because no draft or final EIS was prepared by NMFS before the proposed EIS, the commenter believed that NMFS should first prepare a draft EIS, followed by a final EIS.

One commenter asked the following:

> "Why is NMFS setting out to do an EIS in lieu of an EA?"

Other commenters' understanding is that, at the direction of headquarters, NMFS has opted to prepare an EIS. This decision was apparently based on criteria relating to the significance of the action and the anticipation that it would be controversial. We [the commenters] think this is ill advised. The judge's opinion merely establishes that the original EFH EA was deficient in terms of NEPA standards of analysis. NMFS appears to be bargaining away the public process in an effort to try to satisfy plaintiffs. The commenter recommended that the original EA analysis should be revamped to address NEPA requirements. The relative significance and degree of controversy associated with the action should be no greater than before when an EA was sufficient—the EA analysis just has to be more comprehensive. If the original plan amendment had been rejected on the grounds that it did not meet Magnuson-Stevens Act standards, then perhaps an EIS would be justified, but that was not the case. Further, if a new EA analysis leads to a conclusion that the preferred measures to protect EFH are not adequate (in the original plan, these were status quo measures), and the new measures involve impacts of greater significance or controversy, then the new EA analysis could be expanded into an EIS.

Commenters did not understand why an EIS is required based on a court decision that concluded that the EAs prepared for the EFH amendments were inadequate to determine whether an EIS was necessary. Many stated the following:

> "Nowhere in the decision does the judge conclude that an EIS is necessary."

They further stated that this is reminiscent of the agencies decision to write a new biological opinion with a whole new suite of restrictions instead of simply justifying the restrictions it had in place as requested by the judge (in Greenpeace v. Daley). They asked that the decision to proceed with an EIS be reconsidered.

Several commenters believe that the decision to proceed with an EIS versus an EA may be the direct result of secret talks [with the plaintiffs] and a subversion of the public process. They asked that all confidential negotiations with plaintiffs cease.

Not all comments concerning the type of NEPA document were in opposition to an EIS. Some commenters supported the more detailed analysis that would result by doing an EIS. For example, the Alaska Marine Conservation council stated the following:

> "We look forward to the development of the EFH EIS, and further participation with NMFS in the future."

6.3.5 Council Staff Should Complete the NEPA Process – Not NMFS Staff

Several commenters believed that NMFS staff members were not objective and should not complete the EIS. They suggested that steps should be taken to ensure the objectivity of NMFS staff involved with the development of the EFH EIS. They believed that NMFS' DPSEIS suffers from a failure to incorporate a scientifically balanced assessment of what is known about the effects of trawling off Alaska. The DPSEIS fails to incorporate the best available data and scientific information; this may bode poorly for getting a sound and objective analysis for the EFH action. By the nature of its "programmatic" reach, the baseline in the DPSEIS is supposed to supply a foundation of the best available scientific information for management actions. The recent DPSEIS adopted an approach that is not generally supported by scientific studies or other reviews of the general effects of trawling and, particularly, the effects of trawling off Alaska. Further, the relevance of the scientific baseline adopted for the DPSEIS to trawling off Alaska is very questionable given the relative intensity of trawling, the types of substrates fished, the depths at which trawling occurs, and the specific types of trawl gears (otter trawls) used. The commenters were concerned that a similar unbalanced approach would pervade the development of the EFH EIS.

Consideration should be given to tasking the staff of the Council with the lead role in the preparation of the analysis for this EFH action. The Council staff has great familiarity with the measures already in place to protect EFH, and its staff has expertise in fisheries biology and benthic ecology as it relates to EFH. Furthermore, Council staffers are knowledgeable about competing management objectives and mandates (such as bycatch reduction and sea lion protections) that affect the practicability of further actions to restrict fishing to protect EFH. Last, the Council staff has a proven track record for producing comprehensive and scientifically balanced analyses. They ask that the responsibility for development of the EFH alternatives and analysis be removed from the agency and turned over to Council staff, as has been done in other regions.

The same commenters as above, however, also recommended that NMFS directly involve the agency's scientists who are researching habitat and habitat effects in the analytical team used for this action.

Several commenters recommended that the full involvement of the Council's Science and Statistical Committee in all phases of the development of the EFH EIS and deemed it indispensable.

Another comment was that NMFS should engage a team of objective and allocationally neutral scientists for the preparation of the EFH EIS analysis and the development of management options. They stated that would also be a good way to proceed. Members for such a team could be selected from the list of university researchers who are engaged in the publication of peer-reviewed scientific research on EFH and the effects of fishing thereon.

Many people were concerned regarding the process NMFS will take to develop management alternatives to "minimize, to the extent practicable, effects of fishing gears on EFH."

6.3.6 Consideration of all Other Applicable Laws and Regulations

Several comments emphasized the need for NMFS to consider other appropriate laws when examining mitigation to impacts on EFH. One commenter specifically referred to the E.O. dated May 18, 2001, entitled ‘Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution or Use.” That EO requires agencies promulgating regulations to prepare a statement of energy effects relating to any action that may have “any adverse effects on energy supply...,” for submission to the Office of Management and Budget. The commenter recommended that NMFS prepare this analysis based on the most recent outer continental shelf oil and gas leasing program document.

The EIS must list all existing regulatory controls that are already available to protect essential habitat and explain in detail why EFH regulations do not duplicate each. Existing regulatory mechanisms include the Clean Water Act, Coastal Zone Management Act, Endangered Species Act, and state and local forest practices, mining, and land use laws and regulations. The approach of identifying a broad range of conservation measures to a wide array of fishing and non-fishing activities largely duplicates existing regulatory requirements.

A comment reemphasized that all of the alternatives and the effects of specific recommendations are required to comply with the Regulatory Flexibility Act, as well as NEPA requirements and the FCMA standards for fishery management plans. The FCMA standards require that conservation and management measures be based upon the best scientific information available and, where practicable, minimize costs and avoid unnecessary duplication.

6.3.7 The Completion of the EIS Should Await the Completion of the Interim Regulations

Several commenters stated that completion of the EIS should await revision of the NMFS EFH interim final regulations and guidelines by the new administration. Completing the EFH amendments to the fishery management plans in advance of that reform will likely require revisions to the process later and is likely to lead to further disagreement and confusion. Therefore, we [the commenters] urge NMFS not to proceed further with EFH amendments to FMPs or further implementation of the EFH program until after revised final regulations and guidelines are issued.

6.3.8 Questions on "What is an Adverse Effect?”

Several questions were asked on adverse effects: How is the Council defining an “adverse effect” to a particular type of EFH? What level of short- or long-term loss of these essential habitat components reaches the level of adverse effect? How is the Council’s definition of adverse effect consistent with the Magnuson-Stevens Act and implementing regulations? Is the Council’s definition sufficiently precautionary in terms of protecting EFH or are there other more protective definitions? Is fishing gear resulting in adverse effects to a particular EFH? If yes, then which EFHs are adversely affected and how so? What are the alternatives available to minimize this adverse effect? Which of these alternatives are practicable to implement? How is the Council determining whether an alternative is practical? How is this approach consistent with the Magnuson-Stevens Act and implementing regulations? If a measure is not presently practicable, would it be practicable if phased in, or implemented to occur at a set date in the future? If a gear may be resulting in an adverse effect to EFH, are there any precautionary measures that can be taken to minimize the risk of potential adverse effects to EFH? What information is necessary to determine the risk of an adverse effect to a particular EFH? When will research provide such information? Can that information ever be obtained? The commenters concluded by stating that clear answers to these questions will promote understanding among interested stakeholders as to the approach the Council has taken to protect EFH, consistent with the requirements of the Magnuson-Stevens Act and the EFH Interim Final Rule.

6.3.9 Economic and Cost Analyses

One commenter stated that the EIS must examine in detail the direct and indirect economic and social effects of EFH description and identification, as well as recommended conservation measures, on non-fishing entities, the fishing industry, and local communities. These effects may include additional delays, requests and costs resulting from EFH consultations. Costs include those borne by federal, state, and local agencies and private applicants required to conduct and/or pay for impact analysis and other requirements for obtaining federal authorization or funding.

Conservation measures must minimize costs and duplication.

The EIS must evaluate in detail the direct and indirect economic and social effects of describing and identifying EFH, as well as the effects of recommended conservation measures on non-fishing entities, the fishing industry, and local communities. These effects may include additional delays, requests, and costs resulting from EFH consultation. Costs include those incurred by federal, state, and local agencies and by private applicants required to conduct and/or pay for impact analysis and other requirements for obtaining federal authorization or funding.

Another comment stated that the Magnuson-Stevens Act and NEPA demand that managers balance economic and social considerations and the benefits of food production to consumers (along with additional considerations for the human environment) against the potential benefits of increased protection of EFH. The problem is how to do this when adverse habitat effects are not demonstrable in our region and scientific findings on effects elsewhere are often highly dependent on how the studies were conducted. Further, linkages between habitat effects and productivity are not established, and economic and social data to assess what is practicable are rather deficient. Some will insist that the potential benefits of protections always outweigh the costs, but this is difficult for our fisheries and is inconsistent with the requirements of the Magnuson-Stevens Act.

NMFS should establish a framework for standards of scientific and any "non-scientific" information that the public may want to insert into the analysis. Define how the concept of "adequate precaution" will be applied to information about the effects of all fishing gears in the analytical process.

Analyze for expected continued utilization to date and apply value (net benefit) to the continued use of identified grounds [protective areas].

6.4 Summary of Suggested Alternatives Included in Scoping Comments

These alternatives were not developed by NMFS or the Council or the EFH EIS Committee established by the Council. Instead, these alternatives or suggestions for features that should be considered when drafting alternatives were recommended to NMFS by the public during the comment period of the scoping process. They do not reflect a decision as to what alternatives would be evaluated in the EFH EIS, but they are suggestions that were considered in the development of those alternatives.

One commenter recommended that the EFH EIS should include the following alternatives:

- Status quo
- No net increase in impacts
- Appropriate gear modifications
- Elimination of high impact gear and transition to lower-impact gear
- Closures to all bottom fishing

One commenter recommended that NMFS develop an alternative in the EFH EIS, similar to Alternative 5 in the DPSEIS, and indicated that NMFS should weigh the potential benefits of increasing gear conversion to pots.

One commenter questioned how the EIS process can adequately evaluate the effects of fishing gear on EFH and minimize, to the extent practicable, the effects of fishing gears on EFH when very little information is currently available, especially on fixed gears. An alternative should be included that specifies that no additional protective measures will be taken until adequate scientific information is available.

One commenter stated that significant issues to consider relative to each alternative should include ecosystem health and diversity, the vulnerability of each HAPC to disturbance, and the socioeconomic impacts to fishing fleets and fishing communities.

One commenter recommended the status quo and suggested using existing alternatives. The commenter stated that the court did not ask that the agency develop an EIS; it asked only that it build a better rationale for what it did in the EA, including the expansion of the analysis to include options that were explored in the past when the Council and NMFS developed the existing set of management measures to protect fish and crab habitat. The commenter called for NMFS to limit alternatives in the analysis to include only exploration of past actions taken by the Council.

NMFS and the Council should reconsider existing closed areas. Currently, approximately 20 percent of the BSAI and GOA fishing grounds is closed to bottom trawling. A reasonable alternative would be to rank the importance of identified EFH and if additional areas are identified, give priority to the areas that are most essential, with a limit not to exceed 20 percent of the fishing grounds.

In order to meet the requirements of NEPA, one commenter strongly urged that NMFS develop a comprehensive conservation alternative in its DPSEIS based on an ecosystem approach to groundfish management. A major component of this alternative should be to examine all major options for protecting EFH. With less than 1 percent of our oceans provided permanent protection, the commenter believed this issue is of paramount importance if we are to achieve the desired balance between marine biodiversity conservation, economically viable fisheries, and thriving coastal communities.

One commenter proposed the following alternatives:

- Implementing a maximum-diameter size limit no greater than 4 inches for all ground gear used in the groundfish fishery on trawl nets.
- Implementing a maximum-diameter size limit no greater than 8 inches for all ground gear used in the groundfish fishery on trawl nets.

One commenter recommended that year-around closure of areas should be considered actions of last resort. Alternatives that include gear-modifications and seasonal closures such as are currently done with salmon and herring “savings areas” should be made as specific as possible. Broad-brush approaches to closing fishing grounds could unnecessarily limit the fishing community’s ability to meet other important management goals such as bycatch avoidance and reduction of interactions with Steller sea lions.

Several commenters recommended a range of alternatives for restricting areas open to trawling from something less restrictive than the current no-trawl areas to an option where trawling is limited to the total of the areas where it currently actually occurs. An adequate experimental design would be incorporated into the measures developed within this range.

For the purpose of managing EFH, one commenter proposed that an alternative incorporate the components of Alternative 5 from the Alaska Groundfish Fisheries DPSEIS. This alternative is specifically designed to "protect and restore EFH and accrue benefits to marine ecosystems, while providing for sustainable groundfish fisheries." The concepts and tools of this alternative could be extended to all FMPs for EFH.

One commenter recommended that NMFS take a reasonably precautionary approach based on a balanced interpretation of the existing scientific information on trawl effects as it applies to Alaska, the current health of groundfish stocks under the status quo management regime, and the proven ability of the current management regime to adjust to new peer-reviewed scientific findings in the future. The less restrictive end of the range of alternatives would incorporate a recognition that a portion of the areas currently closed to trawling for habitat protection and for crab protection are, in all probability, not all made up of substrates that are vulnerable to negative effects from trawling (e.g., parts of Bristol Bay currently included in the Bristol Bay Near shore Closure Area). The habitat protection benefit of this end of the range is that it would beneficially spread trawling over a larger area than currently occurs and thus reduce trawling intensity compared to the status quo. This is based on an interpretation of the scientific information on trawl effects as described above. The underlying principle is the recognition that trawl effects range from no observable effect to an observed effect that varies depending on factors such as type of substrate, degree of ambient natural disturbance, specific type of trawl gear used, and other factors. A decrease in the intensity of trawling in areas open to trawling could further ensure that trawling does not create adverse effects. Likewise, we [the commenters] feel that the more restrictive end of the range we suggest for the analysis is scientifically supportable and adequately precautionary given a reasonable interpretation of the science of effects of trawling as it applies to Alaska.

Table A-3. EFH Scoping Comments and Issue Matrix

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
Comment ID (letter number-comment number)	Comment Summary	Criteria for Description and Identification of EFH	Suggested Alternative for Salmon EFH	Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH	HAPC	Scientific Information, Research, and Uncertainty	Effects on Non-fishing Interests of EFH Description □ and Identification	Effects of Fishing on EFH and Mitigation Measures	Economics/ Socioeconomics	Ecosystem, Wildlife and Other Non-targeted Marine Species	Regulatory Compliance	General Comments	Scientific Information/Research	NEPA Document and Process	Regulatory Compliance and Duplication	General Comments	Scientific Information/Research	NEPA Document and Process	Economics/ Socioeconomics
1-01	Because no draft or final EIS was prepared by NMFS before the proposed SEIS, we believe NMFS should first prepare a draft EIS, followed by a final EIS. A SEIS should be preceded by an EIS which has gone through the public review and comment process.																	1	
2-01, 16-02, 22-01	We are concerned that NMFS is conducting a public process at the same time that they are in negotiations with plaintiffs to reach a settlement. This makes us wary of the legitimacy of the scoping process and the analysis that it initiates.																	3	
6-01	Proceed with identifying and protecting both EFH and HAPCs through the EIS process, and involve fishermen and the public generally in the process.																	1	
3-05, 7-06, 9-07, 17-05, 19-09, 20-06	The completion of an SEIS should await revision of the NMFS interim final regulations and guidelines by the new Administration.																	6	
2-01, 16-01, 21-06, 21-07, 22-01, 27-01	The original EA analysis should be revamped to address NEPA requirements; concentrate solely on addressing the NEPA deficiencies in the analysis for its original EFH plan.																	6	
1-02	EFH designations should be evaluated in light of the Presidential Executive Order that requires agencies promulgating regulations to prepare a "Statement of Energy Effects:, relating to any action that may have "any adverse effects on energy supply..." for submission to the Office of Management and Budget (OMB).										1								

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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1-03, 3-01, 17-01, 20-01	Evaluate in detail one or more alternatives that identify and describe EFH based on criteria that limit the extent of EFH to habitat that is a) truly necessary for Council managed fishery species; and b) within the Council's jurisdiction.	4																	
7-01, 8-01, 9-01, 19-02	The SEIS must identify and describe EFH through specific criteria that limits the extent of the program to marine or estuarine environments within the EEZ that are truly essential for fishery species. Each alternative should include explanations of why each area has been identified as EFH.	4	4				4												
2-02, 21-02, 21-08, 22-02	We ask that the responsibility for development the EFH alternatives and analysis be removed from agency and turned over to Council staff.													3					
2-04, 21-01, 22-04	The EFH preferred alternatives should be selected using the National Standards as required under federal law.										3								
4-06	The SEIS should also include existing information on habitat types in the North Pacific and Bering Sea, gear impact assessment from published literature, the status of ecosystem health in the various Gulf, Bering Sea and Aleutian Island regions, and socioeconomic data on industry sectors and fishing communities.											1							
4-07	The SEIS should incorporate the knowledge and experience of both fishermen and local area managers.													1					
21-15	Establish a framework for standards of scientific and any "non-scientific" information that the public may want to insert into the analysis.																	1	

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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4-07, 12-02, 13-01, 13-02, 14-06, 15-05, 23-16	The SEIS should establishing a process to ensure that local stakeholders participate fully in the designation and design of management alternatives for EFH and HAPC. The active involvement of coastal community stakeholders is a valuable incentive for identifying protective measures. For decision making to be precautionary, it must be open, informed, and democratic and must include all potentially affected parties, including indirect stakeholders.													7					
23-16	AOC proposes that NMFS and the NPFMC specifically include a precautionary management approach to protecting EFH in both groundfish fishery management plans... Preventative action to protect habitats should be taken in advance of scientific proof of causality; the proponent of an activity, rather than the public, should bear the burden of proof of showing that a fishing practice or gear will not result in environmental harm.	1				1													
3-02, 7-02, 9-02, 17-02, 19-03, 20-02	The SEIS must identify and evaluate all nonfishing activities that may be affected by EFH. Only activities with significant and direct identifiable effects on EFH should fall under scrutiny.						6												
19-04, 20-03	Limit conservation measures recommended for fishing and nonfishing entities to those truly necessary to supplement stipulations already in place under existing local, State and Federal regulatory controls.														2				
8-03	Each SEIS alternative must identify and evaluate in detail all nonfishing activities that are effected by EFH.						1												

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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3-03, 7-03, 8-04, 9-03, 9-05, 17-03, 19-01, 19-05, 20-05	Limit conservation measures recommended for fishing and nonfishing activities to those truly necessary to supplement those already in place under existing regulatory mechanisms… which include the Clean Water Act, Coastal Zone Management Act, Endangered Species Act, and state and local forest practices, mining, agricultural, and land use laws and regulations. The SEIS must list all existing regulatory controls that area already available and explain in detail why EFH regulations do not duplicate each.														9				
19-08	Conservation measures must be based on the best scientific information available while minimizing costs and duplication and include recommendations to increase scientific research/data in support of the fishery management requirements of the Fishery Conservation and Management Act.			1		1													
14-01	In order to meet the requirements of NEPA, we have strongly urged that NMFS develop a comprehensive conservation alternative in its PSEIS based on an ecosystem approach to groundfish management.	1								1									
14-05, 15-04	We recommend that NMFS establish a timely process for identification of a network of marine reserves in the Bering Sea. We would like to give special emphasis to the critical need for protecting pelagic EFH in this network of marine reserves. HAPCs should also be expanded to include pelagic habitats that meet the criteria of ecological importance, sensitivity to degradation, and stress from development.			1	2														

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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14-06	Identify the need for the application of best available science and with meaningful community involvement in the protection and management of EFH (including MPAs).													1					
14-02	We feel it important to recognize that there is strong scientific justification for protecting key EFH in a network of marine reserves.			1		1													
15-06	AMCC feels that the designation of MPAs should be considered both as a means to protect EFH and HAPCs from damaging fishing practices and as a way to sustain commercial fishing.			1															
18-04	Design sanctuaries or refuges as pockets of biological diversity; management plans which sustain and maintain biological diversity; artificial reefs to enhance habitat.			1						1									
23-20	AOC supports the designation of a network of marine refuges that encompass the major representative habitats found in coastal and offshore areas off the North Pacific coast.			1															
23-17	It is essential that the environmental effects of a network of habitat research areas are fully evaluated in this proposed EIS and immediate measures are taken to implement such areas in both groundfish FMPs.			1		1													
25-01	Even though multiple programs will have to be tailored for each local ecosystem, small areas will have to be set aside as nonharvest zones (only subsistence use).			1															1
23-01	NMFS must take an aggressive approach to protect EFH and the marine environment by implementing measures, including no-take marine reserves, area-based gear restrictions, and other gear modifications.			1															

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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19-01, 19-07, 24-01, 24-03	Examine in detail the direct and indirect economic and social effects of EFH designations on Alaska Natives, and specifically ensure conformity with ANCSA section 2(b), which requires maximum participation of Alaska Natives in decision-making affecting their rights and property.										4								
7-05, 9-06, 15-08, 19-08, 21-10, 21-12	Conservation measures must ...include recommendations to increase scientific research/data in support of the fishery management requirements of the Fishery Conservation and Management Act. Incorporate experimental designs and controls into any measures to protect EFH that may flow from a redefinition of EFH, or into any further measures to minimize, to the extent practicable, effects of fishing gear on EFH.			4		6													
12-03	Research is needed to provide significant stock sustainability and abundance benefits for target species. Efforts are needed to improve the available stock assessment, fish habitat and behavior research.												1						
23-05	Where data is limited, the SEIS must evaluate whether that information can be obtained, and how long it may take to obtain necessary information.												1						

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
Comment ID (letter number-comment number)	Comment Summary	Criteria for Description and Identification of EFH	Suggested Alternative for Salmon EFH	Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH	HAPC	Scientific Information, Research, and Uncertainty	Effects on Non-fishing Interests of EFH Description □ and Identification	Effects of Fishing on EFH and Mitigation Measures	Economics/ Socioeconomics	Ecosystem, Wildlife and Other Non-targeted Marine Species	Regulatory Compliance	General Comments	Scientific Information/Research	NEPA Document and Process	Regulatory Compliance and Duplication	General Comments	Scientific Information/Research	NEPA Document and Process	Economics/ Socioeconomics
2-06, 21-09, 22-06	As part of the designation process the agency and Council should give high priority to seeking expert, unbiased advice and initiating research to correctly identify and rank the importance of EFH. Engaging a team of objective and allocationally neutral scientists (NMFS habitat scientists, NPFMC SSC, university researchers) for the preparation of the EFH EIS analysis and the development of management options would be a good way to proceed.													3					
2-05, 21-04, 22-05	We do not support the inclusion of alternatives that do not seek to minimize the potential adverse effects on the human relationship to the resource.								3										
15-02, 21-14	Quantitative thresholds of uncertainty should be implemented that weigh potential economic and ecological costs against present understanding of the effects of fishing on habitat and species diversity.							2											
21-03	The environmental impacts on the "relationship" of humans to their resource must be included in the EIS.								1										
23-03	The environmental effects of [bottom trawling] must be fully analyzed by appropriate experts in the fields of biology, ecology, oceanography, and fisheries biology, according with the requirements of NEPA.							1		1				1					
21-11	Proceed cautiously with the process of considering changes in the existing management regime to protect EFH off Alaska. Poorly conceived measures may actually concentrate fishing effort, possibly creating problems that did not exist before.			1															

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
Comment ID (letter number-comment number)	Comment Summary	Criteria for Description and Identification of EFH	Suggested Alternative for Salmon EFH	Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH	HAPC	Scientific Information, Research, and Uncertainty	Effects on Non-fishing Interests of EFH Description □ and Identification	Effects of Fishing on EFH and Mitigation Measures	Economics/ Socioeconomics	Ecosystem, Wildlife and Other Non-targeted Marine Species	Regulatory Compliance	General Comments	Scientific Information/Research	NEPA Document and Process	Regulatory Compliance and Duplication	General Comments	Scientific Information/Research	NEPA Document and Process	Economics/ Socioeconomics
21-13	Until a better scientific foundation is available, a reasonable and fair standard of precaution should be adopted to evaluate effects of all options an all bottom tending fishing gears.			1				1					1						
21-15	Define how the concept of "adequate precaution" will be applied to information about the effects of all fishing gears in the analytical process.							1											
4-03	the EFH SEIS should include a reasonable range of alternatives including: status quo; no net increase in impacts; appropriate gear modifications; elimination of high impact gear/transition to lower impact gear; and closures to all bottom fishing. a no-action alternative should be considered when there may be evidence of harm caused by an activity.			1															
6-02	Include among the alternatives a wide range of measures to protect specific habitat areas from the damaging effects of fisheries. These would include total closures at one end of the spectrum, to rotating or seasonal closures, to selective use of fishing gear and ways to encourage conversion to less damaging gear or technique, to perhaps just a monitoring program at the other end.			1															
13-03	Consider a spectrum of protective measures including conversion of bottom trawling to lower impact gears where appropriate, limiting areas open to bottom trawling to where their effects on seafloor habitats are minimal, and closures to all bottom fishing in areas carefully selected for their ecological significance.			1															

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
Comment ID (letter number-comment number)	Comment Summary	Criteria for Description and Identification of EFH	Suggested Alternative for Salmon EFH	Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH	HAPC	Scientific Information, Research, and Uncertainty	Effects on Non-fishing Interests of EFH Description □ and Identification	Effects of Fishing on EFH and Mitigation Measures	Economics/ Socioeconomics	Ecosystem, Wildlife and Other Non-targeted Marine Species	Regulatory Compliance	General Comments	Scientific Information/Research	NEPA Document and Process	Regulatory Compliance and Duplication	General Comments	Scientific Information/Research	NEPA Document and Process	Economics/ Socioeconomics
15-10	Alternatives to consider for the protection of EFH are: status quo; gear modification; gear restrictions/ allocations to promote gear conversion; closures to all or a significant amount of bottom fishing; full area closures.			1															
2-10, 21-18, 22-10	Year-around closure of areas should be considered actions of last resort. Alternatives that include gear-modifications and seasonal closures... should be made as specific as possible.			3															
23-01	NMFS must take an aggressive approach to protect EFH and the marine environment by implementing measures, including no-take marine reserves, area-based gear restrictions, and other gear modifications.			1						1									
23-16	A reasonable range of alternatives, including a no-action alternative should be considered when there may be evidence of harm caused by an activity.													1					
2-08, 22-08	Without additional research, will the agency assume that fixed gear has the same impact as trawl gear or that it has no impact at all?... An alternative should be included that specifies no additional protective measures will be taken until adequate scientific information is available.			2		2		2											
21-19	The range of options for the analysis for areas open to trawling should start from something less restrictive than the current no-trawl areas to an option where trawling is limited to the total of the areas where it currently actually occurs. An adequate experimental design would be incorporated into the measures developed within this range.			1															

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

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23-19	NMFS and the NPFMC must reexamine its dependence on bottom-tending mobile gears and utilize existing fishing practices that have low-impacts to EFH and the environment. NPFMC should analyze the use of incentives such as allowing exemptions for gear shown not to be detrimental to habitat, and voluntarily switching to low impact gears such as hook-and-line and pots.			1															
2-07, 21-16, 22-07	Limit Alternatives in the analysis to include only exploration of past actions taken by the Council.															3			
4-01	Although this level of discrimination may be more appropriate at the HAPC level, considering habitat categories as an alternative to the existing EFH designation could provide a useful exercise and result in a more meaningful use of the EFH term.	1			1														
11-01	I urge the agency to adopt a definition of EFH that can be backed with good science on the importance of that habitat to a species, and that can be applied to specific geographic locations that are critical to the survival and reproduction of a target species. That definition should not be crafted to include any habitat or geographic location where a species is merely known to occur.	1											1						
21-05	Using fishery dependent CPUE data to define which habitats constitute EFH is inappropriate because areas of high CPUE may reflect regulations, availability, fishable bottom, temporary aggregations, etc. rather than habitat critical to particular life stages.												1						
13-05	Consider the impact of bycatch into the equation as you determine EFH.												1						

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
Comment ID (letter number-comment number)	**Comment Summary**	**Criteria for Description and Identification of EFH**	**Suggested Alternative for Salmon EFH**	**Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH**	**HAPC**	**Scientific Information, Research, and Uncertainty**	**Effects on Non-fishing Interests of EFH Description □ and Identification**	**Effects of Fishing on EFH and Mitigation Measures**	**Economics/ Socioeconomics**	**Ecosystem, Wildlife and Other Non-targeted Marine Species**	**Regulatory Compliance**	**General Comments**	**Scientific Information/Research**	**NEPA Document and Process**	**Regulatory Compliance and Duplication**	**General Comments**	**Scientific Information/Research**	**NEPA Document and Process**	**Economics/ Socioeconomics**
14-04	We strongly recommend that NMFS recognize U.S. coastal and marine waters in WWF's priority areas for biodiversity conservation in the Bering Sea as essential fish habitats.				1					1									
15-01	EFH designation must incorporate the biological requirement of not only target species, but those of associated species as well, including upper and lower trophic animals.	1								1									
15-07	The designation of EFH should include the identification of a managed species' general distribution and core habitat areas.	1																	
13-04	Habitat alternatives incorporate precautionary management to account for the biological requirements and ecological interactions of all species in a diverse marine community.	1								1									
15-03	AMCC recommends that HAPCs be used as an additional tool for the protection and designation of EFH. HAPCs are areas of significant value based on "ecological importance, sensitivity to human-induced environmental degradation, stress to the habitat from development activities, and rarity of the habitat."			1						1									
24-01	I am requesting HAPCs because of proposed and existing activities pose a threat to the existing fisheries in Knik, AK.			1															
23-18	FMPs should identify HAPC within EFH for all managed species. One approach the NPFMC can take is to designate, as HAPCs, those areas within a species' EFH that have historically contained the highest abundance levels of a particular stock.			1															

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
		Criteria for Description and Identification of EFH	Suggested Alternative for Salmon EFH	Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH	HAPC	Scientific Information, Research, and Uncertainty	Effects on Non-fishing Interests of EFH Description ☐ and Identification	Effects of Fishing on EFH and Mitigation Measures	Economics/ Socioeconomics	Ecosystem, Wildlife and Other Non-targeted Marine Species	Regulatory Compliance	General Comments	Scientific Information/Research	NEPA Document and Process	Regulatory Compliance and Duplication	General Comments	Scientific Information/Research	NEPA Document and Process	Economics/ Socioeconomics
16-03	Any recommendations or alternatives that are developed without first reviewing the existing management and extensive scallop observer data would be flawed.											1							
16-04	We are concerned that you will not review the thesis of Teresa Turk (MS, University of Washington 2000).												1						
18-01	EFH regulations must be very precise in definition to include affects on all stages of life history of fish biological diversity.	1																	
2-09, 21-17, 22-09	Rank the importance of designated EFH, and if additional areas are identified, priority should be given to the areas that are most essential, with a limit not to exceed 20% of the fishing grounds.	3																	
23-02	Existing EFH designations should not be significantly modified - unless the best scientific information available supports such a modification.	1										1							
18-02	Provide protection for nurseries and rearing grounds; spawning beds; prime feeding areas; upland tributaries; estuaries; kelp beds; geologic formations which create upwelling of nutrients; littoral and supralittoral zones of the shore where forage fish, mollusks, crustaceans etc. spawn critical food web components.	1								1									
18-03	Provide protection from: chemical, physical, and biological alteration of water quality.	1																	
23-06	Gear assessment must include full analysis of the direct, indirect and cumulative adverse effects of physical disturbances, biological disturbances, and chemical disturbances.							1						1					

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
Comment ID (letter number-comment number)	Comment Summary	Criteria for Description and Identification of EFH	Suggested Alternative for Salmon EFH	Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH	HAPC	Scientific Information, Research, and Uncertainty	Effects on Non-fishing Interests of EFH Description □ and Identification	Effects of Fishing on EFH and Mitigation Measures	Economics/ Socioeconomics	Ecosystem, Wildlife and Other Non-targeted Marine Species	Regulatory Compliance	General Comments	Scientific Information/Research	NEPA Document and Process	Regulatory Compliance and Duplication	General Comments	Scientific Information/Research	NEPA Document and Process	Economics/ Socioeconomics
24-02	"I request status quo on any redesignation of lesser protection (EFH) until the impacts of such action can be considered, to the social, economic and environmental to my community of Knik."																		1
4-04	Significant issues to consider relative to each alternative should include the ecosystem health and diversity, the vulnerability of each HAPC to disturbance, and the socioeconomic impacts to fishing fleets and fishing communities.							1	1	1		1							
4-02	In categorizing habitat and identifying HAPC, we believe the following factors need to be taken into consideration: vulnerability or resilience to disturbance; ecological function; and rarity or uniqueness.				1														
4-05	HAPC areas should be designed to accomplish clearly defined habitat objectives with the least disruption to local fishing fleets.				1														
4-08	We recommend that the Agency consider officially designating the Southeast trawl closure area and Sitka Pinnacles as MPAs or HAPC, as appropriate.			1	1														
5-01	For purposes of mitigation identify all areas that are currently closed to trawling... to be analyzed by depth and environment.			1															
15-12	Observer coverage could be modified to more closely monitor habitat identification.																1		
15-09	Mitigation of the effects of fishing gear should include habitat restoration and protection.			1															
2-11, 21-19, 22-11	Alternatives should be designed to minimize reallocative gains to existing participants.								3										

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
		Criteria for Description and Identification of EFH	Suggested Alternative for Salmon EFH	Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH	HAPC	Scientific Information, Research, and Uncertainty	Effects on Non-fishing Interests of EFH Description ☐ and Identification	Effects of Fishing on EFH and Mitigation Measures	Economics/ Socioeconomics	Ecosystem, Wildlife and Other Non-targeted Marine Species	Regulatory Compliance	General Comments	Scientific Information/Research	NEPA Document and Process	Regulatory Compliance and Duplication	General Comments	Scientific Information/Research	NEPA Document and Process	Economics/ Socioeconomics
12-01	The trawl fleet needs to be reduced and more reasonably controlled. A reduction in larger, more powerful vessels should be targeted. Protective measures to convert bottom trawling to lower impact gears to lessen the footprint on the ecosystem.			1						1									
15-11	AMCC recommends that an alternative in the EFH EIS should weigh the potential benefits of increasing gear conversion to pots. This may alleviate some unintended increases of the bycatch of HAPC biota as predicted with longline gear.			1															
15-13	It is important to delineate between various gear types and intensity of effort. This includes consideration of the degrees of impact within a gear type and the impact between different gear types.							1											
23-19	AOC proposes that NMFS and the NPFMC evaluate and implement a maximum diameter size limit on rockhopper and rollergear in the groundfisheries for the purpose of preventing trawling in the most complex habitats.			1															
23-04	We urge NMFS and the NPFMC to include a full analysis of the effects of fishing on EFH and the environment and not rely heavily on prior EFH analyses and NEPA analyses… This assessment must include a full and objective analysis of both environmental and EFH impacts for each gear used in these fisheries and must be based on the best scientific information available.													1					
8-06	Where activities adversely affect EFH, the SEIS must define recommended conservation measures necessary to address and mitigate the impacts.											1							
23-11	What are the alternatives available to minimize this adverse effect?											1							

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

Comment ID (letter number-comment number)	Comment Summary	Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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23-12	Which of these alternatives are "practicable" to implement? How is the Council determining whether an alternative is "practical?" How is this approach consistent with the Magnuson-Stevens Act and implementing regulations?											1							
23-13	If a measure is not presently practicable, would it be practicable if phased in, or implemented to occur at a set date in the future?											1							
23-14, 23-15	If a gear may be resulting in an adverse effect to EFH, are there any precautionary measures that can be taken to minimize the risk of potential adverse effects to EFH? When will research provide such information?					1						1							
2-03, 22-03	HSCC does not support the inclusion of any EFH alternatives in which zero-risk is a goal or in which the fishery is assumed to cause adverse impacts unless it can be proven otherwise.	2																	
12-04	Sea lions are linked to a stable and growing herring stock. All efforts must be quickly organized to sustain and enhance this vital link of the ocean ecosystem of the Gulf of Alaska and Bering Sea.									1									
25-02	"The type of program I was looking at was kelp and herring restoration as a starting point."									1									

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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3-04, 7-04, 8-05, 9-04, 17-04, 19-06, 20-04	Evaluate in detail the direct and indirect economic and social effects on nonfishing entities, including small entities and local communities, of the designation of EFH, activities that adversely affect EFH, and recommended conservation measures. These impacts must include the cost of using consultants to meet EFH consultation requirements. It must also include the cost of processing and approval delays, and costs to federal, state and local agencies, as well as private applicants.						7		7										
5-02	Overlay all foreign fishing data for longlining and trawling (1965-1988) onto the matrix of current fishing areas of the Americanized fisheries.												1						
5-03	Analyze the impact that foreign longlining and trawling had on all identified EFH and HAPC in the Gulf of Alaska and Bering Sea/Aleutian Islands. Factor for gear size that was not under development for bycatch avoidance and unobserved data for both catch rates and area of operation.												1						
5-04	Analyze for expectable continued "utilization" year to date and apply value for the continued usage of all the identified grounds.												1						
5-05	Please place into the scoping comments for EFH SEIS the testimony of Senator Frank Murkowski read into the Congressional Record May 4, 2001.											1							
5-06	Also place the five part series "Environment, Inc." beginning April 22, 2001 in the Sacramento Bee, written by T. Knudson.											1							

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
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23-08	It is imperative that the assessment includes conclusions as to the spatial extent and level and type of disturbance occurring throughout state and federal waters and in each particular EFH.											1							
23-09	How is the council defining an "adverse effect"? How is the Council's definition consistent with the Magnuson-Stevens Act and implementing regulations?							1											
23-10	Is a fishing gear resulting in "adverse effects" to a particular EFH? If yes, then which EFHs are adversely affected and how so?											1							
24-04	Request you incorporate into FMP these dioxin studies: Trace amounts of dioxin readily enter the food chain, and area hazardous to human consumption (EPA water office). Interim report on data and methods for assessment for 2,3,7,8 Tetraclorodibenzo-P dioxin risks to aquatic organisms and associated wildlife (EPA Office of Research and Development). Human health risk report (National Technical Information Service Center, DOC).																1		
24-05	"I am requesting your cooperation in coordinating an assessment for Knik incinerator and Entech incinerator."															1			
24-07	"Suggest you put in FMP that responsibility for assessment lies with facility operator to get assessment."															1			
24-08	"Request a means to access fines for fertilizer and oil spills and pipelines discharges in FMP."															1			

Table A-3. EFH Scoping Comments and Issue Matrix (continued)

		Signficant Issues that Suggest Alternative Actions					Significant Issues to be Analyzed in the EIS					Other Issues to be Considered in the EIS			Issues Not Considered in the EIS				
Comment ID (letter number-comment number)	**Comment Summary**	**Criteria for Description and Identification of EFH**	**Suggested Alternative for Salmon EFH**	**Mitigation Measures to Minimize the Adverse Effects of Fishing on EFH**	**HAPC**	**Scientific Information, Research, and Uncertainty**	**Effects on Non-fishing Interests of EFH Description □ and Identification**	**Effects of Fishing on EFH and Mitigation Measures**	**Economics/ Socioeconomics**	**Ecosystem, Wildlife and Other Non-targeted Marine Species**	**Regulatory Compliance**	**General Comments**	**Scientific Information/Research**	**NEPA Document and Process**	**Regulatory Compliance and Duplication**	**General Comments**	**Scientific Information/Research**	**NEPA Document and Process**	**Economics/ Socioeconomics**
10-1	Well designed and enforced EFH areas and refugia will result in a long-term increase of sustainable catch and allow populations to rebound after being subjected to stress.							1											
14-03	The EFH EIS should look closely at the effects of bottom trawling on crab habitat.							1											
27-02	There is insufficient scientific data available for the preparation of an EIS.												1	1					
27-03	The EIS process will invite attempts to reallocate the resources among participants in the fisheries.								1										
27-04	Fish stocks are currently in good condition. Any fishing impacts occurred long ago. There are no noticeable ongoing impacts.						1												
	Total Unique Comments	15	1	30	6	7	5	11	6	13	3	13	11	10	2	4	2	6	2
	Total Comments	24	4	36	7	13	19	13	16	13	8	13	11	20	11	6	2	18	2

Appendix B
Evaluation of Fishing Activities that May Adversely Affect Essential Fish Habitat

Prepared by

National Marine Fisheries Service

April 2005

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ACRONYMS AND ABBREVIATIONS

ABL	Auke Bay Laboratory
ADF&G	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center
AI	Aleutian Islands
ANOVA	analysis of variance
B_{MSY}	biomass beneficial maximum sustainable yield
BS	Bering Sea
BSAI	Bering Sea/Aleutian Islands
C	centigrade
CFR	Code of Federal Regulations
cm	centimeter
Council	North Pacific Fishery Management Council
CPUE	catch per unit of effort
EBS	eastern Bering Sea
EFH	essential fish habitat
EIS	environmental impact statement
FMP	fishery management plan
F_{MSY}	fishing mortality rate at maximum sustainable yield
FOCI	fisheries oceanography coordinated investigations
GIS	geographic information system
GOA	Gulf of Alaska
HAPC	habitat area of particular concern
INPFC	International North Pacific Fisheries Commission (now the North Pacific Anadromous Fish Commission)
kg	kilogram
kg/cm^2	kilogram per square centimeter
km	kilometer
km^2	square kilometer
lb/in^2	pound per square inch
lbs	pounds
LEI	Long-term Effect Index
m	meter
mm	millimeter
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MMNT	more than minimal and not temporary
MSST	minimum stock size threshold
MSY	maximum sustainable yield
mt	metric ton

MT	minimal or temporary
nm	nautical mile
NMFS	National Marine Fisheries Service
N_{MSY}	equilibrium population size corresponding to MSY
NRC	National Research Council
ppm	parts per million
ppt	parts per thousand
PSEIS	Final Programmatic Groundfish SEIS
QS	quality scores
RACE	Resource Assessment and Conservation Engineering Division
ROV	Remote Operating Vehicle
SST	shortspine thornyheads
t	ton
U	unknown

B.1 Overview

This appendix addresses the requirement in Essential Fish Habitat (EFH) regulations (50 Code of Federal Regulations [CFR] 600.815(a)(2)(i)) that each FMP must contain an evaluation of the potential adverse effects of all regulated fishing activities on EFH. This evaluation must 1) describe each fishing activity, 2) review and discuss all available relevant information, and 3) provide conclusions regarding whether and how each fishing activity adversely affects EFH. Relevant information includes the intensity, extent, and frequency of any adverse effect on EFH; the type of habitat within EFH that may be affected adversely; and the habitat functions that may be disturbed.

In addition, the evaluation should 1) consider the cumulative effects of multiple fishing activities on EFH, 2) list and describe the benefits of any past management actions that minimize potential adverse effects on EFH, 3) give special attention to adverse effects on habitat areas of particular concern (HAPCs) and identify any EFH that is particularly vulnerable to fishing activities for possible designation as HAPCs, 4) consider the establishment of research closure areas or other measures to evaluate the impacts of fishing activities on EFH, 5) and use the best scientific information available, as well as other appropriate information sources.

This evaluation assesses whether fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature (50 CFR 600.815(a)(2)(ii)). This standard determines whether Councils are required to act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable.

Much of the material responsive to this evaluation is located in other chapters of this environmental impact statement (EIS). These areas include the following:

- Descriptions of fishing activities (including gear, intensity, extent and frequency of effort) - Sections 3.4.1 and 3.4.2.
- Effects of fishing activities on fish habitat - Section 3.4.3.
- Past management actions that minimize potential adverse effects on EFH - Sections 2.2 and 4.3.
- Habitat requirements of managed species - Sections 3.2.1, 3.2.2, and Appendices D and F.
- Features of the habitat - Sections 3.1, 3.2.4 and 3.3.
- HAPCs - 2.2.2.7, 2.2.2.8, 2.3.2, and 4.2

Information from these sections is included by reference to avoid duplication. Specific information from these sections will be repeated in this appendix where it is applicable to the remainder of the evaluation.

Relevant rules and definitions from regulations and corresponding determinations

As defined in the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), “Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.”

For the purpose of interpreting the definition of EFH, “waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle (50 CFR 600.10).

This definition differentiates EFH from all other fish habitat based on the extent that the habitat's support of a managed species affects that species' a) ability to support a sustainable fishery and b) ability to fulfill its role in a healthy ecosystem. While habitat functions support individual fish and are affected by fishing at local scales, the support of fisheries and ecosystem roles are accumulated across entire fish populations and ecosystems. Therefore, the appropriate scale for assessing the consequences of the effects of fishing on EFH is that of populations and ecosystems. The importance of habitat properties at specific sites depends on the role of local habitat functions in the full support of each managed species by all habitats. Negative effects to habitat function at specific sites may constitute adverse effects to EFH, but the relevant question is whether such site-specific effects cumulatively have adverse consequences for a stock of a managed species. In other words, do such effects impair the ability of a managed species to support a sustainable fishery or its role in a healthy ecosystem? This does not mean that site-specific effects are not assessed, rather that their cumulative consequences must be considered to evaluate effects on the EFH of each species.

The regulatory language guiding the assessment of effects in this evaluation is as follows:

> Each Fishery Management Plan (FMP) must minimize to the extent practicable adverse effects from fishing on EFH, including EFH designated under other Federal FMPs. Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature (50 CFR 600.815(a)(2)(ii)).

Numerical standards for minimal or temporary effects are not provided, although the preamble to the final rule (67 FR 2354) describes temporary impacts as those that are "limited in duration and that allow the particular environment to recover without measurable impact." No time scale was attached to the term 'limited duration.' The same commentary describes minimal impacts as those that "may result in relatively small changes in the affected environment and insignificant changes in ecological functions." In the EFH context, the terms 'environment' and 'function' refer to the features of the environment necessary for the spawning, breeding, feeding, and growth to maturity of the managed species and their function in providing that support.

As described in the EFH regulations, evaluation of the adverse effects of fishing on EFH is based upon the 'more than minimal and not temporary' standard. Fishing operations change the abundance or availability of certain habitat features (e.g., prey availability or the presence of living or non-living habitat structure) used by managed fish species to accomplish spawning, breeding, feeding, and growth to maturity. These changes can reduce or alter the abundance, distribution, or productivity of that species, which in turn can affect the species' ability to "support a sustainable fishery and the managed species' contribution to a healthy ecosystem" (50 CFR 600.10). The outcome of this chain of effects depends on characteristics of the fishing activities, the habitat, fish use of the habitat, and fish population dynamics. Conducting an analysis considering all relevant factors required that information from a wide range of sources and fields of study be consolidated in order to focus on the evaluation of the effects of fishing on EFH. Professional judgement had to be relied upon to address scientific uncertainty regarding information necessary for analysis.

The duration and degree of fishing's effects on habitat features depend on the intensity of fishing, the distribution of fishing with different gears across habitats, and the sensitivity and recovery rates of habitat features. A numeric model was developed as a tool to structure the relationships between available sources of information on these factors. This model was designed to estimate proportional effects on habitat features that would persist if current fishing levels were continued until affected habitat features reached an equilibrium with the fishing effects. At equilibrium, habitat features will neither further degrade nor improve if fishing effects persist at a constant level. Therefore, such effects would not be of limited duration and would meet the 'not temporary' test.

While subject to considerable limitations and uncertainties, model results consolidate the best available information on each factor determining fishing's effects on the properties (features) that allow the waters and substrates of Alaska to serve as fish habitat. These estimates only partially address the effects of fishing on the EFH of managed species, since the model does not consider the habitat requirements of those species or the distribution of their use of habitat features. Those considerations required qualitative assessments by experts on each species. In spite of its limitations, the model provided a consistent, reasonable perception of fishing's effects on features of the habitat at the smallest feasible spatial scale. This freed the species evaluators from making individual, subjective estimates of how and where fishing affects habitat features, allowing them to focus on what the effects estimated by the model mean for each managed species. Specifically, the evaluators were asked to use the model output in addressing whether the fisheries, as they are currently conducted, are affecting habitat that is essential to the welfare of each managed species. In other words, are continued fishing activities at the current rate and intensity likely to alter the ability of a managed species to sustain itself over the long term?

Evaluators were provided with the maps and habitat use information developed during the EFH designation analyses. Effect estimates from the model, displayed on charts and summed across habitat types and species EFH areas, were then evaluated as to how they impact the habitat's ability to support the spawning, breeding, feeding, or growth to maturity of a managed species. The evaluation considered which habitat features are used by each managed species, the overlap of that use with the effects of fishing on those features, and other evidence relevant to whether fishing affects the EFH of each species. The distribution of fishing effects on habitat features was portrayed to the smallest scale practicable to permit consideration of effects at any sites considered vital enough to have population-level effects. Indications from historical and current stock assessments of each species' ability to maintain productivity while subject to current or higher levels of fishing intensities were also considered. The standard for evaluation was whether the expected effect on the species' ability to support a sustainable fishery or its role in a healthy ecosystem is more than minimal.

The ability of the stock to produce its maximum sustainable yield (MSY) over the long term was used as a measure of its ability to "support a sustainable fishery."[1] Analysts familiar with the stock and the data available were instructed to determine whether there was evidence that habitat impacts due to fishing impaired the stocks' ability to produce MSY over the long term. No such standard was available for the species' "contribution to a healthy ecosystem." However, the stock level necessary to support a sustainable fishery does ensure that substantial numbers of fish are available to serve as prey or predators to other species, as well as fulfilling other ecosystem functions. For species where MSY could not be estimated with available data (e.g., recruitment estimates not available), assessing effects on EFH had to rely on other proxies or ratings of "unknown" were necessary.

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[1] The draft EIS used stock status relative to the minimum stock size threshold (MSST) as a reference point and addressed whether the effects of fishing on EFH would alter the ability of each stock to remain above its MSST over the long term. Given the apparent confusion some commenters expressed over how the National Marine Fisheries Service (NMFS) considered stock status in the analysis, NMFS modified the analytical approach in the final EIS to address whether stock status and trends indicate any potential influence of habitat disturbance due to fishing. Specifically, analysts addressed whether the temporal or spatial pattern of habitat disturbance on stock abundance is sufficient to alter the ability of the stock to produce MSY over the long term.

Substantial scientific uncertainties necessitate close consideration of the appropriate weighting of evidence. The preamble to the final EFH regulations provides the following guidance for these evaluations of fishing effects on EFH. First, Council action to minimize effects of fishing on EFH "is warranted to regulate fishing activities that reduce the capacity of EFH to support managed species, not fishing activities that result in inconsequential changes to the habitat." Therefore, there has to be evidence that such a reduction in capacity would occur. On the other hand, the preamble cautions against setting too high a standard for such evidence by stating the following:

> It is not appropriate to require definitive proof of a link between fishing impacts to EFH and reduced stock productivity before Councils can take action to minimize adverse fishing impacts to EFH to the extent practicable. Such a requirement would raise the threshold for action above that set by the Magnuson-Stevens Act.

Finally, the preamble gives this advice on how to weight different sources of information. "The final rule encourages Councils to use the best available science as well as other appropriate information sources when evaluating the impacts of fishing activities on EFH, and to consider different types of information according to its scientific rigor." Therefore, species evaluators had to consider the scientific basis, uncertainties, rigor of the estimates of effects on habitat features, knowledge of fish biology, distribution and use of the habitat, and the stock assessment information in determining whether effects on EFH were more than minimal and not temporary.

This evaluation does not address the direct effects of the fisheries on the fish themselves, such as catch or as bycatch. Those issues are the subject of other sections of the FMPs. The EFH regulations address adverse effects to species welfare resulting from habitat alterations. Therefore, changes in the abundance or productivity of a fish species due to direct mortalities by the fisheries are not considered adverse effects on EFH. An exception is the situation where a prey species is affected, and the habitat is essential for another managed fish species expressly because that prey species is present.

The remainder of this appendix describes the effects of fishing analysis (What effects on habitat features are not temporary?) and then the subsequent evaluation process (Do those effects on habitat have an effect on species welfare that is more than minimal?). The evaluations resulting from this process are then presented to satisfy the requirements of the EFH final rule.

B.2 Effects of Fishing Analysis

Fishing operations can adversely affect the availability of various habitat features for use by fish species. Habitat features are those parts of the habitat used by a fish species for the processes of spawning, breeding, feeding, or growth to maturity. The literature regarding these effects has grown substantially over the last decade. Recent reviews include Johnson 2002, National Research Council (NRC) 2002, and Thrush and Dayton 2002. Literature most relevant to Alaska fisheries was reviewed in Section 3.2.3. A complex combination of factors influences the effects of fishing on habitat features, including the following:

1. Intensity of fishing effort
2. Sensitivity of habitat features to contact with fishing gear
3. Recovery rates of habitat features
4. Distribution of fishing effort relative to different types of habitat

The goal of this analysis was to combine available information on each of these factors into an index of the effects of fishing on features of fish habitat that is applicable to issues raised in the EFH regulations. This stage of the analysis embodied the risk assessment recommended in Chapter 5 of the National Academy of Sciences' review of the Effects of Trawling and Dredging on Seafloor Habitat (NRC 2002). It synthesized the available data and technical studies to describe the nature, severity, and distribution of the risk to features of the habitat relevant to the marine fish population of Alaska. This quantitative approach was considered preferable to more qualitative methods, such as subjective scoring and summing of factors, because it made the assumptions explicit, preserved the spatial detail of higher quality data sources (e.g., fishing distribution), and provided a consistent representation of the effects of fishing.

While at least some information was available on all of these factors, it varied in quality, spatial coverage, and applicability to Alaska fisheries. There was also no accepted model or analysis for relating this information to the questions posed by the EFH regulations. An initial approach was developed in April 2002 (Witherell 2002), which combined regional statistics into a gear factor, a habitat recovery factor, and a percent coverage factor for each fishery. These factors were then combined into two scores related to whether potential effects are minimal or temporary. A model (Fujioka 2002) was developed in May 2002 that combined this information into an estimate of the proportional reduction in a habitat feature, relative to an unfished state, if a fishery were continued at current intensity and distribution to equilibrium (effects neither increase nor decrease if continued longer). A preliminary analysis (Rose 2002), based on that model and applied on a 5-by-5-kilometer (km) spatial scale, was provided in August 2002 to aid the Council's EFH Committee in selecting potential alternative actions to minimize adverse effects of fishing. The current analysis follows the structure of that preliminary analysis, with improvements based on input from participants in the Council process and scientists inside and outside of NMFS. The analysis also benefits from an outside peer review by the Center for Independent Experts (Drinkwater 2004).

While this analysis provides a tool for bringing disparate sources of information to bear on the evaluation of EFH, numerous limitations arose of which users should remain mindful. Both the developing state of the model and the limited quality of available data to estimate input parameters prevent a robust evaluation of habitat effects. While quantitative output may provide an impression of rigor, the results are actually subject to considerable uncertainty. Notwithstanding, it is the best tool currently available for representing the relative risks to habitat features, but it is not necessarily a definitive predictor.

While some sources of input estimates are relatively good (fishing distribution), others have substantial uncertainty or come from indirect proxies. In many cases, results from other regions, with somewhat different habitats or fishing methods, were used to estimate parameters for Alaska. To facilitate evaluation of the input parameters, each table includes a column of quality scores (QS). These are subjective assessments of the quality of information available to estimate a specific parameter on a scale of 1 to 10. A QS of 10 indicates that NMFS has all the information needed to assess both the value and the variability of the parameter with confidence. A QS of 1 indicates that the provided parameter value has the highest uncertainty (or lowest confidence).

B.2.1 The Effect and Recovery Model

To use estimates of fishing intensity, sensitivity of habitat features, and feature recovery rates in a quantitative analysis required a model linking these factors into a unified measure of the resulting effects. This section describes the derivation of that model, followed by an explanation of how that model was applied to the available information.

Fishing reduces availability of a habitat feature at a rate I. I is the product of the proportion of the feature that the fishing gear contacts per time (f) and the proportion of the contacted elements that are made unavailable, due to damage, removal, or mortality (q):

(1) $I = f \times q$

Assuming elements of a habitat feature can be in only two conditions: let H = the portion of the feature unaffected by fishing, h = the portion of the feature not available to species as functioning habitat, I = rate at which fishing damages or removes the feature, ρ = rate at which the affected portion recovers to the unaffected condition, and e is a constant = 2.718:

(2) $dH/dt = (-I \cdot H) + (\rho \cdot e^{-I} \cdot h)$

so that there is no net loss of habitat, i.e., H + h = constant amount (H_0). This reflects that H is decreased at a rate I and increases as h survives further effects (e^{-I}) and recovers at a rate ρ.

Setting $h = H_0 - H$ and integrating, letting $H = H_0$ and $h = 0$ at time = 0, resulting in:

(3) $\int dH/dt = \int(-I \cdot H + \rho \cdot e^{-I} \cdot (H_0-H))$

(4) $H_t = H_0(Ie^{-(I+\rho S)t} + \rho S)/(I + \rho S)$, where $S = e^{-I}$

This gives the proportion of the original habitat remaining unaffected at any time t. To find the long-term result, when the rates of effect and recovery balance each other, t is set = ∞ (infinity), resulting in:

(5) $H_{equil.} = H_0 \cdot \rho e^{-I}/(I + \rho e^{-I})$

This is converted to a percentage reduction of H at equilibrium, which will be called the long-term effect index (LEI), by:

(6) $LEI = 100 \cdot (1 - H_{equil})$

From this, it can be seen that LEI increases as the effect rate I increases, while a high recovery rate, ρ, results in lower LEIs. Table B.2-1 shows LEI for a range of combinations of I and ρ (and $1/\rho$ = average recovery time). The balance of effect rate and recovery rate determines the proportion of habitat affected over the long term (equilibrium). Only features that recover very quickly (high ρ) could achieve a small LEI under any fishing intensity. Likewise, features that recover very slowly may have a high LEI even with small rates of fishing effects.

This use of q × f to estimate I assumes that habitat features are associated with particular locations and do not have substantial ability to move. Features contacted by fishing gear are reduced in the proportion available to species by the sensitivity proportion, (q). Habitat features that have been contacted recover through time and are vulnerable to subsequent contacts (reduction of the unrecovered remainder by [q]). Under this model, the fishing effort is distributed as very small sites of contact, placed randomly within the area being analyzed. Particularly over large scales, fishing effort distributions aggregate together, with small areas subject to heavy fishing and other areas subject to none. At finer scales, distributions tend to be more random and less patchy (Rijnsdorp et al. 1998). Therefore, this model is best applied separately to many small areas with the results summed to larger regions.

Recovery rate, ρ, reflects the rate of change of affected habitat, h, back to unaffected habitat, H. In the absence of further effects, h would decrease exponentially until all habitat was in H, the unaffected condition. The recovery time can be thought of as the average amount of time the affected habitat stays in the affected state and would equal 1/ρ (in the absence of further effects). Each habitat feature in each habitat may have different recovery times.

The results of this model (LEIs) are proportions of the original abundance of each habitat feature (H_0) remaining at equilibrium. Because this pristine amount is not known for the features and areas studied, the LEIs could not be used to calculate the actual amount of a feature remaining in an area. Instead, they represent the ability of fishing to reduce however much of each feature was present in an area as a proportional reduction. Summing of LEIs without feature distributions assumes that all locations in each habitat have equal value. Actual combined effects would be influenced by areas of high abundance more than by areas of low abundance. Therefore, accumulated LEIs will underestimate real effects for a feature that was originally more abundant in heavily fished areas than in those that were fished lightly or not fished. An overestimate of effects will occur if the reverse is true. Also, because initial feature abundance was not part of the LEI calculations, LEIs were calculated for all areas where fishing occurred, including some areas where the subject feature may never have existed. This particularly affects results for features with limited distributions.

B.2.2 Analysis Process

The model was developed to provide a quantitative tool for evaluating fishing effects based on fishing intensity, sensitivity of habitat features, and rate of habitat recovery. Numerous assumptions and simplifications were necessary to match model structure to the available data. These include assumptions about effect rates, habitat recovery rates, habitat distribution, and habitat utility. Another limitation of the model was the general nature of available information across relatively broad categories of habitats and features. These assumptions are described in each of the following sections, and their potential effects should be acknowledged in considering the results.

Table B.2-2 describes the actual calculations of fishing effects, including input data matrices, calculation steps, and output matrices. Final results appear in the $LEI_{I\,(j\bullet k)}$ matrix, which provides information on the spatial distribution of effects (by 5-by-5-km block and feature), and the $LEI_{(j\bullet k)}$ matrix, which summarizes effects to each habitat feature within each habitat.

To help assess the effect of parameter uncertainties and to demonstrate the potential range of plausible effects, LEIs were calculated using high, medium, and low input values for habitat sensitivity and recovery rates. The model was run three separate times: first with all parameter values that would yield high effect estimates, second with those for medium values, and, finally, with all values yielding low estimates combined. These upper and lower sets of estimates are not statistical confidence levels, but do provide a relative assessment of potential error in the central estimates.

The analysis initially assessed the cumulative effects of all fishing activities. The portion of those effects that could be attributed to individual fisheries was then calculated. The first analysis step ($f \times q = I$) was carried out for each fishery separately. The resulting *I* values were multiplied by the area of each block and summed for each feature/habitat combination, giving each fishery an area-weighted *I* value for each feature habitat combination. The original LEI for each feature/habitat combination (calculated for all fisheries combined) was then apportioned between fisheries according to the area-weighted *I* value for each fishery. The resulting fishery LEIs indicate the amount of the overall LEI attributed to that fishery.

B.2.3 Organizational Categories for Fishing Effects Analysis

B.2.3.1 Designation and Description of Habitats

Habitat information varies in quality between regions. McConnaughey and Smith (2000) and Smith and McConnaughey (1999) described available data on sediments for the Bering Sea (BS) shelf and the relationship of that data to the distribution of flatfish. The results from those studies were used to define five habitats for this analysis (Figure B.2-1). The first habitat, situated around the shallow eastern and southern perimeters of the eastern Bering Sea (EBS) and near the Pribilof Islands, has primarily sand substrates. The second, across the central shelf out to the 200-meter (m) contour, has mixtures of sand and mud. A third, west of a line between St. Matthew and St. Lawrence Islands, has primarily mud (silt and clay) substrates, with some sand. In addition to substrate, depth is an important determinant of species distributions and presumably their use of habitat. Therefore, the EBS slope (200 to 1,000 m), with primarily sand/mud substrates, was the fourth EBS habitat used in this analysis. The areas north and east of St. Lawrence Island, including Norton Sound, have a complex mixture of substrates, but were not included in this analysis because they are subject to almost no fishing effort.

Comprehensive substrate data sets do not exist for the Gulf of Alaska (GOA). Instead, there are only a few isolated pockets of observations. The GOA has a much more complex bathymetry than the EBS, so in this analysis, GOA habitats were defined using depth and slope criteria. The following combinations, based on strata used for Alaska Fisheries Science Center (AFSC) groundfish surveys, were used in this analysis: shallow waters (0 to 100 m), deeper waters on the shelf (100 to 300 m), and upper slope (200 to 1,000 m). Depths between 200 and 300 m were allocated to the slope only in areas where contours indicated a steep area immediately adjacent to the deeper slope depths.

The Aleutian Islands (AI) also have complex bathymetry and very limited available substrate information. Because the shelf is very narrow, AI habitats were separated into shallow (0 to 200 m) and deep (200 to 1,000 m) categories. Because its bathymetry more closely resembles the AI region than the EBS, the strip of the southern BS between 165 and 170º E longitude and south of 54º 30" N latitude (management areas 518 and 519) was considered part of the AI region for this analysis.

Designation of substrate types is useful since many of the recovery rate and fishing effect studies are specific to particular substrates. For the EBS shelf, substrate information was used directly in defining habitat areas, making the appropriate substrate apparent. However, both the GOA and the AI have complicated mixes of substrates, including a significant proportion of hard substrates (pebbles, cobbles, boulders, and rock). Insufficient data are available to describe their spatial distributions. Each of the strata in the GOA and AI were divided into two subhabitats, hard (pebble, cobble, and rock) and soft (silt, sand, and gravel) substrates.

Because distributional data are lacking, the same values for the proportions of hard and soft substrates were applied to each of the blocks in each habitat of the GOA and AI. Because better data or proxies were not available for these hard/soft proportions for the GOA habitat types, an estimate of hard/soft proportions was developed based upon the proportion of sites visited during NMFS groundfish surveys that was found to be appropriate for trawling with standard NMFS survey gear. Stations considered inappropriate for trawling for reasons unrelated to substrate hardness (steep or uneven bottoms, cable zones, or unnavigable waters) were not included. This proxy gives only a rough approximation of substrate as 1) the standard survey trawl may function on smoother pebble or cobble substrates that would otherwise be considered hard, 2) the trawl may be damaged by isolated boulders in predominantly soft substrates that may be mistakenly classified as hard, 3) a trawlable bottom may be found in areas of mostly hard substrate, and 4) soft bottom patches may exist in untrawlable areas, but these patches may not be continuous enough to achieve a minimum trawl tow. The data set also suffers from the inconsistency of reporting between years and lead survey scientists. The resulting proportions from the model were 19 percent hard substrate in the shallow stratum, 5 percent hard substrate in the deep shelf, and 10 percent hard substrate on the slope.

Trawl survey data were not similarly applicable for the AI because relatively few trawlable sites (with the standard survey trawl) have been located. It is likely that a large proportion of the AI seafloor is hard substrate. Therefore, a value of 80 percent hard substrates was used for both shallow and deep strata.

These proportional estimates of hard and soft substrates do not affect the results accumulated within habitats. LEI results reported for proportions of hard substrates are the same as those that would be calculated if the entire habitat area consisted of hard substrates and likewise for the soft substrate results. Proportion estimates do affect the values for individual blocks, where these estimates apportion the hard and soft LEI values for that block into a single value.

The insufficient amount of real data on the types, proportions, and distribution of substrates in the GOA and AI should engender great caution in the application of the analysis results for these regions. These are areas where an intensified search for relevant data and the collection of additional applicable data would significantly improve future analyses of fishing effects.

B.2.3.2 Selection of Habitat Features

The connection between fishing gear effects on habitat and on managed species will depend on which features of the habitats were selected for analysis. Features that are not affected by fishing or do not serve a habitat function for a managed species are not relevant to the EFH analysis. Except for prey, which will be discussed separately, no information was found indicating significant effects of fishing on features of pelagic waters serving a habitat function for a managed species. Therefore, pelagic effects were assessed as minimal and were not analyzed further.

In contrast, numerous studies (see EFH EIS Section 3.4.3) have identified effects of fishing on features of the benthic environment that may, in turn, affect the welfare of managed species. For each feature category used, estimates of sensitivity to fishing gears and recovery rates were derived from the literature. The limited number of relevant effect and recovery studies and the minimal amount of data pertaining to use of habitat features by managed species reduced the consideration of habitat features to broad categories.

Fishing effects have been demonstrated for a variety of organisms that are prey for managed species. These were divided into the categories of infaunal and epifaunal prey. Effects have also been documented for features providing seafloor structure that may be used by fish (particularly juveniles) for spawning/breeding purposes or as shelter from predators, particularly juveniles. These features were divided into the classes of living and non-living structure. A special category of living structure with very slow recovery rates, represented by hard corals, was analyzed separately. The organisms and structures making up infaunal prey, epifaunal prey, living structure, and non-living structure vary between different habitat types. Separate sensitivity and recovery rates were derived and applied to each. The analysis treated each habitat feature class separately for each habitat type, so substrate structure in rocky habitats was not compared directly to substrate structure in sandy habitats.

B.2.3.3 Definition of Fisheries and Description of Gear Used

Data from the NMFS observer program provided detailed information on the distribution and intensity of the effort by groundfish fisheries off of Alaska (Section 3.4.1). For each gear type, a vessel is assigned to a fishery based on the species making up the largest proportion of the total catch for the week. The fisheries of each region are listed in Table B.2-3. The groundfish fisheries use bottom trawls, pelagic trawls, longline gear, and pots. A NMFS workshop in March 2002 generated comprehensive descriptions of the gear used by each of the fisheries off of Alaska (see Section 3.4.1). These descriptions were very useful in deriving the areas covered by a unit of effort for each fishing gear type and in appropriately applying the available research on gear effects.

Groundfish vessels less than 60 feet long are not required to carry observers and are not represented in the observer data. The fleets of trawl and longline vessels under 60 feet each take less than 1 percent of the groundfish catch, so their exclusion from the analysis was not considered likely to significantly change the evaluation. Therefore, these fisheries were not considered.

An initial analysis, prepared by the North Pacific Fishery Management Council (Council) staff (Witherell 2002) and reviewed at the May 2002 EFH Committee meeting, indicated that groundfish fisheries represented all but a small fraction of the potential fishing effects on habitat. This analysis generated scores for each fishery similar to the LEI scores described above. Scallop, Bering Sea/Aleutian Islands (BSAI) crab, and salmon fisheries had negligible effects on EFH, with overall scores for each of these fisheries less than 0.1. For comparison, the analysis found that the groundfish fisheries had LEI scores for trawl fisheries ranging from 0.2 to 11.2. Based on the following evaluations, the non-groundfish fisheries were not included in the final detailed analysis.

For the scallop fishery, the Witherell analysis found that, although the effects of this gear on benthic habitats are greater than for other gear types, the fishery occurs in areas and habitat types with relatively fast recovery rates. Additionally, the overall footprint (area effected annually) of the scallop fishery is very small (149 square nautical miles [nm]), equating to about 0.1 percent of the total available benthic EFH area. The effects of this fishery are concentrated in a very small proportion of EFH; thus, these effects are considered minimal and temporary in nature.

For the BSAI crab fisheries, the analysis found that the fisheries have an extremely small overall footprint, totaling less than 1 square nm) per year, equating to less than 0.0007 percent of the total available benthic EFH area. The effects of this fishery are concentrated in an extremely small proportion of available EFH; thus, these effects are considered minimal and temporary in nature.

For the salmon fisheries, the analysis found that the effects on EFH are almost non-existent because the gear generally never touches benthic habitats. Only the drift gillnet fishery was found to have an overall coverage of more than 0.1 percent of available EFH, but, because the gear never touched the bottom, however, this fishery could not affect benthic EFH. Thus, the effects on benthic EFH of the Alaska salmon fisheries are considered minimal and temporary in nature.

B.2.4 Parameter Estimates

B.2.4.1 Fishing Intensity (f) (by 5-by-5-km blocks)

High-quality fishing effort data are available from the groundfish observer program (see Section 3.4.1). Individual sets were tallied for 5-by-5-km blocks from 1998 to 2002. This 5-year period was selected to represent the current level of fishing effects. Reported effort (duration for trawls, hooks for longlines, and pot drops for pots) was converted into swept areas. Trawl durations were multiplied by speed, trawl width, and proportion of effort on the bottom (Table B.2-4). Width and speed were estimated using a survey of trawlers on gear usage and from information collected by observers. The estimate for the proportion of pelagic trawl effort contacting the seafloor considered both the amount of time in which any part of the trawl contacted the seafloor and the width of trawl contact with the seafloor during different periods of the fishery (e.g., day/night, A and B seasons). Information for this estimate was provided by fishing organizations. As the vulnerability of pelagic trawls to damage precludes their operation on rough and hard substrates, bottom contact was set at zero for the hard-bottom habitats of the GOA and the AI.

For longline and pot fisheries, different methods were used. In reporting effort for the longline fishery, two factors were taken into account, the number of longline hooks multiplied by the length of line per hook and the side-to-side extent or movement of the line. Pot drops were multiplied by the width of the pot and an estimate of the average distance pots traveled across the seafloor. Effort values for vessels not subject to 100 percent observer coverage were extrapolated from an estimate of the proportion of effort that was observed for that fishery and vessel class. While extrapolations for unobserved effort accounted for the total quantity of effort, they could not account for any differences in the geographic distribution of observed and unobserved effort. The values used for each of these swept areas for trawl, longline, and pot fishing are presented in Table B.2-5, along with comments on the source and quality of the estimates. No direct observational data were available for longline effect width, pot movement distance, or the proportion of pelagic trawl effort contacting the bottom, so each value has some uncertainty.

Fishing effort data from the observer database were assigned to 5-by-5-km blocks based on the ending position of the tow, set, or string. The total area covered by the effort was assigned to each block (in square km [km^2]). This total area of effort was divided by the area of the block (25 km^2) and by the number of years (5) to derive an intensity index.

Consequences of assigning effort to blocks using this method include the following:

1) Some effort assigned to each block may actually extend into neighboring blocks because effort was assigned to blocks based on ending positions. In areas of similar intensity, most of such displacements will be nullified by offsetting exchanges of effort between neighboring blocks. More noticeable errors may occur along boundaries, or around isolated cells. However, large-scale patterns will not be substantially affected because no effort is moved farther than the length of a single tow. Averaging across years will also tend to mute the effects of these small-scale-effort displacements.

2) The raw average intensities do not account for uneven distribution of effort within blocks. While this simple ratio could be incorrectly interpreted as an equal number of contacts at every site in the block, actual fishing patterns are more likely to contact previously fished sites repeatedly (overlap) than to display such a simple uniform distribution. Overlapped effort has less total effect because habitat features removed by previous passes are no longer present. It also increases the likelihood that more of the area of a block will not be contacted. The analysis model treats all effort locations as independent, mimicking a random effort distribution. This accounts for the effects of overlap as long as no sites are preferentially targeted.

3) Even on scales smaller than 25 km^2, fishing effort would still be expected to focus on areas that produce higher catches of adult fish and leave some other areas untouched. Since fish, and hence the fisheries that harvest them, tend to aggregate, even at small scales, the random distribution probably

underestimates the proportion of effort overlap occurring in the fisheries and, hence, overestimates habitat effects. The localization of fishing effort and the habitat effect per contact determine the size of any such error.

4) Patchy distributions of fishing efforts, both within and between blocks, will produce different effects at different locations. Since the habitat features and their use by fish can also be patchy, the actual effects on habitat function are influenced by how fishing and habitat-use patterns correspond. High overlap of habitat use and fishing would produce underestimates of habitat effects, while separation between patterns would produce overestimates. Underestimates would be most likely for features used by adult fish that are targeted by the fisheries. Overestimates are more likely for features used by other age classes, where their distribution is different from adults, or for habitat features that occur in areas that are difficult to fish, such as those with very rough, hard seafloors.

B.2.4.2 Sensitivity (q)

As a recent National Academy of Sciences review stated, there have been numerous recent studies on the effects of fishing gear on seafloor habitats with the most studied gear type being bottom trawls. Estimates from those studies, using gear relevant to Alaska fisheries (see Section 3.4.3), were used to generate sensitivity parameters. Information on other Alaska gears, except scallop dredges, is extremely limited. Sensitivity parameters for these gears were assigned using professional judgement.

The most relevant studies were selected to estimate q, the proportion by which habitat function at a particular site is reduced by a single contact with each type of fishing gear. The results of the literature review were compared and combined, taking into account differences in methods, applicability to Alaska fisheries, and the habitats and habitat features studied. Where available, measurements of q from both statistically significant and non-significant results were considered. Thus, this summary analysis does not directly consider the variability from the individual studies. Instead, the sampling unit was defined as a single study result (i.e., one reduction estimate for one species from one study). While weighting by the variability of each estimate would have been preferable, this information was rarely available. Since the statistical distribution of these relatively sparse data was unknown, medians were used to represent the central tendencies of these data results. To allow consideration of the effects of variability on estimates, the 25th and 75th percentiles were also calculated and used to estimate the effects of fishing. Only studies where q could be directly estimated were used in the analysis. This requirement meant the number of gear contacts was known or could be estimated. Another requirement was that sufficient time for recovery to occur had not elapsed. Applicable studies where these requirements were not met were examined for consistency with the results of the studies used.

The gear effects model requires estimates of q and allows these estimates to be specified for each combination of fishing activity, habitat type, and habitat feature. To the extent that different effects can be identified for different components of a fishing gear, the effect rates were averaged after weighting the proportion of each gear component's contact with the seafloor.

While the goal of sensitivity estimation was to calculate changes in habitat function, this parameter is not directly measurable. A measurable property of the habitat features, such as the feature's abundance or condition, had to be used as a proxy for the level of function. Changes in the available biomass of different prey species were used as a proxy for feeding functions. Structure functions, the most important of which were those related to the survival of juveniles to maturity, were more difficult to assess. While the abundance of structure-providing species remaining after trawling was available as a proxy, the decrease in function of damaged organisms (clearly an important consideration) could not be quantitatively assessed with any confidence. A decrease in function of 50 percent was applied to estimate the decrease in function of damaged organisms for this analysis. Values available from studies that indicated mortality resulting from a portion of an organism being damaged were added to the estimates of decreased function for structure-providing organisms. Suitable proxies were less available for non-living substrates.

In estimating the effects of a single gear contact, as required for this analysis, it was necessary to extrapolate results from studies that combined the effects of several contacts. The analysis assumes that the effects of all gear contacts are independent; that is, a second contact decreases habitat function by the same proportion as the first contact. In reality, absolute reduction decreases with each subsequent contact because less habitat function is available for removal. The method to adjust for multiple contacts in a study followed that same assumption.

Therefore, the ratio of features present before n gear contacts (H_b) and after n gear contacts (H_a) is:

(7) $H_a/H_b = (1-q)^n$,

where q is the proportional reduction in habitat per gear contact, and n is the number of contacts. Solving for q gives:

(8) $q = 1- e^{(\ln(Ha/Hb)/n)}$,

which was used to adjust the total reduction estimates from studies using multiple contacts with the gear.

B.2.4.2.1 Bottom Trawls

Infaunal Prey

Infaunal organisms, such as polychaetes, other worms, and bivalves, are significant sources of prey for Alaska groundfish species. Because researchers were not able to determine which crustaceans cited in trawl effects studies were actually infauna, all crustaceans were categorized as epifaunal prey. Studies of the effects of representative trawl gear on infauna included Kenchington et al. (2001), Bergman and Santbrink (2000), Brown (2003), Brylinsky et al. (1994), and Gilkinson et al. (1998).

Kenchington et al. (2001) examined the effects on over 200 species of infauna from trawl gear that closely resembled the gear used off of Alaska. Three separate trawling events were conducted at intervals approximating 1 year. Each event included 12 tows through an experimental corridor, resulting in an average estimate of three to six contacts with the seafloor per event. Of the approximately 600 tests for species effects conducted, only 12 had statistically significant results. The statistical methods were biased toward a Type 1 error of incorrectly concluding an impact. Ten of the significant results are from a year when experimental trawling was more concentrated in the center of the corridors where the samples of infauna were taken. It is likely that more trawl contacts occurred at these sampled sites than the 4.5 estimate (average of three to six contacts) used to adjust the multiple contact results. As such, the results that were available from the study (non-significant values were not provided) represent a sample biased toward larger reductions when used to assess median reductions of infauna. The resulting median effect was 14 percent reduction in biomass.

Bergman and Santbrink (2000) studied effects on infauna (mostly bivalves) from an otter trawl equipped with 20-centimeter (cm) rollers in the North Sea. Because the study was conducted on fishing grounds with a long history of trawling, the infaunal community may already have been affected by fishing. Experimental trawling was conducted to achieve average coverage of 1.5 contacts within the experimental area over the course of the study. Results were provided for two substrate types: coarse sand with 1 to 5 percent of the area contacted, and silt and fine sand with 3 to 10 percent of the area contacted. The five infauna biomass reductions in the first area had a median of 8 percent. The ten infauna biomass reductions from the second area had a median of 5 percent.

In a recent master's thesis, Brown (2003) studied the effects of experimental trawling in an area of the nearshore EBS with sandy sediments. Trawling covered 57 percent of the experimental area. Several bivalves had lower abundance after trawling, while polychaetes were less affected. The median of the reduction in percentages for each species, after adjusting for coverage, was a 17 percent reduction in biomass per gear contact.

Brylinsky et al. (1994) investigated effects of trawling on infauna, mainly in trawl door tracks, at an intertidal estuary. Only three results were provided for infauna in roller gear tracks, but the results were so variable (-50 percent, +12 percent, +57 percent) that they were useless for the purpose of this analysis. Eight results on the effects of trawl doors on species biomass were available for polychaetes and nemerteans. These results had a median of 31 percent reduction in biomass and a 75th percentile of 42 percent reduction in biomass. Gilkinson et al. (1998) used a model trawl door on a prepared substrate to estimate that 64 percent of clams in the door's path were exposed after one pass, but only 5 percent were injured. Doors make up less than 4 percent of the area of the seafloor contacted by Alaska trawls.

The results of Kenchington et al. (2001), Bergman and Santbrink (2000), and Brown (2003) were combined for inclusion in the model, resulting in a median of 10 percent reduction in biomass per gear contact for infaunal species due to trawling, and 25th and 75th percentiles of 5 and 21 percent, respectively (Table B.2-5).

Epifaunal Prey

Epifaunal organisms, such as crustaceans, echinoderms, and gastropods, are significant prey of Alaska groundfish species. However, one of the most common classes of echinoderms, asteroids, are rarely found in fish stomachs. While some crustaceans may be infauna, an inability to consistently identify these species resulted in all crustaceans being categorized as epifaunal prey. Studies of the effects of representative trawl gear on epifauna included Prena et al. (1999), Brown (2003), Freese et al. (1999), McConnaughey et al. (2000), and Bergman and Santbrink (2000).

Prena et al. (1999), as a component of the Kenchington et al. (2001) study, measured the effects of trawling on seven species of epifauna. The median of these results was a 4 percent biomass reduction per gear contact. There appeared to be in-migration of scavenging crabs and snails in this and other studies. Removing crab and snails left only two measurements, 6 and 7 percent reductions in biomass. Bergman and Santbrink (2000) measured effects on four epifaunal species in the experimental coarse sand area (median reduction in biomass was 12 percent) and five epifaunal species in the experimental fine sand area (median reduction in biomass was 16 percent). When crabs and snails were removed, the coarse sand area was unchanged, and the median value for the fine sand area was 15 percent biomass reduction. Brown (2003) studied six epifaunal species, resulting in a median reduction in biomass per gear contact of 5 percent. Combining results from Prena et al. (1999), Brown (2003), and Bergman and Santbrink (2000), and removing crabs and snails, gives a median reduction in biomass of epifaunal species of 10 percent, and 25th and 75th percentiles of 4 and 17 percent, respectively. These are the q values used for the analysis of the effects of full trawls on epifaunal prey, except for those fisheries using tire gear (see below).

The study of McConnaughey et al. (2000) compared the effects of fishing on an area that received heavy fishing pressure between 4 and 8 years previously, using an adjacent unfished area as a control. Therefore, results included a combination of species reductions and recovery, were not adjusted for multiple contacts, and were not directly comparable to the results of the studies above. However, for comparison with previously discussed studies, the resulting median and 75th percentile reductions in biomass for six species of epifauna (excluding snails and crabs) were 12 and 28 percent, respectively. The median result was within the same range as those from the more direct studies, and the 75th percentile result was not sufficiently higher as to indicate substantial error in the direct estimates.

Freese et al. (1999) studied the effects of tire gear on the epifauna of a pebble and boulder substrate. Eight epifaunal species gave a median response of 17 percent reduction in biomass and a 75th percentile of 43 percent reduction in biomass. Before snails were removed, the 25th percentile indicated an increase in biomass of 82 percent due to colonization by snails. The resulting values when two snail taxa were removed were 38 and 43 percent medians and a 5 percent reduction in epifaunal biomass for the 75th and 25th percentiles. The authors noted a strong transition to apparently smaller effects outside of the direct path of the tire gear. For fisheries in hard-bottom areas, where tire gear is most common, epifaunal effects were adjusted for this increased effect within the path of the tire gear. Typical tire gear covers about 25 percent of the full trawl path (i.e., 14 m out of 55 m total), so the resulting q values are 17 percent reduction in epifaunal biomass for the median (0.25 times 38 plus 0.75 times 10), 23 percent reduction for epifaunal biomass for the 75th percentile (0.25 times 43 plus 0.75 times17), and 5 percent reduction for the 25th percentile.

Living Structure

Organisms that create habitat structure in Alaska waters include sponges, bryozoans, sea pens, soft and stony corals, anemones, and stalked tunicates. Studies of the effects of representative trawls on these groups include Van Dolah et al. (1987), Freese et al. (1999), Moran and Stephenson (2000), Prena et al. (1999), and McConnaughey et al. (2000). The first three studies examined the effects on epifauna on substrates such as pebble, cobble, and rock that support attached erect organisms, while the last two studies were located on sandy substrates. Effect estimates were available for only one type of structure-providing organism, the soft coral *Gersemia*, from Prena et al. (1999). After adjustment for multiple contacts, *Gersemia* had a q of 10 percent reduction in biomass per gear contact.

Both the Van Dolah et al. (1987) and Freese et al. (1999) studies identified removal rates and rates of damage to organisms remaining after contact, raising the question of how damage incurred from contact with gear reduces the structural function of organisms. In Freese et al. (1999), sponges were indicated as damaged if they had more than 10 percent of the colony removed, or if tears were present through more than 10 percent of the colony length. Van Dolah et al. (1987) classified organisms as heavily damaged (more than 50 percent damage or loss) or lightly damaged (less than 50 percent damage or loss). Lacking better information, the damaged organisms from Freese et al. (1999) were assigned a 50 percent loss of structural function, and the heavily and lightly damaged organisms from VanDolah et al. (1987) were assigned 75 and 25 percent losses of their function respectively.

Adjustments to the Freese et al.(1999) results were based on observations of a further decrease in vase sponge densities 1 year post-study. Freese (2001) indicates that some of the damaged sponges had suffered necrotization (decay of dead tissues) to the extent that they were no longer identifiable. This percentage was added to the category of removed organisms, resulting in q estimates for epifauna structures in the path of tire gear of a 35 percent median reduction in biomass per contact and a 75th percentile of 55 percent reduction in biomass per contact. Summary results of the VanDolah data show a median of 17 percent reduction in biomass per gear contact and a 75th percentile of 22 percent reduction in biomass per gear contact. Moran and Stephenson (2000) combined all erect epifauna taller than 20 cm and studied their reductions subsequent to each of a series of trawl contacts. They estimated a per contact reduction in biomass (q) of 15 percent. Combining the non-tire gear studies gives a full gear q median per contact reduction estimate of 15 percent and a 75th percentile per contact reduction estimate of 21 percent. Using the same methods as applied to epifauna for combining non-tire gear data with the tire gear data produced effect estimates for trawls employing tire gear of a median per contact reduction of 20 percent and a 75th percentile per contact reduction of 30 percent.

Data from McConnaughey et al. (2000) combining initial effects of high-intensity trawling and recovery had a median value for structure-forming epifauna per contact reduction of 23 percent and a 75th percentile reduction of 44 percent. While these results show greater reductions than the single pass estimates from the other studies, the effects of multiple years of high-intensity trawling can reasonably account for such a difference; thus, the above values for q were not altered.

Hard Corals

While numerous studies have documented damage to hard corals from trawls (e.g., Fossa 2002, Clark and O'Driscoll 2003), only one (Krieger 2001) was found that related damage to a known number of trawl encounters. Fortunately, this study occurred in the GOA with a common species of gorgonian coral (*Primnoa rubi*) and with gear not unlike that used in Alaska commercial fisheries. Krieger used a submersible to observe a site where large amounts of *Primnoa* were caught during a survey trawl. An estimated 27 percent of the original volume of coral was removed by the single trawl effort. The site was in an area closed to commercial trawling, so other trawling effects were absent. This value was used for coral sensitivity in the analysis bracketed by low and high values of 22 and 35 percent.

Non-living Structure

A variety of forms of the physical substrates in Alaska waters can provide structure to managed species, particularly juveniles. These physical structures range from boulder piles that provide crevices for hiding to sand ripples that may provide a resting area for organisms swimming against currents. Unfortunately, few of these interactions are understood well enough to assess the effects of substrate changes on habitat functions. A number of studies describe changes to the physical substrates resulting from the passage of trawls. However, there is no consistent metric available to relate the use of such structures by managed species to their abundance or condition. This lack of relationship effectively precludes a quantitative description of the effects of trawling on non-living structure. The following discussion describes such effects qualitatively and proposes preliminary values of q for the analysis.

Sand and Silt Substrates:
Schwinghamer et al. (1998) described physical changes to the fine sand habitats caused by trawling as part of the same study that produced Prena et al. (1999) and Kenchington et al. (2001). Door tracks, approximately 1 m wide and 5 cm deep, were detected with sidescan sonar, adding to the surface relief of the relatively featureless seafloor. Finer scale observations, made with video cameras, indicated that trawling replaced small hummocky features a few cm tall with linear alignments of organisms and shell hash. A dark organic floc that was present before trawling was absent afterwards. While no changes in sediment composition were detected, measurements of the internal structure of the top 4.5 cm of

sediment were interpreted to indicate loss of small biogenic sediment structures such as mounds, tubes, and burrows. Brylinsky et al. (1994) describe trawl tracks as the most apparent effect of trawls on a silty substrate and the tracks of rollers as resulting in much shallower lines of compressed sediment than tracks of trawls without rollers. A wide variety of papers describes trawl marks; these papers include Gilkinson et al. (1998), who describe the scouring process in detail as part of a model door study.

For effects on sedimentary forms, the action of roller gear trawls replaces one set of cm-scale forms, such as hummocks and sand ripples, with door and roller tracks of similar scales. In habitats with an abundance of such structures, this can represent a decrease in seabed complexity, while in relatively smooth areas, an increase in complexity will result (Smith et al. 2000). The effects on internal sediment structure are considered too small in scale to provide shelter directly to the juveniles of managed species. The extent to which they affect the availability of prey for managed species is better measured by directly considering the abundance or those prey species. This consideration was done by studies cited in the prey sections above. Since the observed effects of a single gear contact are relatively subtle, with ambiguous effects on function, the parameter selected for this analysis represents a small negative effect (-2 percent). This provides some effect size that can be scaled up or down if greater or lesser effects are hypothesized or measured.

Pebble to Boulder Substrates:

In substrates composed of larger particles (large pebbles to boulders), the interstitial structure of the substrate has a greater ability to provide shelter to juveniles and adults of managed species. The association of species aggregations with such substrates provides evidence of their function as structure (Krieger 1992, 1993). Freese et al. (1999) documented that the tire gear section of a trawl disturbed an average of 19 percent of the large boulders (more than 0.75-m longest axis) in its path. They noted that displaced boulders can still provide cover, while breaking up boulder piles can reduce the number and complexity of crevices.

In areas of smaller substrate particles (pebble to cobble), the track of the tire gear was distinguishable from the rest of the trawl path due to the removal of overlying silt from substrates with more cobble or the presence of a series of parallel furrows 1 to 8 cm deep from substrates with more pebble. Of the above effects, only breaking up boulder piles was hypothesized to decrease the amount of non-living functional structure for managed species. A key unknown is the proportional difference in functional structure between boulder piles and the same boulders, if separated. If that difference comprised 20 percent of the functional structure, and 19 percent of such piles were disturbed over one-third of the trawl paths (tire gear section), a single trawl pass would reduce non-living structure by only about 1 percent. Even if piles in the remaining trawl path were disturbed at half the rate of those in the path of the tire gear (likely an overestimate from descriptions in Freese et al. 1999), the effect would only increase to 2 percent. Lacking better information, this speculative value was applied in the analysis.

B.2.4.2.2 Pelagic Trawls

Studies using gear directly comparable to Alaska pelagic trawls, and thus identifying the resulting effect of such gear contact with the seafloor, are lacking. By regulation, these trawls must not use bobbins or other protective devices, so footropes are small in diameter (typically chain or sometimes cable or wrapped cable). Thus, their effects may be similar to other footropes with small diameters (i.e., shrimp or Nephrops trawls). However, these nets have a large enough mesh size in the forward sections that few, if any, benthic organisms that actively swim upward would be retained in the net. Thus, benthic animals that were found in other studies to be separated from the bottom and removed by trawls with small-diameter footropes would be returned to the seafloor immediately by the Alaska pelagic trawls.

Pelagic trawls are fished with doors that do not contact the seafloor, so any door effects are eliminated. Finally, because the pelagic trawl's unprotected footrope effectively precludes the use of these nets on rough or hard substrates, they do not affect the more complex habitats that occur on those substrates.

Two studies of small footrope trawls were used to represent the effects of pelagic trawl footropes on infaunal prey. Since most infaunal prey are too small to be effectively retained by bottom trawls, the large mesh size of pelagic trawls was not considered a relevant difference for the feature. Ball et al. (2000) investigated the effects of two tows of a Nephrops trawl in the Irish Sea on a muddy sand bottom in two different years. Eighteen taxonomic groups were measured in each year, including bivalves, gastropods, crustaceans, and annelids. For the 27 abundance reductions cited, the median effect was a 19 percent reduction abundance per gear contact, and the 75th percentile was a 40 percent reduction in abundance per gear contact, with the adjustment for multiple tows. Sparks-McConkey and Wating (2001) used four passes of a whiting trawl on a clay-silt bottom in the Bay of Maine. The infauna responses measured included three bivalves and seven polychaetes and nemerteans. The median response was a 24 percent reduction in abundance per gear contact, and the 75th percentile was a 31 percent reduction in abundance per gear contact, with the adjustment for multiple tows. Combining the two studies gave a median per contract reduction of 21 percent and a 75th percentile per contact reduction of 36 percent. These values were higher than those for roller gear trawls since there is continuous contact across the footrope and a greater ability of smaller footropes to penetrate the substrate.

Sessile organisms that create structural habitat may be uprooted or pass under pelagic trawl footropes, while those that are more mobile or attached to light substrates may pass over the footrope, with less resulting damage. Non-living structures may be more affected by pelagic trawl footropes than by bottom trawl footropes because of the continuous contact and smaller, more concentrated, surfaces over which weight and towing force are applied. In contrast, bottom trawls may capture and remove more of the large organisms that provide structural habitat than pelagic trawls because of their smaller mesh sizes. The bottom trawl doors and footropes could add complexity to sedimentary bedforms as mentioned previously, while pelagic trawls have an almost entirely smoothing effect. Based on these considerations, values of 20 percent reduction per gear contact and 30 percent reduction per gear contact were selected for both living and non-living structure.

B.2.4.2.3 Longlines

Studies that quantitatively assess the effects of longlines on seafloor habitat features were not found. Due to the light weight of the lines used with longline gear, effects on either infaunal or epifaunal prey organisms are considered to be limited to anchors and weights. Since these components make up less than 1/500th of the length of the gear, their effects are considered very limited (0.05 percent reduction per contact was the value used). Similarly, effects on the non-living structure of soft bottoms are also likely to be very limited.

Organisms providing structure may be hooked or otherwise affected by contact with the line. Observers have recorded anemones, corals, sea pens, sea whips, and sponges being brought to the surface hooked on longline gear (Stellar sea lion protection measures SEIS, 2001), indicating that the lines move some distance across the seafloor and can affect some of the benthic organisms. The effects on non-living structure in hard-bottom areas due to hang-ups on smaller boulder piles and other emergent structures are limited to what may occur at forces below those necessary to break the line. Similar arguments to those used for bottom trawl effects on hard non-living structure would justify an even lower effect than the value generated for bottom-trawling (1 percent). Unfortunately, there are no data to indicate what proportion the retained organisms represent of those contacted on the seafloor or the level of damage to any of the affected organisms. Values for reduction of living structure equal to one-half of those for bottom trawls were used for the area contacted by longlines.

B.2.4.2.4 Pots

The only studies on pots (Eno et al. 2001) have examined gear much smaller and lighter than that used in Alaska waters and are, thus, not directly applicable in estimating effects of pots on habitat. Alaska pots are approximately 110 times as heavy and cover 19 times the area as those used by Eno et al. (2001) (2.6 kilograms [kg], 0.25 m^2). The Eno et al. (2001) study did show that most sea pens recovered after being pressed flat against the bottom by a pot. Most Alaska pots have their mesh bottoms suspended 2.5 to 5 cm above their weight rails (lower perimeter and cross pieces that contact the substrate first); hence, the spatial extent to which the greater weight of those pots is applied to organisms located underneath the pots is limited, but more intense.

The area of seafloor disturbed by the weight rails is of the greatest concern, particularly to the extent that the pot is dragged across the seafloor by bad weather, currents, or during hauling. Based on the estimated weight of the pots in water, and the surface area of the bottom of these rails, the average pressure applied to the seafloor along the weight rails (about 1 pound per square inch [lb/in^2] [0.7 kilogram per square centimeter (kg/cm^2)]) is sufficient to penetrate into most substrates during lateral movement. The effects of pots as they move across the bottom were speculated to be most similar to those of pelagic trawls with smaller contact diameter and more weight concentrated on the contact surface. Therefore, structure reduction values 5 percent greater than those determined for pelagic trawls were used.

B.2.4.3 Recovery Rate

A small proportion of studies on the effects of fishing have looked at recovery periods for different features and habitat types. Most of these studies were summarized in Collie et al. (2000). This paper contained plots that combined results from studies that examined many gear types, including intertidal dredges, scallop dredges, beam trawls, and small footrope trawls. Nearly all of the organisms represented in the plots are from groups that are classified as infaunal or epifaunal prey. The only points in the plots representing living shelter are from the Van Dolah et al. (1987) study. The logarithmic time scale used for the figures in that paper makes it somewhat difficult to extract exact recovery periods. Careful measurements and known landmarks (i.e., there was generally a recognizable group of studies with 1 year in all plots) were used to achieve the following estimates. Fishing effects in sand habitats were reduced to very near zero effect within about 2 months, though a small amount of reduction in biomass remained until 1 year. Therefore, the estimated timeframe for recovery in sand habitats was 3 months or 0.25 year (Table B.2-6) to account for the small reduction over time. Mud/sand mixes and mud habitats were estimated to recover at 12 months and 6 months, respectively. Studies using roller trawls in those environments included Kenchington et al. (2001), which detected no remaining effects in a sand/mud mix after 1 year, and Brylinski et al. (1994) with polychaetes and nematodes in intertidal sand/mud mixes recovering in 1 to 2 months. The recovery period selected for sand/mud mixes was 0.75 year and 1 year for mud habitats.

To allow for evaluation of scientific uncertainty, the same data were considered to derive long and short recovery times for each habitat. The resulting values were 3 to 4 months for sand, 6 to 12 months for sand/mud, and 6 to 18 months for mud habitats. The inverses of all of these values were calculated to estimate the recovery rates needed for the effect model (Table B.2-6).

In general, very little data are available on the recovery periods for living structure. A literature review has undertaken to determine growth rates, recovery rates, fecundity values, and recruitment rates for major structuring invertebrate taxa (sponges, hard and soft corals, bivalves, hydroids, polychaetes, anemones, sea pens, and bryozoans) from previous studies. There was minimal information on most of these taxa from studies conducted in Alaska, and few studies were conducted in temperate or arctic waters in general. Preliminary data were available for EBS anemone populations, which indicated that the recovery rate of sea anemones from trawling effects may have been as great as 30 percent per year in soft bottom habitats (McConnaughey 2003). This finding was consistent with the Wahl (1985) study in temperate waters. In hard-bottom areas of the GOA, Freese (2001) returned to an area affected by tire gear and found no visible indications of healing or regrowth of vase sponges. A study gave a recovery rate for gorgonian corals of about 4 percent per year in a marine sanctuary in Florida (Gittings et al. 1988). In Alaska, gorgonian growth rates have been observed to be 0.2 and 0.58 cm per year (Stone et al. 2001, Andrews et al. 2002), indicating a 1-m-high coral could be more than 100 years old. An evaluation of maximum ages, growth rates, and recruitment rates for bivalves and polychaetes suggested their recovery times could be shorter than recovery times for corals, sponges, and anemones. VanDolah et al. (1987) found full recovery of sponges and octocorals in less than 1 year in a shallow water study off of North Carolina. Leys and Lauzon (1998) estimated that some sponges in a deepwater fjord averaged 35 years old with a maximum age of 220 years.

A meeting was scheduled with a panel of experts to discuss and estimate recovery rates of structure-forming invertebrates that would be acceptable to use in the fishing effects model. The participants included scientists who had previously studied invertebrate taxa. Attendees were Braxton Dew (RACE), Linc Freese (ABL), Bob McConnaughey (RACE), Chris Rooper (RACE), Craig Rose (RACE), Matt Wilson (FOCI), Bruce Wing (ABL), Cynthia Yeung (RACE), and Mark Zimmermann (RACE). The literature review of growth rates, recovery rates, fecundity values, and recruitment rates for “structuring invertebrate” taxa was circulated among the scientists before the meeting. This life history information served as background information for determining the potential recovery of these invertebrates. There was consensus that a reasonable range for recovery rates of structure-forming invertebrates associated with the soft bottom, based on their life history characteristics, was 10 to 30 percent per year with a mean of 20 percent per year. There was also consensus that hard-bottom recovery rates were slower, 1 to 9 percent per year, with a mean of 5 percent per year based on hard-bottom invertebrate life history characteristics. These were converted to exponential rates for use in the model by the following formula:

$$\rho = \ln\,(1+\text{annual percent increase}).$$

Resulting rho values were 0.26, 0.18, and 0.10 for soft substrate habitats and 0.09, 0.05, and 0.01 for hard substrate habitat.

Recovery rates of gorgonian corals are potentially much longer and, therefore, were evaluated separately in the analysis. Short, middle, and long recovery periods of 50, 100, and 200 years were the values used for gorgonian corals. Growth rates from Leys and Lauzon (1998) indicated that some sponges recover at rates between those of the other hard-bottom, living structure, and coral groups.

Recovery of non-living structures can occur from current and wave action or burrowing animals. Studies indicated that door marks had became undetectable within 2 to 4 months (Brylinski et al. 1994) or 1 year (Schwinghamer et al. 1998), and other marks dissipated more rapidly. Therefore, the recovery rate for soft substrates was determined to be 1 year for the purposes of the model. In hard substrates, the breaking up of boulder piles is not an effect that will recover on biological time scales, but disturbances of pebble-size substrates could be modified by biological action. The effect/recovery model is not a good fit for this type of habitat feature. While boulder pile habitat will not recover, the total effect possible is the difference between the habitat value of the piles and the habitat value of the same boulders when isolated. Past that point, no further degradation of that feature could occur, although the model continues to apply proportional reductions beyond that point. This is an area where more detailed information on habitat usage, description, and distribution is needed. For purposes of this analysis, a recovery period of 100 years, with a range of 50 to 200 years, was used to capture recovery of pebble site substrates.

B.2.4.4 Habitat Categorization

The habitat and regional boundaries (see B.2.3.1) were overlaid using geographic information systems (GIS) (ArcMap), resulting in the classification of each of the 5-by-5-km blocks by habitat type. Where a boundary passed through a block, the area within each habitat was calculated, and those areas were analyzed separately. For the GOA and AI habitats, the estimates of proportions of hard and soft substrate habitat types were entered into the classification matrix for each block.

B.2.4.5 Area (A)

The total area of each benthic habitat was calculated through GIS based on coastlines, regional boundaries, habitat boundaries, and depth contours (Table B.2-7).

B.2.5 Results of the Analysis of Effects of Fishing on Habitat Features

No fishing occurred in blocks covering a large proportion of the seafloor area shallower than 1,000 m from 1998 to 2002 (Table B.2-8), and even more blocks were unaffected by trawling. Most of the fished blocks experienced intensities less than 0.1, and only a small proportion of the area (2.5 percent BS, 0.8 percent AI, and 0.9 percent GOA) was in blocks with intensities above 1.0. These fishing intensities determined the spatial distribution of the indices of fishing effects estimated by the model.

The analysis estimated an LEI of the effects of fishing on infaunal prey, epifaunal prey, living structure (coral treated separately), and non-living structure across different habitats and between fisheries. The LEI estimated the percentage by which these habitat features would be reduced from a hypothetical unfished abundance if recent intensity and distribution of fishing effort were continued over a long enough term to achieve equilibrium. Equilibrium is defined as a point where the rate of loss of habitat features from fishing effects equal the gain from feature recovery. The spatial pattern of long-term effect indices largely reflects the distribution of fishing effort scaled by the sensitivity and recovery rates assigned to different features in different habitat types. Thus, patterns on the charts of LEI for each feature class were very similar, with higher overall LEIs for more sensitive or slower recovering features (Figures B.2-2 to B.2-5). Prey LEIs were substantially lower than structure LEIs, reflecting their lower sensitivity and faster recovery rates.

All habitats included substantially unfished and lightly fished areas that have low LEIs (less than 1 percent) as well as some areas of high fishing that resulted in high LEIs (more than 50 percent or even more than 75 percent). In the AI, GOA, and EBS slope, substantial LEIs were primarily concentrated into many small, discrete pockets. On the EBS shelf, there were two larger areas where high LEIs were concentrated: (1) an area of sand/mud habitat between Bristol Bay and the Pribilof Islands and (2) an area of sand habitat north of Unimak Island and Unimak Pass, mostly inside of the 100-m contour.

Some of the patterns in fishing effects can be related to areas closed to bottom trawl fishing. In the GOA, no bottom trawling is allowed east of 140ºE longitude, and fishing effects are light there. Bottom trawling has been substantially restricted within specified radii (10 and 20 nm) of Steller sea lion rookeries and haulouts. The effects of these actions on LEI values are most clearly seen in the AI, where high LEI values are concentrated in small patches where the narrow shelf does not intersect these closures. Two large EBS areas around the Pribilof Islands and in and adjacent to Bristol Bay both mostly in sand substrates, are closed to bottom trawling to protect red king crab habitat. These closures concentrate fishing in the southern part of the EBS into the remaining sand, sand/mud, and slope habitats, which likely increases the predicted LEI in those areas.

Aggregate LEIs for each of the habitats are shown in Table B.2-9. As discussed above, prey declined less than biostructure due to lower sensitivity and faster recovery rates. No prey feature was reduced by more than 3.5 percent (BS slope habitat). Biological structure features had LEIs between 7 and 9 percent in the hard substrate habitats where recovery rates were slow. LEIs above 10 percent were indicated for the biological structure of the sand/mud and slope habitats of the EBS where fishing effort is concentrated, and recovery rates are moderately slow.

Because of uncertainties in key input parameters, some evaluation was needed to determine how widely the resulting estimates might vary. In addition to the LEIs cited above, which were generated with median or central estimates for each input parameter (referred to below as central LEIs), LEI was estimated for both large and small values of sensitivity and recovery. High estimates of sensitivity were combined with low recovery rates to provide an upper LEI, and low estimates of sensitivity were combined with high recovery rates to produce a lower LEI. Lower LEIs for the habitat features (except for coral, which is discussed below) ranged from 8 to 50 percent of the original median estimates. Infaunal and epifaunal prey lower LEIs were all at or below 0.5 percent proportional reduction habitat, those for non-living structure were below 2 percent, and those for living structure were below 4 percent. The corresponding upper LEIs ranged from 1.5 to 3 times the original median estimate. The largest upper LEI values for infauna and epifauna prey were for the EBS sand/mud and slope habitats and ranged from 3.5 to 7 percent, with all other upper LEIs below 2 percent. Non-living structure upper LEIs were greatest on the GOA hard substrates, the AI shallow water habitat, and the EBS slope, ranging from 7 to 14 percent, with all other upper LEIs below 4 percent. In six habitats (the three GOA hard substrates, the AI shallow water habitats, and the EBS sand/mud and slope habitats), the upper LEI exceeded 10 percent, with the highest value (21 percent) on the GOA slope.

The analysis also calculated the proportion of each LEI attributable to each fishery. Fishery-specific LEI values for the habitat/feature combinations with the highest overall LEIs (all involving living structure) in each region are presented in Table B.2-10. While the pollock pelagic trawl fishery was the largest single component (4.6 percent) of the total effects on living structure in the EBS sand/mud habitat, the combined effects of the bottom trawl fisheries made up all of the remaining 6.3 percent (total LEI of 10.9 percent). This was not true for living structure on the EBS slope, where nearly all (7.2 percent out of 10.9 percent) of the LEI was due to the pollock pelagic trawl fishery. Living structure on hard bottom substrates of the GOA slope was affected by bottom trawling for both deepwater flatfish and rockfish. While the LEIs of these two fisheries were nearly equal, it is likely that much more of the rockfish effort occurred on hard substrates as compared with trawling for deepwater flatfish. [Because the spatial distribution of hard and soft substrate was unknown, such differences are not explicitly accounted for in the fishing effects analysis.] Therefore, most of the effects on this feature were attributed to the rockfish trawl fishery. In the shallow, hard substrate habitat of the AI, most of the effects (4.2 out of 7.3 percent) on living structure were attributable to the trawl fishery for Pacific cod. The remainder was attributed to Atka mackerel trawling at 2.5 percent. Living structure was the only habitat feature in which the effect of a passive gear fishery, longlining for Pacific cod, had an LEI above 0.1 percent. This fishery accounts for the consistent light blue (less than 1 percent LEI) coverage in Figure B.2-3 (a, b, and c) of many shallow areas of the AI not open to trawling.

Results for ultra-slow recovering structures, represented by hard corals, were different from those of other living structure in several ways. Corals had the highest LEI values of the fishing effects analyses. Because the very slow recovery rate of these organisms results in very high (more than 75 percent LEI) eventual effects with more than the most minimal amount of trawl fishing (annual trawl effort less than one tenth the area of the block), the distribution of high LEI values directly reflects the distribution of blocks subject to more than minimal trawl effort (Figure B.2-6 [a, b, and c]). The LEI values by habitat range from 6 to 20 percent with the highest values in the shallow AI and GOA slopes. These results mostly reflect the proportion of blocks in each habitat type subject to more than minimal trawl effort. Even though fairly wide ranges of both sensitivity and recovery rates were used for the upper and lower LEI estimates for coral, the range between upper and lower LEI was not as wide as for the other living structure organisms, ranging from plus 40 to -33 percent of the central value.

This analysis combined available information to assess the effects of Alaska fisheries on marine fish habitat. It estimated the effects (as measured by LEIs) of fisheries on habitat features that may be used by fish for spawning, breeding, feeding, or growth to maturity. These LEIs represent the proportion of feature abundances (relative to an unfished state) that would be lost if recent fishing patterns were continued indefinitely (to equilibrium). Therefore, all LEIs represent effects that are not limited in duration and satisfy the EFH regulation's definition of "not temporary." The magnitude and distribution of feature LEIs can, thus, be compared with the distribution of the use of that feature by fish species to assess whether the effects are "more than minimal" relative to that species' EFH (Section B.3). Effects meeting this second element would necessarily meet both elements (more than minimal and not temporary) due to the nature of the LEI estimates.

B.2.6 Effects on Habitat Features—Summary

Across broad habitats, LEIs were generally small (the largest central LEI was 11 percent). Living structure was the most vulnerable of the features, followed by non-living structure. Both infaunal and epifaunal prey were more resilient, with a maximum central LEI for a habitat of 3.5 percent.

As fishing efforts were the only data available on a small spatial scale, the details of the LEI maps represent distributions of fishing effort, weighted on a much broader scale for habitat vulnerability characteristics. Therefore, they only represent the potential for reduction of whatever habitat features may be present in each block, without discriminating differences in habitat function between blocks.

In particular locations, certain LEIs (particularly for living structure) were quite substantial. The area with the largest overall LEIs was a patch of sand habitat north of Unimak Island and Unimak Pass, where biological structure LEIs for most of the 5-by-5-km blocks were more than 75 percent. A larger area in the sand/mud habitat of the EBS between Bristol Bay and the Pribilof Islands had living structure LEIs mostly between 25 and 75 percent with a few above 75 percent. Areas with larger LEIs on the EBS slope and in the GOA and AI were much smaller and more scattered. The intensity of effects in these patches is likely affected by redistribution of fishing effort from existing fishing closures. The Unimak patch is the only sand habitat remaining open to trawling in the southern BS shelf after closures to protect red king crab habitat. The other EBS patch is directly between the two areas affected by those closures.

Hard coral LEIs represent animals with ultra-slow recovery rates, which make them very vulnerable to long-term effects from fishing. LEI calculations indicated that wherever these features encountered trawling effort above one-tenth of a block's area per year they had LEIs above 75 percent. The spatial distribution of coral LEIs (Figure B.2-6 [a, b, and c]) essentially identified all trawled areas. As described above, LEIs are estimated for all areas regardless of the abundance, or even the presence of a habitat feature. Because hard corals have particular habitat requirements, including hard substrate and significant currents, a large proportion of the blocks in Figure B.2-6 (a, b, and c) with high coral LEIs does not include suitable habitat for hard corals; hence, no coral reduction actually occurs. Therefore, consideration of coral LEIs focuses on the AI and the GOA slopes, areas of known hard coral abundance. Leys and Lauzon (1998) estimated that some sponges in a deepwater fjord averaged 35 years of age with a maximum age of 220 years. Therefore, effects for some sponges may be better represented by the hard coral LEIs than those for the general living-structure category.

Coral LEIs were also particularly subject to biases (described in Section B.2.2) due to interactions between the small-scale patchiness of the presence of these organisms with the patchiness of fishing effort. In hard-bottom areas, fishing location must consider seeking higher abundances of fish and avoiding structures (including rocks and rough bottom) that may damage fishing gear. This tends to move fishing effort toward smoother seafloors and away from rough, hard-bottom habitats. Higher concentrations of coral in rough, hard-bottom habitats would cause an overestimate of the actual LEI. Adding a seafloor constraint also concentrates fishing into known areas of fishable bottom, increasing overlap between tows. To the extent that such overlap exceeds what would occur if tows were randomly placed, LEIs overestimate actual effects because trawling encounters less undamaged structure. Therefore, the raw coral LEIs should not be taken at face value, and the above effects should be considered in their application.

In addition to the primary objective of assessing effects of fishing on habitat, another important function of this analysis was to identify weaknesses in the information base on which such an assessment must rely. Many of the parameters used in this analysis are speculative and only indirectly supported. These areas should be developed with further, or in some cases, initial, research. Areas of particular need include sensitivity of Alaska habitat species to fishing gear used in Alaska, the recovery rates of biological structure-forming organisms, the proportion and distribution of pelagic trawl effort in contact with the seafloor, the definition and characterization of habitat types and features relevant to managed species, the contact of longlines and pots with the seafloor and their effects, and methods for reducing the effects of fishing gears on habitats. Finally, a vital information gap is establishing linkages between changes in the availability of habitat features, the success of the life-history processes of fish species, and the subsequent effects on population abundances and structures.

Determining whether reductions of EFH are more than minimal and not temporary is conditioned on the premise that the habitat features being measured in some way affect the ability of managed species to feed, reproduce, and grow to maturity. Also considered is the extent to which a reduction in habitat limits a species' ability to support a fishery or participate in environmental linkages. Strong and specific dependencies on habitat would be necessary for the reductions in habitat features noted here to result in fish population reductions of similar magnitudes. Results of this analysis show reduction proportions well below the annual harvest rate for most of the managed species. On the other hand, much more specific knowledge of habitat dependencies would be needed to detect species-specific limitations that could create a population bottleneck. The following section will, to the extent possible with available information, assess the effects of the estimated reductions in habitat on the populations of managed species.

The results of the fishing effects analysis reflect the generalizations from the fishing-effects literature on which the model was based. The spatial pattern of effects primarily reflected the distribution of trawl fishing with some variation due to differences in habitat sensitivity and effort from other gears. The differences in LEI between habitat features (e.g., infauna prey versus living structure) indicated the potential for long-term changes in community composition and structure as seen in McConnaughey et al. (2000) and reviewed in Thrush and Dayton (2002). Since fishing effort has been at or above current levels for 30 years, most of the estimated effects may be reflected in current feature levels. For most of the parameters used in the analysis, 95 percent of the effects would be realized in less than 25 years (Fujioka, J., NMFS Lab, Auke Bay, personal communication). The exception is ultra-slow recovery species and low fishing rates (e.g., coral in the AI), where the effects would accumulate more slowly.

To test the validity of the model, catches of living-structure invertebrates by the annual groundfish survey of the EBS from 1990 to 2004 were analyzed to see if predicted changes due to varying fishing intensity could be detected. A year-to-year version of the model, based on Equation 4, was used instead of the equilibrium version that estimates LEIs. The survey structure of sampling at consistent sites every year at 85 stations with a range of fishing histories was well suited to such an analysis. Limiting the analysis were a sampling gear not optimized for these species (i.e., trawls are designed to catch fish, not corals or sponges) and a lack of information to independently estimate H_0, the unfished abundance. The requirement to estimate H_0 while fitting the model prevented a test of the model's ability to predict long-term trends. Instead, the analysis was limited to how well the model anticipated responses to year-to-year differences in fishing intensity.

Comparison of model results with abundance estimates from the survey indicated that little, if any, of the variation in the values from the survey could be attributed to fishing effects. Periods of high fishing effort were associated with both increases and decreases in the measured abundance, while drops in fishing effort did not usually result in the expected increases. The scale of abundance changes estimated from survey catches was much larger than that of the changes the fishing model predicted. Such large changes were prevalent at both fished and unfished stations. Much of the variation may be due to sampling error, including spatial variation between yearly survey sites, trawl performance variation, or catch sampling methods. However, many of the abundance patterns were large enough and showed enough consistency across years and between adjacent stations that they should have reflected significant changes in abundance. While the fishing effort data also had limitations, some of the indicated effort contrasts should have produced detectable effects if fishing effects were a substantial cause of variation in the abundance of these animals at the fishing intensities prevalent over those years. These results indicated that the model was not a powerful and robust predictor of year-to-year abundance changes under those conditions. It may be more useful for situations where fishing has a more dominant effect. The model's use as an LEI, which could not be directly tested without independent estimates of H_0, may be more robust than indicated for the short-term effects tested here.

While the model provides a tool for bringing disparate sources of information to bear on the evaluation of fishing effects on EFH, the validation results and data limitations indicate that LEI values only provide a coarse index of potential vulnerabilities. Both the developing state of the model and the limited quality of available data to estimate input parameters prevent this from providing a clear view of habitat effects. While output detail may provide an illusion of precision, the results are actually subject to considerable uncertainty. It is merely the best tool currently available for this assessment, not a definitive predictor.

B.3 Evaluation of Effects on Managed Species

The principal application of this document is to evaluate whether the fisheries, as they are currently conducted off of Alaska, will affect habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. The above analysis has identified changes to habitat features that are not expected to be temporary. The habitat features were selected as those which a) can be affected by fishing and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes relate to the EFH of each managed species and whether they constitute an effect to EFH that is more than minimal.

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to "support a sustainable fishery and the managed species' contribution to a healthy ecosystem" (50 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the "more than minimal" standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that species (a term used to represent "the ability of a species to support a sustainable fishery and its role in a healthy ecosystem").

B.3.1 Evaluation Methods

The following evaluation assesses whether the fisheries, as they are currently conducted off of Alaska, are affecting habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The following resources were used:

1. The results of the effects of fishing analysis (Section B.2).

2. Literature and other sources of knowledge regarding what each species requires to accomplish spawning, breeding, feeding, and growth to maturity.

3. Knowledge of the responses of the recruitment, biomass, and growth of these species during periods with similar fishing intensities.

4. Spatial and temporal length, weight, age, diet, and catch-per-unit-of-effort (CPUE) data from the NMFS surveys, as well as fishing effort time series estimates. [Note: CPUE distribution maps are available on the following website: http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm.]

5. The knowledge and professional judgement of scientists who manage and study these species.

For each species, a knowledgeable scientist was designated to perform the evaluation; the analyst was someone who was familiar with the biology and population dynamics of the stock, as well as the data available for the species. The initial step was identification of any known linkages between the life stages of the species and the habitat features in each habitat used in the effects-of-fishing analysis. These linkages are summarized in Table B.3-1. Scientists then reviewed these linkages and other knowledge to describe the known habitat connections between the species and/or species group and the three life history processes of spawning/breeding (combined), feeding, and growth to maturity (including feeding, growth, and survival before maturity). The texts of these reviews, labeled Habitat Connections, are found in Sections B.3.2 to B.3.4.

The scientists were then asked to evaluate the following question: Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature? To conduct this evaluation, the analysts first reviewed the LEI output from the fishing effects model to assess overlap with the distribution of each stock. The analysts then focused on habitat impacts relative to the three life-history processes of spawning/breeding, feeding, and growth to maturity (the evaluation criteria are provided in Table B.3-2). Finally, the analysts assessed whether available information on the stock status and trends indicated any potential influence of habitat disturbance due to fishing. More specifics regarding this evaluation process are provided below.

Because EFH comprises the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem, a consistent, existing benchmark was useful to represent these concepts in the EFH evaluations. The ability of the stock to produce MSY over the long term was used as a measure of its ability to support a sustainable fishery. No similar benchmark was available for the role of each species in a healthy ecosystem. However, population levels sufficient to support a sustainable fishery would ensure that substantial numbers of fish are available to serve as prey or predators to other species, as well as fulfilling other ecosystem functions. For species where MSY could not be estimated with available data (e.g., recruitment estimates were not available), scientists assessing the effects on EFH had to rely on other proxies, or ratings of "unknown" were necessary.

Given the LEIs from the effects-of-fishing analysis and the linkages identified in the habitat connections exercise, the analysts assessed whether the expected effects on species welfare were more than minimal. Evaluators considered which life history functions could be affected by changes in available habitat, the role of those functions in species welfare, and the spatial overlap of habitat use with the estimated fishing effects. For many species, limited information was available for one or all of these factors. Therefore, the professional knowledge and judgement of the evaluator were important. Because LEIs are inherently not temporary, any such effects assessed as more than minimal met both elements of the test for effects requiring Council action to minimize the effects of fishing on EFH.

To aid in the evaluations, LEI charts and all three LEI values (lower, central, and upper) for each habitat were provided. The LEI charts provided effect information at the finest feasible scale, allowing evaluators to focus on any specific sites considered important to their species. To assist evaluators in considering the cumulative effects on habitats across the distribution of each species, LEIs were aggregated for the intersections of each habitat and two geographical EFH areas for each species, the general distribution and the known concentration. Derivation and charts of these areas are in Section B.2.3.1 and Appendix D. This process also provided the proportion of each species' EFH within each habitat. The resulting LEIs and habitat proportions are displayed in Table B.3-3.

To assess the levels of habitat impact on the spawning/breeding, feeding, and growth to maturity of managed species, the analysts were provided with a trigger question to help focus their evaluations: Is the temporal or spatial pattern of habitat disturbance on spawning/breeding, feeding, or growth to maturity sufficient to impact the ability of the stock to produce MSY over the long term in a manner that is more than minimal and not temporary? The analysts were provided with spatial and temporal information on length, weight, age, diet and CPUE data from the NMFS surveys, as well as fishing effort time series estimates (this information is provided on the following website: http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). It was up to the analysts to determine if any of this information was comprehensive enough to be useful in their evaluations. For some species, this information was either too sparse to evaluate, or simply did not exist.

The final evaluation consideration was an assessment of the stock status and trends. For at least 30 years, fishing effort and, presumably, its habitat effects have been at similar or higher levels than the recent levels evaluated here. The condition of fish populations through this period is, therefore, one indicator of their response to all effects of fishing, including those on EFH. The EFH of species that maintained a favorable stock condition through this period, while supporting a fishery, was considered resistant to habitat effects caused by this level of fishing. While poor stock performance could result from a number of factors, including the direct effects of fishing and environmental change, consistently favorable stock conditions indicate that none of these, including fishing's effect on habitat, has jeopardized stock productivity. Again, the knowledge and expertise of each evaluator were required to assess the effect of any special circumstances for each species that made this a stronger or weaker form of evidence.

For fish stocks where information was available to estimate recruitment, recruitments from the late 1970s to the present were used in assessing stock condition relative to its MSY. These estimated recruitments, as well as other stock characteristics such as growth rates, represent a range of recent history when impacts to the stock from fishing practices would have been expected. As part of the Final Programmatic Groundfish SEIS (PSEIS) (NMFS 2004), 10-year projections were made to assess whether the stocks would be likely to fall below their MSST level under the status quo harvesting policy, as well as a broad range of alternative policies. These projections combine the current stock status and historical distributions of population parameters, both of which reflect any effects of historic levels of fishing that have been similar to or greater than current levels.

The analysts considered not only whether the temporal or spatial pattern of habitat disturbance on stock abundance was sufficient to adversely affect the ability of the stock to remain above MSST, but also whether the temporal or spatial pattern of habitat disturbance on stock abundance was sufficient to adversely affect the ability of the stock to produce MSY over the long term. Evaluators knew of potential peculiarities in their species' history that would make these indicators more or less relevant. No BSAI or GOA groundfish stocks have a current population biomass below the level necessary to produce MSY (Figure B.3.1-1).

Under this analytical approach, either of the two lines of consideration (habitat connections or sustainability analysis) could be sufficient to indicate a potential effect of fishing on EFH that is more than minimal, depending on the available information. Definitive proof of a population level effect was not required to rate effects as more than minimal and not temporary. Instead, the authors were expected to weigh the specific evidence for any consequences of habitat effects. For example, a strong stock history could be overcome by a clear connection between LEIs and species requirements. Given the current state of knowledge, uncertainties were expected, and evaluators indicated where these might be important or raised concerns.

B.3.2 Effects of Fishing on Essential Fish Habitat of Salmon, Scallops, and Crab

The following evaluations were made to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?"

B.3.2.1 Salmon Species

Habitat Connections

Five species of Pacific salmon (chinook, chum, pink, coho, and sockeye) are managed under the Alaska salmon FMP. Because all of these species use similar types of habitat, including habitats where fishing activities may occur, fishing effects on EFH were evaluated for all species together.

Spawning/Breeding—Salmon spawn and deposit their eggs in gravel areas of freshwater rivers and streams. Successful spawning depends upon the numbers of spawners, available habitat for spawning and nursery areas, and environmental conditions. Impacts to spawning and breeding of salmon occur when these habitat areas are disturbed, spawning biomass is reduced, or spawners are unable to reach suitable spawning areas.

Feeding—Once salmon smolts begin to enter the ocean, they feed on copepods. As they get larger, they add squid, juvenile herring, smelt, and other forage fish and invertebrate species to their diets. Salmon smolts use the nearshore area after entering the ocean, moving offshore as they get older, using pelagic habitats when at sea.

Growth to Maturity—Salmon feed throughout the open ocean of the North Pacific for up to 6 years (depending upon species) before maturing and returning to their natal rivers to spawn. Growth and mortality of juveniles depend on food availability, predation, bycatch in fisheries, and environmental conditions.

Evaluation of Effects

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—No commercial fisheries in Alaska are thought to adversely affect salmon spawning habitat given almost no effort (except recreational and subsistence fisheries) in freshwater spawning and rearing areas. Thus, the effects of the fisheries on spawning of salmon are considered minimal and temporary in nature.

Fisheries are considered not to have any impact on freshwater or pelagic habitats used by juvenile salmon. However, fisheries do catch some species eaten by piscivorus species of salmon in the ocean, including squid, capelin, and juvenile herring. Currently, the catch of these prey species is very small relative to overall population size of these species, so fishing activities are considered to have minimal and temporary effects on feeding of all salmon species.

As stated above, fisheries are considered to have minimal effects on prey availability of salmon, including juveniles. Fisheries impacts on juvenile salmon at sea are due to incidental catches in groundfish fisheries. Bycatch in groundfish fisheries is almost nonexistent for pink salmon, coho salmon, and sockeye salmon, but does occur in measurable numbers for chum salmon and chinook salmon taken in trawl fisheries, particularly the pollock trawl fisheries (Witherell et al. 2002). The bycatch amounts are considered to be a small proportion of the stocks and do not cause a substantial impact on salmon populations (Witherell et al. 2002). Thus, fishing activities are considered to have minimal and temporary effects on growth to maturity of salmon.

Fishing activities are considered to have overall minimal and temporary effects on the EFH for all salmon species. Fishing activities only interact with salmon habitat to any degree in the ocean habitats, and the concerns about these interactions center on effects on prey availability and bycatch. Prey of salmon (from copepods up to squid and forage fish) are not subject to directed fisheries removals, and bycatch is not a significant factor in total mortality. Professional judgement led to the conclusion that fisheries do not adversely affect the EFH of salmon species.

B.3.2.2 Weathervane Scallops

Habitat Connections

Weathervane scallops are found from shallow intertidal waters to depths of 300 m, but abundance tends to be greatest between depths of 40 to 130 m on beds of mud, clay, sand, and gravel (Hennick 1973, Turk 2000). Scallop beds tend to be elongated along the direction of current flow. A combination of large-scale processes (overall spawning population size and oceanographic conditions) and small-scale processes (site suitability for settlement) influence the recruitment of scallops to beds.

Spawning/Breeding—Successful scallop recruitment depends upon high egg-fertilization rate, transport of spat to nursery areas, environmental conditions, and survival to the adult stage. Scallop gametes are broadcast into the water and rely on currents to mix sperm and eggs. If males and females are not close together, the dilution of sperm can limit fertilization. Thus, spatial distribution is thought to be a critical component of the spawning/breeding success of scallops (Stokesbury 2000, Alaska Department of Fish and Game [ADF&G] 2000). Indicators of potential effects on spatial distribution are changes in population biomass and fishing mortality.

Feeding—Scallops are filter feeders. Successful feeding depends on the concentration and quality of suspended food particles, particularly phytoplankton. Prey availability depends on localized plankton blooms. Fishing activity can impact feeding of scallops through introduction of particles low in nutrient quality or organic content, thus diluting the naturally occurring nutritional particles (MacDonald 2000). More fishing activity by trawl or dredge gear could potentially introduce additional inorganic particulate matter that could negatively affect scallop feeding success, or conversely, introduce organic matter that could be beneficial to scallops.

Growth to Maturity—Growth to maturity is measured in terms of survival to maturity (which occurs at sizes smaller than those commercially harvested). The consequences of fishing activities on scallop survival depend upon habitat alteration and gear-induced damage and mortality (Grant 2000). The effects of habitat alternation may depend primarily on sediment resuspension and the potential for siltation, which would increase mortality.

Evaluation of Effects

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	U (Unknown effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—Because scallops have limited mobility, scallop settlement generally occurs on substrates and in locations where adults are already found (Turk 2000). Thus, the nursery areas are the same areas occupied by adults. These are also the areas where the directed scallop fisheries occur. However, there is no evidence that scallop recruitment has decreased with the current level of scallop fishing effort.

The overall footprint (area effected annually) of the scallop fishery was small (149 square nm), equating to about 0.1 percent of the total available amount of those habitat types (sand, mud, and gravel) (Witherell 2002). Although the effects of scallop dredge gear on the bottom are thought to be higher than other gear types, the fishery occurs in areas and habitat types that have relatively fast recovery rates. Thus, the effects of the fishery are concentrated in a relatively small proportion of benthic habitats. The effects on spawning and breeding of scallops are considered minimal and temporary in nature.

Sediment resuspension by dredges can have positive or negative effects on scallop feeding. The current fishing effort intensity of the Alaska scallop fishery does not appear to affect scallop growth, so one may surmise that feeding is not disturbed. However, there is not enough information to evaluate this issue.

The weathervane scallop resource is considered to be at sustainable biomass levels and has maintained relatively high recruitment in most areas over the past 10 years (Barnhart, J., ADF&G, personal communication). This species does not depend upon any habitat feature vulnerable to fishing activities. Based on the overlap of fisheries with juvenile and adult scallop stock distribution, there appear to be minimal effects on the weathervane scallop habitat.

B.3.2.3 Red King Crab

Habitat Connections

Habitat effects on crab concern effects on prey and on living and non-living structures on and in the ocean bottom. Effects on the population due to bycatch in trawl fisheries are not included as a habitat effect. Direct effects due to bycatch mortality in trawl fisheries on crab populations were addressed in the PSEIS (NMFS 2004). The focus of this report is on the linkages to fishing-induced impacts on habitat and their subsequent effects on spawning/breeding, growth to maturity, or adult feeding of red king crab.

Spawning/Breeding
Spawning and breeding success of crab species depends upon high egg-fertilization rate, successful transport of pelagic larvae to nursery areas, good environmental conditions, and survival to the adult stage. Egg fertilization success depends upon the size and number of mature male crabs (and hence the amount of sperm) available. The eggs are attached to the underside of females and carried for nearly a year before hatching. Transport of larvae depends upon environmental conditions, and survival depends upon the quantity and quality of nursery habitat and the presence of predators.

Settlement and nursery areas are important components of spawning success for crab species. In the southeastern BS, females remain in relatively shallow nearshore waters most of the year, whereas males move offshore into deeper water during the summer and fall, then return to shallower water for breeding in the winter and early spring (Loher 2001). The location of females hatching eggs and prevailing currents determine the general area where larvae settle. Settling larvae have moderate swimming capability and have some ability to choose the micro-habitat where they settle (Loher 2000). Suitable substrates for survival of settling larvae appear to be largely rock or cobble bottoms, mussel beds, or other areas with a variety of epifauna such as hydroids or epiflora (i.e., kelp hold fasts) (Loher 2000, Stevens and Kittaka 1998).

Adult Feeding
From settling larvae to senescence, crabs dwell on the bottom and depend on benthic feeding. Red king crab are omnivorous. Bivalves, barnacles, polychaetes, snails, Tanner crab, echinoids, and hydroids have been found in stomachs of red king crab from shallow waters near Kodiak during May and June (Feder and Jewett 1981). Juvenile red king crab near Kodiak have been observed to eat sea stars, kelp, sea lettuce, red king crab molt exuvia, lettleneck clams, mussels, nudibranch egg masses, and barnacles (Dew 1990).

Growth to Maturity
Early stage red king crabs seek out biological cover in which to hide. Survival at this stage depends upon availability of cover. After they reach a size exceeding 25-millimeter (mm) carapace length, red king crabs form pods, which consist of similar sized crabs of both sexes, and may contain hundreds to thousands of crabs. Pods of juvenile crabs form during the daytime, but disperse at night for feeding. As crabs grow, they move to deeper water in Bristol Bay where the substrate is mostly sand, silt, and mud.

Evaluation of Effects

LEI Values Relative to Species Distribution
The Japanese established a trawl closure known as the pot sanctuary that remained in effect from 1959 to 1977 (Figure B.3.2.3-1). The pot sanctuary encompassed an area from the western end of Unimak Island to 160º W in Bristol Bay; however, the areas changed somewhat over that time. Within the pot sanctuary, a special area was established beginning in 1964. The area was established for a directed pot fishing only. The area expanded over time, however, and consisted generally of the area north of Unimak Island (Dew and McConnaughey in press).

The United States established trawl closure areas beginning in 1995 with the Pribilof Islands Conservation Area, the Red King Crab Savings Area, and the nearshore Bristol Bay Closure Area (waters east of 162º W) (Witherell and Pautzke 1997). Bycatch caps for groundfish trawl fisheries were also established for red king, Tanner, and snow crab.

Spatial overlap exists between current female red king crab distribution and fishing effects only in the areas near 162 to 163º W and about 55.5º N and 56.5º N (Figure B.3.2.3-2). Male red king crab may migrate through this area in the spring when mating occurs; however, when the survey occurs (June) in Bristol Bay, most males are farther offshore and are protected by existing trawl closure areas (Figure B.3.2.3-3). During the 1970s, female distribution extended farther west and south than the distribution from current surveys (Dew and McConnaughey 2003). The change in distribution of female red king crab from the 1970s to the current distribution farther east could have been affected by bycatch in trawl fisheries in the late 1970s and early 1980s (Dew and McConnaughey 2003). At present, however, most of the female red king crab distribution is protected by trawl closure areas.

The importance of the high fishing effects area north of Unimak pass for spawning/breeding is unknown. Larval drift would tend to be along the Alaska Peninsula from females hatching eggs nearshore from Unimak Island westward (Loher 2001). If larvae are carried offshore into the middle of Bristol Bay, however, survival may be less likely. The distribution of females hatching eggs may be an important factor in future recruitment strength. Recruitment from eggs hatched in the late 1960s resulted in the high biomass levels in the 1970s (Figures B.3.2.3-4 and B.3.2.3-5). Recruitment resulting from eggs hatched from the 1970s to the present has been relatively low.

The distribution of female red king crab in the area north of Unimak Island during the increasing abundance of the 1970s could have been an expansion of their range rather than a requirement for good recruitment. There is scant information on the distribution of red king crab prior to the 1970s. The Bureau of Commercial Fisheries conducted surveys in Bristol Bay in 1959 and annually from 1963 to the present; however, data from the surveys in the 1960s are unavailable for analysis, except for tables of catch per tow in 1968 (International North Pacific Fisheries Commission [INPFC] [now the North Pacific Anadromous Fish Commission] 1968). A survey of Bristol Bay was conducted in spring (May) and in fall during 1968. The highest densities of female red king crab in the spring survey were found from about 163 to 160º W (Figure B.3.2.3-1).

Catch of female red king crab per tow from the 1959 survey indicates that high densities occurred at about 163º W and at about 161.5º W, similar to the 1968 survey (Figure B.3.2.3-6) (INPFC 1959). Some crab were caught as far west as about 165º W in the area north of Unimak Island, however in lower numbers than to the east.

Japanese exploratory fishing during the 1960s was conducted using tangle nets and reported in INPFC document 765 (Figures B.3.2.3-7 through B.3.2.3-10). The area north of Unimak Island as far west as about 165º W was fished only in 1963 and 1964 during the spring. The reports do not define the extent of the exploratory fishing areas or the exact dates when fishing occurred. The 1963 and 1964 catch per tan (a Japanese unit of fishing effort for tangle nets) indicates that the large male distribution was widespread and extended from about 165 to about 160º W (Figures B.3.2.3-9 and B.3.2.3-10). Female red king crab distribution was similar to large males in 1964; however, it did not extend as far west in 1963 (Figures B.3.2.3-7 and B.3.2.3-8).

The limited data presented above indicate that the distribution of red king crab varied over time and to some extent included the area north of Unimak Island; however, it was mostly east of 163 to 164º W, except in the 1970s. Habitats effects in mud and sand were up to 35 percent on living structure and less than 5 percent for other effects (Table B.3-3).

Habitat Impacts Relative to Spawning/Breeding

As discussed in the previous section, there is only a small area of overlap between current female red king crab distribution and areas where trawling occurs. This overlap would only occur in the areas between about 162 and 163º W where fishing effects are generally low. Male and female red king crab migrate to nearshore waters generally less than 50 m deep to hatch their eggs and mate. North of Unimak Island, some of the high fishing effects area extends into waters less than 50 m deep; however, to the east, trawling generally occurs more than 50 m deep. The mating areas would experience little impact; however, trawling in deeper waters somewhat overlaps the migration route to mating areas.

Habitat Impacts Relative to Growth to Maturity

There are essentially no fishing effects in areas important to juvenile red king crab. All known juvenile rearing areas are currently protected by trawl closure areas (Figure B.3.2.3-11). Growth per molt for BS red king crab showed no change between the late 1950s and the 1990s based on tag data (Council 2004). Molting probability during different time periods has been estimated in a stock assessment model; however, parameters are confounded by change with natural mortality, and it is difficult to assess the age of crab. Molting probability was estimated as higher in the 1950s and lower in the 1960s from tag data

(Balsiger 1974). Model estimates of molting probability were higher in the 1970s than those from the 1960s tag data and have been lower since then (Council 2004).

Habitat Impacts Relative to Feeding

Changes in growth for Bristol Bay red king crab are unknown. Most of the distribution of red king crab is to the north and east of the high fishing effects areas.

Stocks Status and Trends

Mature biomass of red king crab estimated from NMFS surveys declined from a high in the late 1970s to relatively low levels from 1983 to 2004 (Figure B.3.2.3-12). The reason for the sharp decline in abundance in the early 1980s is unknown; however, it was probably due to a combination of factors including reduced recruitment due to environmental conditions and predation, directed fishing, and bycatch. Mature biomass has fluctuated during the last 20 years around a level lower than the pre-1983 biomass. The stock is currently considered to be above B_{MSY} due to prevailing environmental conditions, where B_{MSY} is estimated as the average of the survey mature biomass from 1983 to 1997 (BSAI Crab FMP).

Calibrated fishery CPUE from Japanese and United States fleets indicate that biomass was higher in the 1950s, then declined to a low near 1970 (Figure B.3.2.3-4) (Balsiger 1970). Fishery CPUE data may not accurately represent changes in abundance due to areas and times fished and gear changes; however, these data generally indicate that biomass levels previous to the early 1970s were higher than current biomass, but lower than biomass in the late 1970s.

Overall trawl effort in the BS was highest from 1981 to 1985 then declined (Figure B.3.2.3-13). Trawl effort in the EBS high effects area was high from 1981 to 1983, generally lower from 1984 to 1992, increased from 1993 to 1998, then declined. Estimated recruitment was highest in the late 1960s (approximate year eggs were fertilized) and peaked in 1970, then declined throughout the 1970s and has stayed at low levels to the present. Recruitment was already low when the time series of trawl effort began in 1981.

The increased recruitment to the mature crab biomass in the 1970s would have resulted from eggs hatching in the mid- to late 1960s. The declining biomass in the 1960s resulted from lower recruitment of eggs hatching in the 1950s. Recruitment strength may depend on the distribution of red king crab mature females where eggs are hatched, which, along with current environmental conditions, would determine the general area where larvae will settle.

Mechanisms determining recruitment strength are unknown for red king crab. The lack of increased recruitment from high mature biomass in the 1970s could have been due to unobserved bycatch (Dew and McConnaughey 2003) or poor environmental conditions for larval and juvenile survival.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unknown effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

B.3.2.4 Blue King Crab

Habitat Connections

Spawning/Breeding
Spawning and breeding success of crab species depends upon a high egg-fertilization rate, successful transport of pelagic larvae to nursery areas, and survival to the adult stage. Egg fertilization success depends upon the size and number of mature male crabs (and hence the amount of sperm) available. The eggs are attached to the underside of females and carried for many months prior to hatching. Transport of larvae depends on environmental conditions, and survival depends upon the quantity and quality of nursery habitat and the presence of predators.

Settlement and nursery areas are important components of spawning success for crab species. For king crabs, selection of benthic habitat by glaucothoe appears to be an important mechanism leading to increased probability of larvae settling on an appropriate substrate. Such substrates appear to be largely rock or cobble bottoms, mussel beds, or other areas with a variety of epifauna such as hydroids or epiflora (i.e., kelp hold-fasts).

Review of the LEI maps reveals that the overlap of groundfish trawl effort with mature female blue king crabs is very limited, and the expected fishing-induced reductions in living and non-living structure are small (Table B.3-3, Figure B.2-2a). The existing trawl closure area in the Pribilof Islands encompasses nearly the entire Pribilof Islands stock, and there is virtually no overlap of trawl fisheries with the St. Matthew blue king crab stock. There is some bycatch of St. Matthew blue king crab that occurs in groundfish fisheries in the vicinity of St. Matthew Island. However, the amount of habitat impact associated with groundfish fisheries in the vicinity of St. Matthew Island area is low. See Section 3.2.1.2.2 for further discussion and references.

Adult Feeding
From settling larvae to senescence, crabs dwell on the bottom and depend upon benthic feeding (Table B.3-1). Changes in diet due to habitat disturbance caused by fishing may impact crab survival and production. However, the magnitude of habitat disturbance is expected to be low, and the effects of these changes will be difficult to assess given the limited information on feeding requirements of crab species.

Growth to Maturity
Early stage blue king crabs probably seek out biological structure in which to hide similar to red king crab, although no studies have been conducted for blue king crab (Table B.3-3). Survival at this stage probably depends upon availability of cover. The Pribilof Islands habitat conservation area was established in 1995 to eliminate potential effects of trawling on this habitat feature and to reduce bycatch (Council 1995).

No information on changes in growth is available for blue king crab stocks.

Recruitment trends are generally similar for the Pribilof Island and St. Matthew Island stocks because biomass trends are similar. Since there have been low levels of trawling near St. Matthew Island, this would indicate that habitat effects were not a major factor in recruitment strength (Figure B.3.2.4-1). Also, the area has been protected from trawling since 1995, and the biomass has declined since that time (Figure B.3.2.4-2).

Stock Status and Trends
Both the Pribilof Islands stock and the St. Matthew blue king crab stocks increased in abundance from the mid 1980s to the late 1990s, then they declined(Figures B.3.2.4-1 and B.3.2.4-2). Both stocks are currently below their MSST and have been declared overfished. Rebuilding plans have been developed and implemented. The similarity in trends in biomass and the small amount of trawling that has occurred near St. Matthew Island indicate that habitat effects were probably not a major factor in declines in abundance.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unknown effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—Fishing activities are considered to have overall minimal and temporary effects on the EFH for blue king crab, although both the Pribilof Islands stock and the St. Matthew stock of blue king crabs are considered to be below MSST. Habitat loss or degradation by fishing activities probably did not play any role in the decline of these stocks. For the Pribilof Islands blue king crab, any fishing activities thought to have adverse consequences have previously been mitigated by establishment of the Pribilof Islands trawl closure area. For St. Matthew blue king crab, there has never been a groundfish bottom trawl fishery in the area. Given the current very small overlap and fishing intensity in areas with blue king crab of all life stages, professional judgement indicates that fisheries do not currently adversely affect the EFH of blue king crab.

B.3.2.5 Golden King Crab

Habitat Connections

Spawning/Breeding
Spawning and breeding requirements for golden king crab are unknown. It is likely that settlement and nursery areas are important components of spawning success. For other species of king crabs, selection of benthic habitat by glaucothoe appears to be an important mechanism leading to the increased probability of larvae settling on an appropriate substrate.

The overlap of groundfish trawl effort with mature female golden king crabs is very limited. Trawl fishing intensity does overlap with crab distribution on the EBS slope to some extent, but not in the AI slope area.

Adult Feeding
From settling larvae to senescence, crabs dwell on the bottom and depend on benthic feeding. The importance of habitat quality to crab diet seems intuitive, but it is not quantified for benthic life stages. Changes in diet due to habitat disturbance and alternative may impact crab survival and production. The effects of these changes will, however, be difficult to assess given the limited information on feeding requirements of crab species.

Growth to Maturity
Early stage king crabs may seek out biological structure in which to hide. It is not known how the fisheries affect habitat used by juvenile golden king crabs.

Stocks Status and Trends
Stock status and trends are unknown as this stock is not regularly surveyed, and no stock assessment model has been developed.

Summary

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Fishing activities are considered to have overall minimal and temporary effects on the EFH for golden king crab. Groundfish trawl fishing in the EBS slope is of some concern; however, any effects are thought to be minimal. Professional judgement indicates that fisheries do not adversely affect the EFH of golden king crab.

B.3.2.6 Scarlet King Crab

Habitat Connections

Spawning/Breeding
Spawning, breeding, and habitat requirements for scarlet king crab are unknown. Nevertheless, the overlap of groundfish trawl effort with mature female crabs is likely very limited, given the deep-water nature of this species. There is virtually no directed pot fishery for this species. A few landings were made in 1995 (2,600 pounds [lbs]) and 1996.

Adult Feeding
Nothing is known about the feeding requirements for this species.

Growth to Maturity
Factors affecting growth and survival of this species are not known. Almost none is taken as bycatch in groundfish or crab fisheries.

Stocks Status and Trends
This stock is not surveyed, so stock status and trends are unknown.

Summary

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Fishing activities are considered to have overall minimal and temporary effects on the EFH for scarlet king crab. This is a deepwater species with almost no overlap with commercial fisheries, so habitat effects are unlikely. Professional judgement indicates that fisheries are unlikely to adversely affect the EFH of scarlet king crab.

B.3.2.7 Tanner Crab

Habitat Connections

Spawning/Breeding
Spawning and breeding success of crab species depends upon a high egg-fertilization rate, successful transport of pelagic larvae to nursery areas, and survival to the adult stage. Egg fertilization success depends on the size and number of mature male crabs (and hence the amount of sperm) available. The eggs are attached to the underside of females and carried for nearly a year prior to hatching. Transport of larvae depends on environmental conditions. Tanner crabs settle on mud habitats to the north and in shallower water than adult crab distribution, depending on environmental conditions. See Section 3.2.1.3.5 for further discussion and references.

Adult Feeding
Tanner crabs feed on an extensive variety of benthic organisms, including bivalves, brittle stars, crustaceans (including other snow crabs), polychaetes and other worms, gastropods, and fish.

Growth to Maturity
No studies indicate a direct dependence of juvenile Tanner crabs on any vulnerable habitat feature. They are believed to settle and grow on mud habitat. Recruitment strength depends on transport to suitable habitat towards the north and west.

Evaluation of Effects

LEI Values Relative to Species Distribution
Current adult male and female Tanner crab and juvenile Tanner crab distributions overlap high fishing effects areas north of Unimak Island and high fishing effects areas east of the Pribilof Islands (Figures B.3.2.7-1, B.3.2.7-2, and B.3.2.7-3). The distribution of mature male and female Tanner crab is mainly in the area just north of Unimak Island; however, it extends northward as well. Juvenile crab distribution is generally to the north of mature crab habitat; and also to the west, extending north of the Pribilof Islands. The juvenile crab distribution overlaps the mature distribution in the area east of the Pribilof Islands in the high fishing effects area.

The distribution of large male Tanner crab in the 1980s and early 1990s was centered farther east and north towards Bristol Bay mostly outside the areas of high fishing effects compared to the current distribution (Figures B.3.2.7-4 through B.3.2.7-8). As abundance declined in the 1990s, the distribution of large male Tanner crab shifted from Bristol Bay (mostly east of 164º W) to the south and east into the area of high fishing effects north of Unimak Island (Figure B.3.2.7-2).

Groundfish trawl bycatch caps were established for BS Tanner crab to limit the effect of trawling. The caps began in 1982 for foreign fisheries and in 1987 for joint-venture fisheries (Witherell and Pautzke 1997). The bycatch limits have been reduced several times since their inception. The existing BS trawl closure areas in Bristol Bay that were established in 1995 do not include the majority of the current Tanner crab distribution. They do, however, encompass a large fraction of the historical range of this species. Tanner crab are also caught as bycatch in the red king crab and snow crab pot fisheries. Tanner crab live mostly on mud and sand habitats, which are the least affected habitat in the BS (from 11 to 20 percent for living structure and less than 5 percent for other effects) (Table B.3-3).

Habitat Impacts Relative to Spawning/Breeding

NMFS survey data indicate that the large female tanner crab distribution was farther west and south of the large male distribution in the early 1990s, overlapping the areas of high fishing effects (Figures B.3.2.7-1 and B.3.2.7-2) (e.g., NMFS 2002). The current distribution of large females based on summer survey data shows high density around the Pribilof Islands. The current distribution of large females outside the Pribilof Islands overlaps the regions where fishing is expected to have the greatest impact on habitat.

Review of historical survey data reveals a long-term westward shift in male tanner crab distribution. The distribution of large males in 1979 (Figure B.3.2.7-4) was similar to the 1980s, except that the three largest catches were near the Alaska Peninsula between about 164 and 162.5º W (Figures B.3.2.7-5, B.3.2.7-6, and B.3.2.7-7). During these years, the most dense concentrations of male crabs more than 5.5 inches in carapace width (138 mm) were located east of 165º longitude. By 1994, male crabs more than 5.5 inches in carapace width (138 mm) began to shift into in the middle shelf of the southern EBS (Figure B.3.2.7-8). By 2004, large male crabs were concentrated along the outer shelf of the southern EBS and in regions surrounding the Pribilof Islands. This analysis of the spatial distribution of tanner crabs relative to expected habitat impacts indicates that tanner crabs have not demonstrated shifts away from regions heavily impacted by fishing. The closure of the Bristol Bay region and its associated reduction in habitat impacts did not attract crabs to the region.

Recruitment was high in the late 1960s and early 1980s (fertilization year) (Figure B.3.2.7-9). Recruitment was low in the 1970s and from 1985 to the present. In the early 1980s, the distribution of large females overlapped the areas of high fishing effects somewhat, with less overlap for large males. Fishing effort was higher during periods of highest recruitment in the early 1980s than currently.

Habitat Impacts Relative to Growth to Maturity

Tanner crab settle and grow on mud habitat, which was the least affected habitat in the EBS (Table B.3-3). Some areas of high abundance of small Tanner crabs (Figure B.3.2.7-3) are protected by trawl closure areas around the Pribilof Islands. There are no tagging data to compare growth per molt or molting probability over time for BS Tanner crab.

Habitat Impacts Relative to Feeding

The effects of fishing activities on Tanner crab feeding activities is minimal. Relative to the distribution of fisheries and the intensity of fisheries effects, only a small reduction of the infauna and epifauna prey occurs on mud habitats (Table B.3-3).

Stocks Status and Trends

Mature biomass declined in the late 1970s to a low level in the early 1980s, then increased to a peak in 1991, then declined to below MSST in 1996 (Figure B.3.2.7-9). The fishery was closed in 1997 and has remained closed through 2004. The BS Tanner crab stock was declared overfished in 1999, and a rebuilding plan was put into place in 2000 (Council 2000a).

Overall trawl effort in the low effects area was highest in 1981 to 1983. Trawl effort declined gradually from 1984 to 2002 (Figure B.3.2.7-10). Trawl effort in the high effects area was high in 1981 to 1983, generally lower in 1984 to 1992, increased in 1993 to 1998, then declined. The biomass of Tanner crab decreased as trawl effort declined in the 1980s, then biomass increased in the late 1990s, then declined as trawl effort increased in the mid-1990s. In the late 1990s, when Tanner crab were at low abundance, however, the distribution shifted more into the high trawling effects area.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—Fishing activities are considered to have overall minimal and temporary effects on the EFH for Tanner crabs.

B.3.2.8 Snow Crab

Habitat Connections, Evaluation of Effects

Spawning/Breeding
Spawning and breeding success of crab species depends upon high egg-fertilization rate, transport of pelagic larvae to nursery areas, and survival to the adult stage. Egg fertilization success depends upon the size and number of mature male crabs (and hence the amount of sperm) available. The eggs are attached to the underside of females and carried for nearly a year prior to hatching. Transport of larvae depends on environmental conditions. Snow crabs settle on mud habitats. See Section 3.2.1.3.6 for further discussion and references.

Adult Feeding
Snow crabs feed on an extensive variety of benthic organisms including bivalves, brittle stars, crustaceans (including other snow crabs), polychaetes and other worms, gastropods, and fish.

Growth to Maturity
No studies indicate a direct dependence of juvenile snow crabs on any vulnerable habitat feature. They are believed to settle and grow on mud habitats, which was the least affected habitat in the EBS.

Evaluation of Effects

LEI Values Relative to Species Distribution
The centers of distribution of male snow crab were located in the middle shelf in 1978. During the early 1980s, distributions shifted north and west, with centers located on the outer shelf. Between 1984 and 1994, the distribution shifted between the shelf break and the middle shelf at latitudes north of those observed in the early 1980s. After 1994, the distribution returned to the shelf break, but the centers of distribution remained located at higher latitudes (Figure B.3.2.8-1) (Orensanz et al. 2005).

In the late 1970s, the center of the distribution of mature female snow crab overlapped the area of high fishing effects to the east of the Pribilof Islands. The current center of distribution is in the area of low fishing effects, north of the Pribilof Islands to St. Matthews Island. Juvenile crab are distributed to the north and east of mature crab areas and migrate to the south and west into deeper water as they age (Orensanz et al. 2005).

Trawl effort declined in the 1980s as snow crab biomass was increasing to a high in 1992. The distribution of mature snow crab shifted over time to the north and west, away from the high fishing effects areas. However, recruitment was highest from the period of high trawl effects in 1980, when the center of distribution of female snow crab was in the northern edge of the high effects area east of the

Pribilof Islands (Figures B.3.2.8-2 and B.3.2.8-3). In 1986, a recruitment event of lesser magnitude occurred when the center of distribution of mature snow crab was still close to the northern edge of the high effects area. Recruitment has been low since the 1986 year class.

Snow crab occur on mud and sand habitats which are the least effected habitat in the BS (Table B.3-3). Habitat effects are less than 10 percent on living structure in mud and sand habitats and less than 3 percent on other components.

Habitat Impacts Relative to Spawning/Breeding

From 1978 to 1999, the distribution of snow crab shifted away from the areas of high trawling effects. It is not known, however, if habitat degradation contributed to this shift or whether climate-change-directed fishing taking place mostly in the southern portion of the snow crab's range and trawl bycatch occurring mostly in the southern portion of the range were more important factors.

Female snow crab shift to a biennial spawning cycle when waters are colder than about 1.5° centigrade (C), which occurs in the northern part of their range. Current recruitment strength may be affected by the location of the mature female stock. The shift in distribution of snow crab may be due to the combined influences of warmer waters in the BS after 1976, and directed fishing that occurred mainly in the southern part of the snow crab distribution, and bycatch in trawl fisheries. The current distribution of snow crab does not overlap the high trawl effects area to any extent (Figures B.3.2.8-2 and B.3.2.8-4).

Habitat Impacts Relative to Growth to Maturity

Juvenile snow crab distribution does not overlap areas of high trawling effects. It occurs on mud substrate, which is the least affected substrate.

Habitat Impacts Relative to Feeding

Snow crabs feed on an extensive variety of benthic organisms, including bivalves, brittle stars, crustaceans (including other snow crabs), polychaetes and other worms, gastropods, and fish. The LEI table indicates that the reduction in epifauna and infauna prey is quite low (less than 3 percent), but may be as high as 9 percent for living structures in this habitat. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. Considering the distribution of fisheries and the intensity of fisheries effects, only a small reduction in the infaunal and epifaunal prey is projected for mud habitats. Based on this information, fishing effects on snow crab habitat and the subsequent impacts on snow crab feeding are expected to be minimal.

No information is available to evaluate growth changes over time.

Stocks Status and Trends

The mature biomass of snow crab was high in the late 1970s, declined to a low level in the mid-1980s, then increased to a high in 1991 (Figure 3.2.8-3). Snow crab declined in the early 1990s, increased again in the mid-1990s, then declined to below the MSST in 1999. The stock was declared overfished in 1999. A rebuilding plan was developed in 2000 and is currently in effect (Council 2000b).

Summary

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

B.3.2.9 Deepwater Tanner Crabs

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Spawning/Breeding—The spawning, breeding, and habitat requirements for grooved Tanner crab and triangle crab are unknown. Nevertheless, the overlap of groundfish trawl effort with mature female crabs is likely very limited, given the deep water nature of these species. There has been virtually no directed pot fishery for this species in recent years. Only a few landings of deepwater Tanner crab have been made in the EBS: 49,000 lbs of triangle crab in 1995 and minor confidential landings in 1996 and 2000, as well as 106,000 lbs of grooved crab in 1996 and minor confidential landings in 2000. Also, 145,000 lbs of grooved crabs were harvested in the AI in 1995.

Feeding—Nothing is known about the feeding requirements for these species.

Growth to Maturity—Factors affecting growth and survival of this species are not known. Almost none are taken as bycatch in groundfish or crab fisheries.

Summary of Effects—Fishing activities are considered to have overall minimal and temporary effects on the EFH for deepwater Tanner crabs. These are deepwater species with almost no overlap with commercial fisheries, so habitat effects are unlikely. Professional judgement led to the conclusion that fisheries are unlikely to adversely affect the EFH of deepwater Tanner crabs.

B.3.3 Effects of Fishing on Essential Fish Habitat of Groundfish Species

The following evaluations were made to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?"

B.3.3.1 Walleye Pollock (BSAI and GOA)

Habitat Connections

Spawning/Breeding

Peak pollock spawning occurs on the southeastern BS and eastern AI along the outer continental shelf around mid-March. North of the Pribilof Islands spawning occurs later (April and May) in smaller spawning aggregations. The pollock of the Aleutian Basin spawn in deep water and appear to spawn slightly earlier, late February to early March. In the GOA, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area occurs 2 to 3 weeks earlier than in Shelikof Strait.

Spawning occurs in the pelagic zone, and egg development occurs throughout the water column (70 to 80 m in the EBS shelf; 150 to 200 m in Shelikof Strait). The rate of development depends on water temperature. In the EBS, eggs take about 17 to 20 days to develop at 4º C in the Bogoslof area and 25 days at 2º C on the continental shelf. In the GOA, development takes approximately 14 days at ambient temperature (5º C). Larvae are also distributed in the upper water column. In the EBS, the larval period lasts approximately 60 days. The larvae eat progressively larger naupliar stages of copepods as they grow, then small euphausiids as they metamorphose to juveniles (approximately 25 mm standard length). In the GOA, larvae are distributed in the upper 40 m of the water column, and diet is similar to EBS larvae. FOCI survey data indicate larval pollock may use the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which tend to prefer deeper water. See Section 3.2.1.2.1 for further discussion and references.

Feeding

Adults feed mainly on pelagic zooplankton. Major prey species are euphausiids, followed by calanoid copepods. Benthic zooplankton and shrimp make up 7 percent of pollock diet in the EBS, 11 percent of pollock diet in the AI, and 25 percent of pollock diet in the GOA. Pollock consumption is primarily in the pelagic pathway of the food web, so affected habitat features of the seafloor are not directly linked to pollock diet, though indirect links may exist.

Growth to Maturity

Pollock larvae are pelagic. Carlson (1994) reported observations of age-zero pollock forming “shoals of hundreds to a few thousand loosely aggregated individuals within 1 m above the bottom or off rock ledges at 20 to 30 m” at a study site in Auke Bay, Alaska. Juvenile pollock are faced with mortality risks due to predation by surface diving seabirds and marine mammals, from other groundfish species, and cannibalism. These risks vary both seasonally and on an interannual basis. For example, the risk of cannibalism for age-zero and age-1 pollock would increase in the presence of a strong year class of age-2 pollock. Juvenile pollock may have various mechanisms to avoid predation risk, but their behavior is likely an adaptive interplay between multiple influences such as thermal preferences and food availability, as well as predation risk (Duffy-Anderson et al. 2003). Juveniles (in particular, 1-year olds) are common near the bottom based on the summer bottom trawl surveys. The degree that this association is due to refuge value of benthic habitat structure (living or non-living) is unknown. There is some evidence that pollock associate with living structure. In the pelagic zone, juvenile pollock have been found with jellyfish in the EBS (Brodeur 1998). However, the importance of jellyfish as refuge from predation is unclear since jellyfish appear to feed significantly on larval (age-zero) pollock (Brodeur et al. 2002). Sogard and Olla (1993) evaluated association with seagrass beds in a laboratory experiment using juveniles collected in Port Townsend, Washington. In the absence of predators, juvenile pollock avoided artificial seagrass plots. In the presence of an artificial predator, pollock sought refuge and remained in the artificial seagrass plots. Utilization of seagrass beds by pollock has not been observed in Alaska.

Adults are semipelagic, are demersal at times, and are associated with a variety of habitats. They exhibit strong diel vertical migrations with nightly movements away from the bottom up into the water column. See Section 3.2.1.2.1 for further discussion and references.

Evaluation of Effects

LEI Values Relative to Species Distribution

In the BS, spatial overlap exists between the areas with high fishing effects and the extent of pollock distribution observed during June, July, and August (Figure B.2-2a, Table B.3-3). The benthic habitat in this area is primarily sand and a sand/mud composite (Table B.3-1). Estimated reductions of epifaunal and infaunal prey due to fishing are quite low (approximately 2 percent). However, reduction may be as high as 13 percent for living structure in this habitat across the entire BS. Substantial areas to the north of Unimak Island and on the middle shelf within pollock EFH show LEI impacts in excess of 50 percent for living structure.

In the GOA, estimated reductions of epifaunal and infaunal prey due to fishing are less than 1 percent for all substrate types. For living structure, LEI impacts ranged between 3 and 7 percent depending on the substrate. Local areas with LEI values in excess of 50 percent occur to the east of Kodiak Island in Barnabus, Chiniak, and Marmot Gullies. These are areas that support high densities of pollock.

The impacts that areas with high LEI effects have on the availability of prey for individual pollock or their ability to find refuge are unknown. The high LEI effects for living structure in areas that support high pollock densities may be a concern due the unknown role that these habitat features play in pollock survival to maturity. Nevertheless, pollock remain abundant in areas with high fishing effort. For example, trends in CPUE data from surveys in the EBS, AI, and GOA indicate similar patterns between the highly fished areas and areas that have had little or no fishing effort (Figure B.3.3.1-1). In addition, analysis of survey CPUE in the EBS shows that the spatial pattern of habitat use during summer months does not shift away from, or into, regions of high LEIs. See the following Website: http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm.

To address the concern that classification of 5-by-5-km^2 blocks into high effort and low effort areas was based only on fishing effort from 1998 to 2002, a more extensive data set of fishing effort extending back to 1981 was examined. This data set contains effort measured as the number of tows (not area swept) and is more uncertain due to lower observer coverage. Density of non-pollock tows has been consistently high in the high effort areas since the late 1980s or early 1990s, depending on the region (Figure B.3.3.1-2). The shifts in effort in the late 1980s reflect the development of the domestic groundfish fishery. These shifts suggest that detecting fishing effects on EFH that occur on decadal scales would be difficult using differential growth and relative abundance patterns in areas where current effort is high or low. This is because the level of effort changed (spatially) after the 1990s.

Habitat Impacts Relative to Spawning/Breeding

The areas of Shelikof Strait in the GOA and north of Unimak Island in the EBS are the main spawning regions for pollock. Spawning is thought to peak from February to April and occurs in the pelagic zone. In Shelikof Strait, there has been a decline in spawning stock biomass. However, the spatial overlap between spawning areas and high levels of fishing impact is minor. In the EBS, fishing impacts are concentrated in areas of spawning. Echo-integration trawl surveys conducted at the time of spawning in these areas have not detected a shift in the spatial component of spawning since surveys began in 1979. The small-scale spatial distribution of pollock spawning shows considerable year-to-year variation. This variation is likely due to a number of factors unrelated to seafloor habitat, such as the age structure of the population, water temperature, extent of ice cover, and speed of ice retreat.

Since recruitment in both the GOA and EBS varies highly (while fishing effort and catch have been relatively stable), the magnitude of recruitment is unlikely to be driven primarily by fishing impacts on habitat. As with the spatial distribution of spawning pollock, environmental factors are thought to play an important role in determining year-class strengths (i.e., during years when favorable bio-physical factors exist, pollock survival through egg and larval stages improves, which results in higher recruitment levels). However, high recruitment variability makes it unlikely that relatively subtle habitat effects can be detected.

There is no evidence that the existing level of habitat disturbance due to fishing is impacting pollock spawning/breeding. The precautionary measures for overall exploitation rates (which explicitly consider spawning population conservation) in these areas are intended to ensure that the pollock stocks will approach B_{MSY} on average (Ianelli et al. 2004a, Dorn et al. 2004, Barbeaux et al. 2004).

Habitat Impacts Relative to Growth to Maturity

Patterns in high or low relative pollock weight (given length and sex from summer bottom trawl survey data) indicate significant year and fishing effort effects. Relative weights are slightly higher in the high fishing effort areas in the GOA and EBS, but not in the AI. This may simply indicate that the fishery tends to concentrate in areas of high pollock abundance, where conditions would expected to be favorable for pollock growth. The difference in relative weight between high and low impact areas shows no trend over time that would indicate of gradual degradation in habitat quality (Figure B.3.3.1-3). These patterns suggest that the impact of fishing on habitat has not adversely affected pollock growth.

Habitat Impacts Relative to Feeding

Since pollock feed primarily on zooplankton and pelagic organisms, the fishing impact on habitat features of the seafloor would not be expected to show a correlation to their feeding success. Analysis of feeding distributions in the BS show that pollock are broadly distributed over the shelf region and in the pelagic zone and that this distribution does not appear to have shifted over time. In the GOA, there has been a trend towards a broader spatial distribution of pollock at the same time that mean abundance has been decreasing (Shima et al. 2002). This pattern is contrary to the expected range contraction with declining abundance, suggesting that other factors may be influencing spatial pattern. Shima et al. (2002) noted the possibility of both fishing disturbance and environmental factors, but fishing effects on habitat could also result in a broader spatial distribution if the best habitats are reduced in quality.

Stock Status and Trends

Stock information for pollock in these regions has been available from fisheries catch and catch at age since 1964. Survey and other abundance index data are available through major parts of these time series and allow reasonable calibrations of age-structured stock assessment models. Model estimates indicate that the pollock spawning biomass in the GOA began at low levels and reached peaks in the 1980s after a period of high recruitment, then subsequently declined (Figure B.3.3.1-4). Spawning stock dropped below the B_{MSY} proxy of B35 percent in 1999, but is projected to increase to above B_{MSY} in 2005. Estimates of pollock biomass in the EBS also began at relatively low levels and grew to high levels in the mid-1980s and have remained relatively high and variable (due to recruitment fluctuations) at around 10 million tons (mt) of age 3 and older total biomass (Figure B.3.3.1-5).

The female spawning biomass has produced strong recruitment in both areas and has maintained levels above or near B_{MSY} estimates for the past 20 years. Annual fishing mortality rates have been below F_{MSY} levels during this period. There is no evidence at the stock level that the cumulative effects of fishing activity on habitat have impaired the stocks' ability to produce MSY over this time.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—Pollock is a generalist species that occupies a broad geographic niche and can use a wide variety of different habitats (Bailey et al. 1999). The ability of pollock to invade and adapt to marginal habitats has been suggested as a possible reason for the rapid increases in abundance during the environmental changes that occurred in the North Pacific in the 1970s (Bailey 2000). Pollock's ecological plasticity may allow adaption to habitats that have been modified by fishing impacts. Fishing impacts might even be beneficial, particularly if there are significant adverse impacts on predators or competitors more dependent on seafloor habitat features.

The overall evaluation of fishing impacts on pollock EFH is based primarily on extensive life history information that shows that pollock eggs, larvae, juveniles, and adults are not associated with seafloor habitat features affected by fishing. Some pollock life history stages are more demersal (i.e., age-1 juveniles), but even here the association is more likely related to temperature tolerances and avoidance of predators higher up in the water column than any characteristic of the bottom that can be impacted by trawling. The rating for fishing impacts on spawning/breeding for BSAI/GOA pollock is MT because pollock are pelagic spawners, as are their eggs and larvae. The rating for fishing impacts on feeding for BSAI/GOA pollock is MT because adults feed mainly on pelagic euphausiids followed by calanoid copepods.

The primary concern for pollock is the reduction in living structure in areas that support high pollock densities and its potential importance to juvenile pollock in providing refuge from predation. Changes in predation (or cannibalism) on juveniles have been proposed as a mechanism for population control in both the BSAI (Hunt et al. 2002) and the GOA (Bailey 2000). An increase in juvenile mortality will reduce spawning output per individual and, if large enough, could impair the ability of the stock to produce MSY over the long term (Dorn 2004). In the GOA, there is evidence of an increase in pollock mortality due to increases in the abundance of the dominant piscivores (Bailey 2000, Hollowed et al. 2000). However, evidence is weak that living structure plays a significant role in mediating mortality risk for juvenile pollock in the BSAI and the GOA, and it appears more likely that juveniles avoid predation risk through behavioral mechanisms such as shoaling and position in the water column. In addition, the overall reduction in living substrate for pollock EFH is relatively small (7 percent). Therefore, the rating for fishing impacts on growth to maturity for BSAI/GOA pollock is MT.

B.3.3.2 Pacific Cod (BSAI and GOA)

Habitat Connections

Spawning/Breeding
Spawning takes place in the sublittoral-bathyal zone (40 to 290 m) near bottom. Eggs sink to the bottom after fertilization and are somewhat adhesive. Optimal temperature for incubation is 3 to 6° C, optimal salinity is 13 to 23 parts per thousand (ppt), and optimal oxygen concentration is from 2 to 3 parts per million (ppm) to saturation. Little is known about the optimal substrate type for egg incubation. See Sections 3.2.1.1.2 and 3.2.1.2.2 for further discussion and references.

Feeding
Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the BSAI and GOA are polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, fishery discards, and yellowfin sole. Small Pacific cod feed mostly on

invertebrates, while large Pacific cod are mainly piscivorous. See Sections 3.2.1.1.2 and 3.2.1.2.2 for further discussion and references.

Growth to Maturity
Larvae are epipelagic, occurring primarily in the upper 45 m of the water column shortly after hatching, moving downward in the water column as they grow. Juveniles occur mostly over the inner continental shelf at depths of 60 to 150 m. Adults occur in depths from the shallow water of the shoreline to 500 m. Average depth of occurrence tends to vary directly with age for at least the first few years of life, with mature fish concentrated on the outer continental shelf. Preferred substrate is soft sediment, from mud and clay to sand. See Sections 3.2.1.1.2 and 3.2.1.2.2 for further discussion and references.

Evaluation of Effects

LEI Values Relative to Species Distribution
Long-term effect indices are shown in Table B.3-3. Figures B.2-1 through B.2-6c provide a more spatially explicit summary of the long-term effect indices. As this table and these figures show, there are overlaps between habitat features for which long-term effects are expected and areas of habitat use by Pacific cod. A rough estimate of the potential significance of the overlap between Pacific cod habitat and fishing's long-term effect on a given habitat feature can be obtained by weighting the long-term effect indices by the proportion of Pacific cod habitat made up of each habitat type and summing across habitat types. This results in the following set of weighted average LEIs (these are based on the 75 percent concentration; the weighted averages based on the 95 percent concentration are all lower):

Habitat Feature	BSAI	GOA
Infauna Prey	0.02	0.01
Epifauna Prey	0.01	0.01
Living Structure	0.10	0.06
Non-living Structure	0.02	0.01
Hard Coral	0.02	0.19

Only three habitat features have weighted average LEIs exceeding 2 percent: living structure in the BSAI (10 percent) and GOA (6 percent) and hard coral in the GOA (19 percent).

These weighted averages are only approximate estimates of potential significance for two reasons:
1) In order for the weighted averages to apply to the Pacific cod stock (as opposed to the Pacific cod *habitat*), fish would have to be evenly distributed across the area of 75 percent concentration (i.e., the proportion of fish in a given habitat type would have to equal the proportion of that habitat type in the area of 75 percent concentration). For example, the most significant impacts on several habitat features in the BSAI occur just north of Unimak Island (Figures B.2-2a through B.2-6c), where a major spawning aggregation of Pacific cod occurs, in which case the weighted averages may tend to underestimate the impacts on spawning fish. 2) The weighted averages say nothing about any particular habitat feature's importance to Pacific cod. For example, a 19 percent reduction in GOA hard coral may mean very little if hard coral is not a limiting factor in the population dynamics of GOA Pacific cod.

Because the areas of hard coral abundance are very small compared to the area of 75 percent Pacific cod concentration, it seems unlikely that hard coral is a limiting factor. The most important habitat features from the perspective of Pacific cod are probably infaunal and epifaunal prey, where the weighted average LEIs are only 1 to 2 percent for both the BSAI and GOA.

Given that the habitat features most important to Pacific cod are expected to be reduced by only 1 to 2 percent relative to their unfished condition (the above caveats notwithstanding) and given that the spawning biomass of Pacific cod at MSY is likely to be less than half the spawning biomass in the unfished condition (therefore requiring substantially fewer resources than in the unfished condition), it is reasonable to conclude that the relationships between the LEI values and the distribution of Pacific cod do not provide substantial evidence that fishing's effects on habitat features will significantly impair the stocks' ability to sustain itself at or near the MSY level.

Habitat Impacts Relative to Spawning/Breeding

When Figures B.2.2a through 2.6c are compared with annual maps showing the distribution of fishery and survey CPUE, no linkage between habitat disturbance and spawning/breeding success is obvious. For example, within the heavily fished area north of Unimak Island, which is an area traditionally associated with high concentrations of spawning Pacific cod, the survey almost invariably achieves a high CPUE in at least some stations.

It is possible, however, that such examinations miss subtle tendencies. Therefore, survey CPUE was compared and contrasted statistically between three treatments, defined by those areas in which fishing was high, low, or nonexistent. For the times covered by the respective surveys (AI, BS, and GOA), eight regulatory areas contain Pacific cod CPUE observations in all years and all three treatments: Area 541 in the AI; Areas 509, 513, 516, and 517 in the BS; and Areas 610, 620, and 630 in the GOA. These data were examined as follows: First, average CPUE of adult Pacific cod was computed across the time series for each area and treatment. Second, the average CPUE values were compared on a pairwise basis between treatments in each area. Third, the number of areas in which a given treatment had the higher CPUE in each pairwise comparison was tabulated. The results are shown below:

Comparison:	High versus Low		High versus None		Low versus None	
Treatment:	High	Low	High	None	Low	None
Number of regulatory areas in which average CPUE was higher:	4	4	4	4	5	3

If fishing were the primary determinant of adult biomass, one might expect areas of high fishing to have a lower average CPUE than areas of low fishing or no fishing. Areas of low fishing would be expected to have lower average CPUE than areas of no fishing. However, such tendencies are not apparent. High fishing was just as likely to achieve a higher CPUE than either low fishing or no fishing, and low fishing was slightly more likely to achieve a higher CPUE than no fishing. None of the differences between average CPUE was significant at the 5 percent level.

The above analysis was repeated using two alternative measures of relative biomass: average proportion CPUE and average logit proportion CPUE. The results in both cases were broadly similar to the above, except that three comparisons were significant at the 5 percent level when average proportion CPUE was used. In one area (541), high fishing was associated with significantly lower average proportion CPUE than no fishing, and in two areas (509 and 517), high fishing was associated with a significantly higher average proportion CPUE than no fishing.

Comparisons of long-term averages such as those described above may miss trends over time (e.g., two time series may have the same average, but one may be increasing while the other is decreasing). Therefore, the trend in relative adult biomass was examined for each time series in the high fishing treatment. Regardless of whether relative adult biomass was measured by average CPUE, average proportion CPUE, or average logit proportion CPUE, the results showed more negative than positive trends. Only two of the trends were significant at the 5 percent level, however: Area 513 showed a significant negative trend using either average proportion CPUE or average logit proportion CPUE, and Area 517 showed a significant negative trend using average CPUE.

Data are insufficient to determine whether Pacific cod maturity at age has changed over time.

Given the above, it is reasonable to conclude that the available information regarding the spatio-temporal distributions of the fishery and the adult portion of the Pacific cod stock does not provide substantial evidence that fishing's effects on habitat features will significantly impair the stocks' ability to sustain itself at or near the MSY level.

Habitat Impacts Relative to Growth to Maturity

In terms of survival to maturity, several studies have shown that early life stages of other *Gadus* species exhibit higher survival in the presence of habitat structure (e.g., Cote et al. 2001, Gregory and Anderson 1997, Laurel et al. 2003). The extent to which the results of these studies can be transferred to Pacific cod is unclear, however. For example, some of these studies focus only on very nearshore areas (depths of 1 to 2 m, or within 50 m of shore), whereas most Pacific cod spawning occurs in much deeper water. Also, it is possible for results to differ significantly between closely related species. For example, the study by Laurel et al. (2003) showed different responses between Atlantic cod (*Gadus morhua*) and Greenland cod (*Gadus ogac*). While it is probably safe to assume that habitat structure confers some amount of benefit to early life stages of Pacific cod, it would probably be a mistake to assume that early life stages of Pacific cod depend on habitat structure, given the fact that much Pacific cod spawning takes place in habitat with relatively little structure. In habitat types such as sand or sand/mud, the net impact of trawling on habitat structure is unclear.

In terms of growth to maturity, the available evidence does suggest a possible effect of fishing. The following weight-length relationship was fit separately to data from the EBS, AI, and GOA, distinguishing in each case between areas of high fishing and low fishing:

$$W(I) = \exp(\ \theta + \rho \times \ln(L(I))\ )$$

where $W(I)$ represents weight of the ith fish, $L(I)$ represents length of the ith fish, and θ and ρ are parameters to be estimated. In the EBS, the 95 percent confidence intervals for the high fishing and low fishing parameter estimates did not overlap. The same was true in the AI. However, in the GOA, there were very few data from high fishing areas, so the 95 percent confidence ellipse for the low fishing parameter estimates was entirely subsumed by the 95 percent confidence ellipse for the high fishing parameter estimates. The length ranges within which high fishing had negative/positive effects on predicted weight at length are summarized below:

Area	W@L is lower under high fishing at:	W@L is higher under high fishing at:
EBS	L < 59 cm	L > 58 cm
AI	all lengths	no lengths
GOA	L > 56 cm	L < 57 cm

Although statistically significant effects can be identified, at least in the EBS and AI, they are not very large. In the EBS, the maximum expected decrease in weight at length is never more than 6 percent, and there is a less than 5 percent chance of a decrease more than 10 percent except at lengths less than 21 cm. In the AI, the maximum expected decrease in weight at length is never more than 3 percent, and there is less than a 5 percent chance of a decrease more than 10 percent, except at lengths less than 25 cm. In the GOA, the maximum expected decrease in weight at length is never more than 1 percent, and there is a less than 5 percent chance of a decrease more than 10 percent at all lengths.

Sample sizes are probably too small to detect significant temporal trends in weight at length.

Given that the point estimates of change in weight at length are all very small and that there is only a small length range within which the probability of even a 10 percent change exceeds 5 percent, it is reasonable to conclude that the available information regarding the relationship between fishing and growth to maturity does not provide substantial evidence that fishing's effects on habitat features will significantly impair the stocks' ability to sustain itself at or near the MSY level.

Habitat Impacts Relative to Feeding

Overall, there is little reason to suspect a link between habitat disturbance and feeding success of Pacific cod. As noted in the preceding subsection, fishing seems to have little effect on the weight-length relationship, which would not be the case if fishing resulted in a chronic inability of Pacific cod to find sufficient food.

Survey CPUE distributions over time do not reveal any obvious changes that might be attributable to decreased feeding success in heavily fished areas. On the contrary, areas of sustained heavy fishing are often associated with areas of sustained high survey CPUE.

Data are insufficient to determine whether there has been a detectable change in the diet of Pacific cod attributable to fishing.

Given the above, it is reasonable to conclude that the available information regarding the relationship between fishing and feeding success does not provide substantial evidence that fishing's effects on habitat features will significantly impair the stocks' ability to sustain itself at or near the MSY level.

Stock Status and Trends

In both the EBS and GOA, spawning biomass of Pacific cod has been above the MSY level throughout the history of management under the Magnuson-Stevens Act. Depending on the endpoints used to compute a trend; however, negative trends in spawning biomass can be identified in both the EBS and GOA. In the EBS, any time period beginning in the interval from 1980 to 1997 and ending in 2004 has a negative slope that is significant at the 5 percent level. In the GOA, any time period beginning in the interval from 1980 to 2001 and ending in 2004 has a negative slope that is significant at the 5 percent level.

As with spawning biomass, recruitment of Pacific cod in both the EBS and GOA has tended to fluctuate around the levels associated with MSY. Depending on the endpoints used to compute a trend; however, negative trends in recruitment can be identified in both the EBS and GOA. In the EBS, the periods from 1978 to 2004, 1979 to 2004, and 1982 to 2004 all have negative slopes that are significant at the 5 percent level. In the GOA, any period beginning in the interval from 1978 to 1992 and ending in 2003 has a negative slope that is significant at the 5 percent level.

Fishing is expected to affect future recruitment because fishing has effects on spawning biomass, to which recruitment is presumably related, at least on average. Unfortunately, it is typically difficult to estimate the relationship between spawning biomass and recruitment (Thompson and Dorn 2004). If, in addition to biomass-mediated effects on future recruitment, fishing also imposes habitat-mediated effects on future recruitment, these will be hard to detect. In an effort to estimate some of the uncertainty surrounding both biomass-mediated and habitat-mediated effects of fishing on future recruitment, the following stock-recruitment relationship was examined in a Bayesian framework:

$$R(t+1) = S(t) \times \exp(-\alpha - \beta \times S(t) - \gamma \times F(t))$$

where R(t+1) represents age 1 recruits at time t+1; S(t) represents spawning biomass at time t; F(t) represents fishing mortality at time t; and α, β, and γ represent parameters to be estimated. The parameter γ represents all non-biomass-mediated effects of fishing on recruitment. To be precautionary, it was assumed that all such effects are mediated through fishing's effect on habitat.

The time series of age-1 recruits, spawning biomass, and fishing mortality were taken from the most recent stock assessments (Thompson and Dorn 2004 and Thompson et al. 2004 for the EBS and GOA stocks, respectively). The fishing mortality rates represent all fishing mortality on Pacific cod, regardless of target, season, or gear type.

Normal prior distributions were specified for each of the three parameters. The mean of the prior for α was set equal to -1 minus the average log (recruits-per-unit-spawning-biomass), the mean of the prior for β was set equal to 1 over the average spawning biomass, and the mean of the prior for γ was set equal to zero. When the stock-recruitment relationship is estimated using the means of the three prior distributions, the stock achieves equilibrium at the average spawning biomass and the geometric mean replacement rate.

The standard deviations for all three prior distributions were set such that there was a 1 percent probability that the parameter had a sign opposite that of the mean, except in the case of γ, where the slope of a least-squares regression of log (recruits-per-unit-spawning-biomass) against annual fishing mortality was substituted for the mean.

A lognormal likelihood was assumed, and the maximum likelihood estimate of variance was assumed to be the true value of this parameter in subsequent computations.

The marginal posterior distribution of γ was obtained for the EBS and GOA stocks. For the EBS stock, the probability that γ is positive was 71 percent. For the GOA stock, the probability that γ is positive was nearly 100 percent. Therefore, in both areas, this analysis suggests that fishing probably has some level of habitat-mediated effect on recruitment.

However, it is important to consider not only the existence but the magnitude of any habitat-mediated effect on recruitment, specifically with regard to the stocks' ability to sustain itself at or near the MSY level. To examine this question, it was assumed that the biomass associated with maximum recruitment is equal to the MSY level. This is a conservative assumption, because MSY biomass is typically somewhat lower than the biomass associated with maximum recruitment. It was also assumed that the stocks' ability to sustain itself at or near the MSY level would not be impaired unless equilibrium biomass under average fishing mortality (computed over the available time series, 1978 to 2003) was less than MSST. The average fishing mortality rate was used to focus the analysis on the expected long-term effects of the overall management regime. To simplify the analysis, MSST was assumed to equal half the

MSY level (this is a special case of the full, official definition of MSST). In the EBS, the point estimate of equilibrium biomass under average fishing mortality is 155 percent above MSST. In the GOA, the point estimate of equilibrium biomass under average fishing mortality is 23 percent above MSST. However, the results from the GOA analysis depend heavily on the strengths of the two most recent year classes. These year classes are the least precisely estimated in the time series. If they are removed, the point estimate of equilibrium biomass in the GOA is 91 percent above MSST.

Although the point estimates of equilibrium biomass are above MSST in both the EBS and GOA, uncertainty remains as to whether habitat-related effects could drive the stock below MSST. Could habitat-related effects of fishing cause the stock to fall below MSST, given that the biomass-related effects would not cause the stock to fall below MSST? In the EBS, this conditional probability is nearly zero. In the GOA, this conditional probability is 27 percent. As noted above, however, the results of the GOA analysis are heavily dependent on the strengths of the two most recent (and least precisely estimated) year classes. If these two year classes are removed, the conditional probability is only 1 percent.

Caveats

1. The model described above was completed late in the process of preparing this FEIS. Little time was available for reviewing the model or applying it to other species prior to the deadline for completion of the FEIS.

2. The model described above may not be useful for all species. In particular, it would probably be difficult to identify any non-biomass-mediated effect of fishing in the case of a species characterized by highly variable recruitment or highly stable fishing mortality.

3. Estimation of stock-recruitment relationships is a difficult exercise in the field of stock assessment for two reasons: 1) the spawning biomass values and the recruitment values are invariably measured with error, and 2) because the errors in the recruitment measurements are necessarily autocorrelated (Walters and Ludwig 1981). In contrast, most estimation methods, including the approach used above, are based on the assumptions that the spawning biomass values are measured without error and that the errors in the recruitment measurements are uncorrelated. Furthermore, the approach used above is based on the assumption that the standard deviations of the error terms (on a log scale) are all equal; it is likely, however, that the error terms for the more recent year classes are larger than for earlier, more fully observed, year classes. To date, the Scientific and Statistical Committee has not viewed existing estimates of the standard two-parameter (α and β) Ricker stock-recruitment relationship as being reliable enough to use in setting acceptable biological catch levels for Pacific cod. Addition of a third parameter (γ) would be expected to further decrease the reliability of the estimates.

4. Generally speaking, statistical significance does not necessarily imply biological significance. Statistical significance deals with the question, “Do the data indicate that an effect exists?” Biological significance deals with the question, “Is the effect of sufficient magnitude to be important to the organism (or population, or ecosystem, etc.)?” Therefore, results pertaining to the probable existence of habitat-mediated fishing effects should not be viewed in isolation from results describing the biological significance of those effects.

5. While it was assumed above that all non-biomass-mediated effects of fishing are a result of fishing's effect on habitat, other interpretations are possible (e.g., fishing could disrupt spawning aggregations directly).

6. In the above analysis, the total annual fishing mortality impacting the Pacific cod stock was used as a proxy for the total annual fishing mortality impacting Pacific cod habitat. This assumption could be problematic to some extent if either of the following conditions holds:

   A. The distribution of the fishery between seasons or gear types has changed substantially, and substantial differences exist in any habitat-mediated impacts of the fishery between seasons or gear types.
   B. Pacific cod vacate a substantial portion of their habitat during some part of the year, and a substantial fishery takes place for other species in that portion of the habitat during the same time of year.

7. It is possible that the habitat-mediated effects attributed above to fishing were actually caused by some other variable that is highly correlated (either causally or coincidentally) with fishing mortality.

8. The above analysis was based on a single modeling approach. Many other modeling approaches are possible. Two examples are discussed below.

Alternative Models

The model described above has some similarities to a model proposed by Shester (2004). Shester's model assumes logistic growth in population numbers and a constant catch harvest policy. Fishing's effects on carrying capacity are assumed to be proportional to catch. These effects are subtracted from the pristine carrying capacity (i.e., the long-term average population size that would be expected in the absence of fishing). In equation form, Shester's model can be written as follows:

$$dN/dt = r\times N\times(1 - N/(K - \Omega\times h)) - h$$

where N represents population size in numbers, r represents the intrinsic rate of increase, K represents pristine carrying capacity, h represents catch, and Ω represents the rate at which catch affects carrying capacity. If Ω is greater than zero, and if the values of r and K are known, Shester's model indicates that both MSY and the equilibrium population size corresponding to MSY (N_{MSY}) will be lower than would be predicted if Ω were assumed to equal zero.

As originally configured, Shester's model has limited applicability to management of North Pacific groundfish fisheries because management of those fisheries is not based on a constant catch policy. However, it is easy to reconfigure Shester's model to reflect a constant rate policy, which would be closer to the policy actually used in managing the North Pacific groundfish fisheries:

$$dN/dt = r\times N\times(1 - N/(K - \Omega\times F\times N)) - F\times N$$

In the above reconfiguration of Shester's model, it can be shown that the effect of Ω on N_{MSY} is exactly the same as in Shester's original configuration. However, it can also be shown that fishing mortality sustainable yield (F_{MSY}), the fishing mortality rate corresponding to MSY, is completely independent of Ω. That is, equilibrium yield is maximized by fishing at the same value of F (specifically, r/2), regardless of fishing's effects on carrying capacity.

The model used here is more precautionary than Shester's model because F_{MSY} in this model varies inversely with the rate of habitat impacts, while N_{MSY} varies directly with the rate of habitat impacts. In other words, if fishing imposes a habitat-mediated impact on recruitment, F_{MSY} will be lower, and N_{MSY} will be higher than would be the case if fishing did not impose a habitat-mediated impact on recruitment.

Conclusions with Respect to Stock Status and Trends

Given the above, it is reasonable to conclude that the available information regarding the relationship between fishing and stock status and trends does not provide substantial evidence that fishing's effects on habitat features will significantly impair the stocks' ability to sustain itself at or near the MSY level.

Summary

Issue	Evaluation
Spawning/Breeding	MT (Minimal or temporary effect)
Growth to Maturity	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)

Summary of Effects—Fishing's effects on the habitat of Pacific cod in the BSAI and GOA do not appear to have impaired either stocks' ability to sustain itself at or near the MSY level. When weighted by the proportions of habitat types used by Pacific cod, the long-term effect indices are low, particularly those of the habitat features most likely to be important to Pacific cod (infaunal and epifaunal prey). The fishery appears to have had minimal effects on the distribution of adult Pacific cod. Effects of fishing on weight at length, while statistically significant in some cases, are uniformly small and sometimes positive. While the fishery may impose some habitat-mediated effects on recruitment, these fall below the standard necessary to justify a rating of anything other than minimal or temporary.

B.3.3.3 Sablefish (GOA and BSAI)

Habitat Connections

Spawning/Breeding

Spawning occurs from 300 to 500 m deep near the edges of the continental slope (McFarlane and Nagata 1988), with eggs developing at depth and larvae developing near the surface as far offshore as 290 km (Wing 1997). The average spawning date based on otolith analysis is March 30 (Sigler et al. 2001). Sablefish are not thought to have any particular spawning grounds like halibut, so spawning likely is widespread along the upper continental slope. During surveys of the outer continental shelf, most young-of-the-year sablefish are caught in the central and eastern GOA (Sigler et al. 2001), implying that spawning is more likely to be successful in these areas. Particular habitat affiliation within broad habitat categories of gully and slope have not been noted for sablefish. They are distributed throughout these hydrographic features and occur in a wide range of habitats. They do not demonstrate any exclusivity to particular habitat features like some rockfish species that use primarily rocky habitat.

Feeding

Larval sablefish feed on a variety of small zooplankton, ranging from copepod nauplii to small amphipods. Young-of-the-year are epipelagic and feed primarily on macrozooplankton and micronekton (e.g., euphausiids) (Sigler et al. 2002). Juveniles less than 60 cm feed primarily on euphausiids, shrimp, and cephalopods (Yang and Nelson 2000), while sablefish more than 60 cm feed more on fish. Both juvenile and adult sablefish are considered opportunistic feeders. Fish most important to the sablefish diet include pollock, eulachon, capelin, Pacific herring, Pacific cod, Pacific sand lance, and some flatfish, with pollock being the most predominant (10 to 26 percent of prey weight, depending on year). Squid, euphausiids, and jellyfish were also found, squid being the most important of the invertebrates (Yang and Nelson 2000). Feeding studies conducted in Oregon and California found that fish made up 76 percent of the diet (Laidig et al. 1997). Off the southwest coast of Vancouver Island, euphausiids dominated sablefish diet (Tanasichuk 1997). The diet of sablefish is similar to that of the large flatfish such as arrowtooth flounder and Pacific halibut (Yang and Nelson 2000).

Growth to Maturity
Juveniles are pelagic and move into comparatively shallow nearshore areas where they spend the first 1 to 2 years (Rutecki and Varosi 1997). After their second summer, juveniles begin moving offshore, eventually reaching the upper continental slope as adults. Fish first appear on the upper continental slope, where the longline survey and longline fishery primarily occur, as early as age 2 and fork length about 50 to 53 cm, although only 10 percent are estimated to reach the slope at that young age. Fish are susceptible to trawl gear at an earlier age than to longline gear because trawl fisheries usually occur on the continental shelf and shelf break areas that are inhabited by younger fish. Sablefish grow rapidly in early life, gaining 1.2 mm per day during their first spring and summer (Sigler et al. 2001). Within 100 days after first increment formation, they average 120 mm. They reach average maximum lengths and weights of 69 cm and 3.4 kg for males and 83 cm and 6.2 kg for females. Fifty percent of females mature at 65 cm, while 50 percent of males are mature at 57 cm (Sasaki 1985), corresponding to ages 6.5 years for females and 5 years for males.

No specific connections to habitat features are known for sablefish, although in general one would expect a demersal roundfish such as sablefish to be adapted to habitat with benthic biostructure rather than to habitat without or with greatly reduced biological structure. Moore (1999) indicates that unlike roundfish, flatfish do not require a complex structured habitat and notes that Rijnsdorp and van Leeuwen (1996) found an increase in growth rate of flatfish in intensely fished areas of the North Sea.

Evaluation of Effects

LEI Values Relative to Species Distribution
A number of areas experience high fishing intensity on the continental shelf and are distributed in a few large areas on the BS shelf and in smaller localized areas on the GOA shelf. While Table B.3-3 indicates that only a small percentage of total sablefish EFH is on the continental shelf, total sablefish EFH, as estimated in the table, is biomass based and primarily determines the adult distribution. Because of their small size and intermittent abundance, EFH for juvenile sablefish may not be well determined, and the importance of shelf habitat for juvenile sablefish may be underestimated. While the areas of importance to juvenile sablefish may not be well represented in Table B.3-3, it does indicate that high LEIs do occur in the sablefish EFH detected on the southwest BS shelf.

Habitat Impacts Relative to Spawning/Breeding
While there are areas of high bottom trawling intensity along the continental slope, and sablefish are believed to spawn along the slope, there is little information to determine the spawning distribution or detect shifts in distribution. Changes in the maturity of age for sablefish have not been detected.

Habitat Impacts Relative to Growth to Maturity
There has been a downward trend in sablefish recruitment over the last 25 years. Years of strong young-of-the-year survival have occurred from 1980 to the 1990s, so the failure of strong recruitment to the mature stage suggests a decreased survival of juveniles during their residence as 2- to 4-year-olds on the

continental shelf. While no specific link can be established, areas of the continental shelf may be more important to juvenile sablefish than indicated in Table B.3-3. Intense bottom trawling on the continental shelf may have reduced both benthic biostructure and the ability of juvenile sablefish to compete or otherwise survive to maturity. A lack of spatial and temporal distribution information of historical bottom trawling effort limits the ability to establish a link to decreased recruitment should one exist.

Habitat Impacts Relative to Feeding

The length-to-weight relationship of sablefish sampled from areas defined as high and low fishing intensity was compared. No significant differences were found. Limitations such as insufficient sample size, the lack of contrast between high and low areas within similar habitat and geographic areas, and the likelihood that fish did not confine themselves to the respective treatment areas preclude determining if possible effects exist. The lack of such finding is not proof that habitat impacts have no effects on the feeding success of sablefish.

Stock Status and Trends

There has been a negative trend in sablefish recruitment estimates since the late 1970s (see Figure 3.11 in Sigler et al. 2004). This negative trend in recruitment has resulted in a downward trend in the estimates of biomass reference points such as $B_{40\%}$, $B_{35\%}$, and MSST. These values are directly related to the stock's average recruitment. Figure B.3.3.3-1 shows retrospective estimates of $B_{40\%}$ using three variations of estimating sablefish average recruitment.

After strong year classes in the late 1970s and early 1980s peaked in biomass, sablefish spawning stock biomass decreased steadily and has since remained below target biomass levels ($B_{40\%}$) (see Figure 3.10 in Sigler et al 2004). The spawning stock has remained below target levels in spite of fishing rates being adjusted below the level ($F_{40\%}$) that should have allowed recovery to $B_{40\%}$ and the long-term attainment of $B_{40\%}$.

There is no direct evidence to attribute these trends to fishing impacts on habitat. Whether the decreasing trend in recruitment is the result of climate conditions or altered benthic habitat is unclear. However, juvenile sablefish reside in the demersal habitat of the continental shelf for 2 to 4 years before they recruit to deeper waters as adults. Areas of the continental shelf have been bottom trawled intensively. In one area in particular in the BS north of Unimak Island, juvenile sablefish from the strong 1977 year class were observed at high levels from 1978 to 1980 (Umeda et al. 1983). Even though indications of high egg-larval-young of the year survival have occurred since the 1977 year class, 2- to 4-year-old sablefish abundance has been uncommon in this area. This area north of the Alaska Peninsula was closed to trawling by Japan in 1959 and apparently was untrawled until it was opened to United States trawling in 1983 (Witherell 1997, Fredin 1987). This area is currently one of the most intensely bottom trawled areas in Alaska. Bioshelter LEI values for much of this area are high.

A plausible indirect linkage attributing these trends to fishing impacts on habitat is suggested by the increase of arrowtooth flounder on the shelf of the GOA and BS. Arrowtooth flounder in the area north of Unimak Island has increased significantly since the mid 1980s while the abundance of sablefish has been minimal since then (Connors et al. 2004, Umeda et al. 1983). Moore (1999) indicates that, unlike roundfish, flatfish do not require a complex structured habitat and notes that Rijnsdorp and van Leeuwen (1996) found an increase in growth rate of flatfish in intensely trawled areas of the North Sea. This suggests intensive trawling has the potential to improve conditions for flatfish.

Whether sablefish are linked to arrowtooth flounder as prey or through competition is unknown. Food studies by the AFSC do not indicate sablefish as a prominent prey item; however, juvenile sablefish are available only intermittently and at lower numbers than more abundant prey such as pollock and cod. Therefore, it is not inconceivable that sablefish are preyed upon by arrowtooth to the detriment of sablefish without them being detected as prominent prey compared to other more numerous species. The diet of sablefish is similar to that of the large flatfish, arrowtooth flounder, and Pacific halibut (Yang and Nelson 2000), so competition may be a factor.

The decreasing trend in recruitment and resulting estimates of biomass reference points and their corresponding yield levels indicate that the level of MSY has been impaired. The decreasing estimate of a target biomass, $B_{40\%}$, has led to a lowering of the expectation of the long-term catch level. Biomass reference points such as $B_{35\%}$ or $B_{40\%}$ are one form of estimate or surrogate for MSY. It is likely that any other estimate of MSY would have decreased over the same time period.

While the stock is currently above the latest estimate of a biomass of 35 percent, this should not be taken as proof that the sablefish stock productivity is unimpaired. Considerations should include the following points:

1. The biomass is projected to decrease again in the near future.

2. The biomass has been below $B_{35\%}$ in the recent past.

3. Given the harvest control rules and the resultant fishing rates, the biomass should have been fluctuating around $B_{40\%}$.

4. Estimates of $B_{35\%}$ have decreased over time.

5. The current biomass is below what $B_{35\%}$ would have been estimated at 10 years ago.

Summary

Issue	**Evaluation**
Spawning/Breeding	MT
Growth to Maturity	U (Unknown)
Feeding	U (Unknown)

Summary of Effects—The estimated productivity and sustainable yield of sablefish have declined steadily since the late 1970s. This is demonstrated by a decreasing trend in recruitment and subsequent estimates of biomass reference points and the inability of the stock to rebuild to target biomass levels despite of the decreasing level of the targets and fishing rates below the target fishing rate. While years of strong young-of-the-year survival have occurred in the 1980s and 1990s, the failure of strong recruitment to the mature stage suggests a decreased survival of juveniles during their residence as 2- to 4-year-olds on the continental shelf. While climate-related changes are a possible cause for reduced productivity, the observations noted above are consistent with possible effects of fishing on habitat and resulting changes in the juvenile ecology of sablefish, possibly through increased competition for food and space. Given the concern for the decline in the sustainable yield of sablefish, the possibility of the role of fishing effects on juvenile sablefish habitat, and the need for a better understanding of the possible causes, an MT rating is not merited, and sablefish growth to maturity and feeding is rated unknown.

B.3.3.4 Atka Mackerel (BSAI and GOA)

Habitat Connections

Habitat preferences for the early life stages of Atka mackerel, particularly the larval and early juvenile stages, are poorly known in comparison to the adult stage. The available information is summarized in Table B.3-1. Spawning is demersal in moderately shallow waters; observations extend to approximately 100 m, but the lower depth limit for spawning and nesting of Atka mackerel in the AI is unknown. Female Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. The egg stage is noted to occur in AI shallow habitat, which extends to 200 m (Table B.3-1). Although Atka mackerel nests with eggs have not been observed in the GOA, the assumption is made that eggs would be found in the same substrate as observed in the AI (GOA shallow habitat, Table B.3-1). Eggs develop and hatch at depth, releasing planktonic larvae, which have been found up to 800 km from shore. It is presumed that the larval and early juvenile stages are pelagic. Little is known of the distribution and habitat preferences of young Atka mackerel prior to their appearance in trawl surveys and the fishery at about 2 to 3 years of age. At some point, they are assumed to migrate to the bottom and take up a demersal existence, but catches of juveniles less than 20-cm fork length is relatively rare in the fishery and bottom trawl surveys. Older juveniles have been taken only infrequently in the trawl surveys and fishery.

Adult Atka mackerel occur in large localized aggregations, usually at depths less than 200 m, and generally over rough, rocky, and uneven bottom near areas where tidal currents are swift. Associations with corals and sponges have been observed for AI Atka mackerel (NMFS 2004, Stone 2004). Adults are semi-demersal, displaying strong diel behavior with vertical movements away from the bottom occurring almost exclusively during the daylight hours, presumably for feeding, and little to no movement at night (Nichol and Somerton 2002).

Spawning/Breeding
Females deposit adhesive eggs in benthic nests in rocky crevices and hollows and among stones or on kelp in shallow water at depths less than 100 m.

Feeding
The adults feed mainly on pelagic euphausiids followed by calanoid copepods, which are not one of the affected habitat features (Yang 1999). As euphausiids and copepods are pelagic rather than benthic in their distribution and are too small to be retained by any fishing gear, fishing probably has a minimal or temporary effect on the availability of prey to Atka mackerel.

Growth to Maturity
Larvae and young juveniles are presumed to be pelagic. As noted above, habitat requirements for the larval and young juvenile life stages of Atka mackerel are mostly unknown. Younger juveniles (less than 20-cm fork length) are rarely caught on groundfish fishing gear, so it is likely that fishing does not occur (and thus has no direct effect) on whatever habitat they do occupy. However, older juveniles and adults are demersal at times and are associated with rough, rocky habitat generally less than 200 m deep and are the target of a bottom trawl fishery. Adult Atka mackerel have been observed in association with corals and sponges (NMFS 2004, Stone 2004), and they may prefer the rocky substrate inhabited by such epifauna. Although the importance of these associations is uncertain, bottom trawling is known to damage such living substrates, which could have an impact on Atka mackerel.

Evaluation of Effects

LEI Values Relative to Species Distribution

The center of abundance for Atka mackerel is in the AI, and currently there is no directed fishery for GOA Atka mackerel. Historically, a fishery had occurred in the GOA as far as Kodiak Island through the mid-1980s; catches in the GOA peaked at about 28,000 mt in 1975 (Lowe and Lauth 2003). Subsequently, recruitment to the AI population was low from 1980 to 1985, and catches in the GOA dropped to almost zero in 1986. In 1988, GOA Atka mackerel were combined in the other species category due to low abundance and the absence of a directed fishery for the previous several years. After a series of large year classes recruited to the AI region in the late 1980s, the population and the fishery re-established (at a much lower level) in the early 1990s in the western GOA. The Council separated Atka mackerel from the other species category in 1994. Catches again declined after the mid-1990s, and the GOA Atka mackerel fishery has been managed as a bycatch-only fishery since 1997, with catch quotas of 1,000 mt in 1997 and 600 mt from 1998 to 2004. Just before to 2003, the catch of GOA Atka mackerel had been less than 100 mt but jumped dramatically in 2003 to nearly 600 mt. Two strong back-to-back year classes (1998 and 1999) have shown up prominently in the AI, and the GOA Atka mackerel have been determined to largely comprise the 1999 year class, as indicated by fish sampled from the 2003 GOA survey and fisheries. Observations of small catches of Atka mackerel in 2003 from the fishery and the survey extended well into the Kodiak regulatory area. The recent increase in observations of Atka mackerel in the GOA, which largely comprise a single cohort (1999 year class), do not appear to indicate an expanded population with a broad distribution of age classes.

The evaluation of fishing effects on habitat for Atka mackerel focuses on AI Atka mackerel, which are the main source of the population and have a long history of exploitation. The significant decline of the GOA Atka mackerel fishery (and population) after the mid-1980s suggests that this area may be the edge of the species' range. During periods of high recruitment in the AI, it is thought that juvenile Atka mackerel may move into the GOA under favorable conditions (Kimura and Ronholt 1988). In addition, it is presumed that there is some limited spawning activity in the GOA and larval settlement in the area, perhaps enhanced by the same favorable environmental conditions contributing to good recruitment in the AI. The history of the GOA fishery and population seems to indicate that GOA Atka mackerel may be at the margin of their distribution, where they are more patchily distributed than in the AI. Hence, they exhibit a greater vulnerability to the direct effects of fishing (Lowe and Lauth 2003). There are no studies that link habitat disturbance with the ability of the stock to maintain itself in the GOA. Environmental conditions and the direct effects of fishing (fishing mortality) likely have the greatest impacts on GOA Atka mackerel.

The habitat information that is available for Atka mackerel indicates that they are associated with living structure, non-living structure, and hard corals (Table B.3-1). Atka mackerel are found in the AI deep and shallow habitats, but predominantly in the AI shallow habitat; 50 percent of the concentrated Atka mackerel distribution (75 percent column) is estimated to be within the designated AI shallow habitat (Table B.3-3). The LEI table estimates a 20 percent reduction in living structure within the AI shallow habitat that overlaps with the 75 percent concentration of Atka mackerel distribution (Table B.3-3). However, the LEI map indicates quite a broad range in the potential reduction in living structure features of habitat areas where AI Atka mackerel are found (1 to 50 percent, Figure B.2-3c). The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. Furthermore, the LEI maps are difficult to interpret because of the irregularity and patchiness in the distribution of habitat features. This is especially true for living substrate features such as sponges and corals, which are likely to be patchily distributed and occur on a finer scale than presented in this analysis. What these maps do indicate is that Atka mackerel are found over a broad range of low to high fished areas within the AI (Figures B.2-3c, B.2-4c, and B.2-6c).

The estimated reduction in non-living structure within AI Atka mackerel habitat is lower relative to estimates for living structure, ranging from 1 to 25 percent according to the LEI map (Figure B.2-4c). The LEI table estimates a 13 percent reduction in non-living structure within the AI shallow habitat that overlaps with the 75 percent concentration of Atka mackerel distribution (Table B.3-3). The LEI index for hard corals in the AI where Atka mackerel occur is much higher relative to the estimates for living and non-living structure. The LEI table estimates a 40 percent reduction in hard corals within the AI shallow habitat that overlaps with the 75 percent concentration of Atka mackerel distribution (Table B.3-3). The LEI map indicates many areas with less than 1 percent estimated reduction for hard corals, but it also indicates many areas with more than 50 percent estimated reductions within the AI (Figure B.2-6c). As noted above, the LEI maps are difficult to interpret, and this is particularly true for the distribution of LEI of fishing effects on coral. The LEIs were, however, calculated wherever fishing occurred. The actual distribution of coral is much more restricted and is not specifically known. Therefore, the maps indicate reductions in many areas where no coral, and hence no actual coral loss, occurs (Figures B.2-6a-c).

The extent and nature of the associations between AI Atka mackerel and living and non-living substrate and hard corals are unknown. However, if these are desirable habitat features for Atka mackerel and there is a significant dependance on these features, the potential large reduction (more than 50 percent) in hard corals in many areas of the AI could be of concern. It is unclear what the impact of the estimated reductions for living, non-living, and hard coral habitat features would be for Atka mackerel. Overall, the Atka mackerel stock is in relatively good condition and is currently at a high abundance level. There are no indications that the affected habitat areas that overlap with the distribution of Atka mackerel would impair the ability of the stock to produce MSY over the long term. This is not to say that affected habitat areas have no impact on Atka mackerel, but environmental conditions may be such that they are favorable for Atka mackerel and override impacts due to the effects of fishing on habitat features important to Atka mackerel. Also, while the maps indicate areas of relatively high LEIs, particularly for coral, there are also many areas of very low LEIs (less than 1 percent) in the AI.

GOA Atka mackerel eggs are presumed to be associated with shallow benthic habitats based on observations in the AI (Table B.3-3). Juveniles and adults are also associated with benthic habitats, specifically hard, non-living substrate on the GOA deep shelf (Table B.3-3). Overall, the GOA shallow and deep shelf habitats comprise 4 and 5 percent, respectively, of the areas designated as the Atka mackerel 75 percent concentration distribution within the AI/GOA (Table B.3-3). It is assumed that the impact of the estimated reductions for living, non-living, and hard coral habitat features would be negligible or minimal for GOA Atka mackerel.

Habitat Impacts Relative to Spawning/Breeding

Spawning is demersal in moderately shallow waters; observations extend to approximately 100 m, but the lower depth limit for spawning and nesting of Atka mackerel in the AI is unknown. Female Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Figure D-94 (Appendix D) shows the general distribution of adult Atka mackerel in the BSAI, but the distribution of specific locations of nesting sites throughout the AI is unknown. Specific spawning and nesting sites have been observed off Seguam Island and on offshore reefs and in and around island passes from Stalemate Bank to Akutan Pass (Lowe et al. 2004). Just based on depth considerations, there is likely some overlap of the fishery with the distribution of nesting sites (Table B.3-3), but the extent of the overlap with the spatial distribution of fishing impacted areas is unknown. However, overlap with spawning areas is likely to be low due to the following factors: 1) Atka mackerel are summer spawners, and the directed fishery is conducted during two seasons that run from January 20 to April 15 (A season) and from September 1 to November (B season); 2) observations to date indicate that at least some spawning and nesting grounds occur in areas too shallow and rough for the fishery to operate; 3) there are trawl exclusion zones within 10 nm of all sea lion rookeries in the AI and within 20 nm of the rookeries on Seguam and Agligadak Islands (in area 541); and 4) there are maximum seasonal catch percentage limits in place for sea lion critical habitat areas in the central (542) and western (543) AI. These sea lion protection measures likely afford protection to several spawning grounds, and other spawning grounds that are not in closed areas but that occur in untrawlable habitat are also afforded protection.

Summer resource assessment trawl surveys conducted biennially in the AI at the time of spawning provide a relative measure of abundance of the spawning biomass and have not detected a shift in the spatial distribution of biomass (Lowe et al. 2004, refer to http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm for survey CPUE maps). The distribution of survey catch per unit effort data indicates a relatively consistent occurrence in the spatial distribution of Atka mackerel catches (Lowe et al. 2004). What is evident in recent surveys is an increase in the occurrence of Atka mackerel catches due to increased abundance levels. In summary, the impacts of fishing due to habitat disturbance have not reached a level that has resulted in the movement of fish out of the impacted region or the failure of continued recruitment to the region.

Only one study has estimated age at maturity for Atka mackerel from the GOA and AI with data collected from 1992 to 1994 (McDermott and Lowe 1997). Efforts are currently underway to look at inter-annual variability in maturity-at-age (Cooper, D., AFSC, personal communication). To date, there is no evidence to suggest a link between habitat disturbance and the spawning/breeding success of AI Atka mackerel.

Habitat Impacts Relative to Growth to Maturity

As noted above, habitat preferences for the early life stages of Atka mackerel, particularly the larval and early juvenile stages, are poorly known in comparison to the adult stage. Younger juveniles (less than 20-cm fork length) are rarely caught on groundfish fishing gear, so it is likely that fishing does not occur on whatever habitat they do occupy and, thus, has no direct effect. However, older juveniles and adults are demersal at times, are associated with rough, rocky habitat at depths generally less than 200 m, and are the target of a bottom trawl fishery. Adult Atka mackerel have also been observed in association with corals and sponges (NMFS 2004, Stone 2004) and may prefer the rocky substrate inhabited by such epifauna. Although the importance of these associations is uncertain, bottom trawling is known to damage such living substrates, which could have an impact on Atka mackerel. At present, however, review of time trends in size at age do not indicate that past and current levels of habitat disturbance of these substrates is affecting the growth to maturity for Atka mackerel.

Growth analyses of length at age, weight at age, and weight at length of AI Atka mackerel caught in low trawl intensity areas versus high trawl intensity areas have been computed, but are uninformative. The statistical power of these tests is expected to be low due to very small sample sizes in the high trawl intensity areas. Atka mackerel samples from the high effort areas in the AI were collected over 3 years (1994, 2002, and 2004), with sample sizes of 9, 25, and 23 fish, respectively. Data from the years 2002 and 2004 were analyzed, and results indicated statistically significant differences in weight and length-at-age and weight-at-length for both years, where the higher values were found in the high fishing effort treatment group. Although these results seem counter-intuitive and the sample sizes are questionable, they do corroborate previous growth studies for Atka mackerel. Kimura and Ronholt (1988) and Lowe et al. (1998) documented a longitudinal trend in growth in three sub-areas of the AI and the western

GOA. Results showed length-at-age was smallest in the western AI (a region lightly fished) and largest in the eastern AI and western GOA (regions of relatively heavy fishing impacts).

A large and sustained Atka mackerel fishery has been conducted throughout the AI since the early 1970s. Catches fluctuated with the demise of the foreign fishery and the development of the domestic fishery. In subsequent years, the fishery was concentrated in the eastern AI where the largest fish reside (Lowe et al. 1998). The fish in the western AI have not been heavily exploited since 1980 after the foreign fishery, but they have historically been the smallest size fish for a given age. The geographic size cline consistently noted in the growth data seems to run counter to what might be expected, given the differential fishing pressure. The growth data do not indicate any detectable adverse impacts on the growth to maturity for Atka mackerel due to habitat disturbance.

Habitat Impacts Relative to Feeding
The adults feed mainly on pelagic euphausiids followed by calanoid copepods, which are not one of the affected habitat features (Yang 1999). As euphausiids and copepods are pelagic rather than benthic in their distribution and are too small to be retained by any fishing gear, fishing probably has a minimal or temporary effect on the availability of prey to Atka mackerel.

No direct evidence is available to suggest that feeding distributions have changed. Euphausiids are a major prey of Atka mackerel. Euphausiids are not believed to be directly associated with the bottom, but rather are thought to be advected onshore near bottom at the upstream ends of underwater canyons where they become easy prey for planktivorous fishes (Brodeur 2001). This would indicate that any change in feeding distribution is caused by oceanographic influences rather than habitat disturbance.

No direct evidence is available that indicates any change in the diet of Atka mackerel. Because euphausiid and copepod distributions are likely not affected by habitat disturbances and are known to be widespread in the AI, it is doubtful that diet changes would be detectable between heavily fished and lightly fished regions. In summary, there is no evidence that habitat disturbance has affected feeding success of Atka mackerel.

Stock Status and Trends
Stock assessment information for Atka mackerel has been available from fisheries catch and fisheries age composition data since 1977, and trawl survey estimates of abundance and age composition data have been available since 1986 (Lowe et al. 2004). The age-structured stock assessment model indicates that Atka mackerel female spawning biomass increased during the early 1980s and again in the late 1980s to early 1990s. The stock has shown a steep increase in abundance after 2002 due to recruitment of three back-to-back strong year classes (1998, 1999, and 2000). The 2004 female spawning biomass is estimated at 204,400 mt (98 percent of the peak 1993 level). The data do not show a negative trend in spawning biomass or evidence of chronic low abundance. Because information is not available for the years before 1977, the trends prior to 1977 are unknown, as is the influence that long-term impacts to the habitat may have had on Atka mackerel abundance.

Model estimates of recruitment vary greatly but show above average (more than 20 percent of the mean) recruitment from the 1977, 1986, 1988, 1992, 1995, 1998, 1999, and 2000 year classes (Lowe et al. 2004). The 1999 year class is estimated to be the largest year class in the time series, contributing to the increased recent abundance levels. No obvious trend in recruitment is discernable since 1977, other than apparent above-average recruitment throughout the assessment time series. The data do not show a negative trend in recruitment or evidence of chronic low recruitment. Historical estimates of recruitment prior to 1977 are, however, not available for comparison.

There is no evidence that the cumulative effects of fishing activities on habitat have impaired the stock's ability to produce MSY since 1977. Spawning biomass is at a peak level, the stock has produced several years of above average recruitment since 1977, and recent recruitment has been strong (the 1999 year class is estimated to be the largest year class in the time series).

Summary

Issue	**Evaluation**
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Growth to Maturity	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of Atka mackerel are considered to be minimal and temporary or negligible. Affected habitat areas may impact Atka mackerel, but environmental conditions may be the dominant factor affecting the Atka mackerel population, given the moderate exploitation levels since 1977. Environmental conditions since 1977 may favor Atka mackerel and override impacts of fishing on habitat features important to the species. Some information, however, suggests that bottom trawling may have a negative effect on the benthic habitat, especially corals and sponges. The LEI analysis indicates that there is a potential for large reductions in hard coral habitats, which intersect with Atka mackerel habitat, and Atka mackerel have been observed in association with sponges and corals. The extent and nature of the associations between AI Atka mackerel and living and non-living substrate and hard corals are largely unknown. If these are desirable habitat features for Atka mackerel, however, and there is a significant dependance on these features, the potential large reduction (more than 50 percent) in hard corals in many areas of the AI could be of concern. Overall the Atka mackerel stock is in relatively good condition and is currently at a high abundance level. There are no indications that the affected habitat areas that overlap with the distribution of Atka mackerel would impair the ability of the stock to produce MSY over the long term.

There is some presumed overlap of the fishery with the distribution of Atka mackerel nesting sites, but the extent of the overlap with the spatial distribution of fishing impacted areas is likely to be low due a variety of factors. These factors include Steller Sea Lion protection measures, which likely afford protection to several Atka mackerel spawning grounds. Other spawning grounds that are not in closed areas, but that occur in untrawlable habitat, are also afforded protection. Summer resource assessment trawl surveys conducted biennially in the AI at the time of spawning provide a relative measure of abundance of the spawning biomass and have not detected a shift in the spatial distribution of biomass. To date, there is no evidence to suggest a link between habitat disturbance and the spawning/breeding success of AI Atka mackerel. There is also no evidence to suggest that habitat disturbance impairs the stock's ability to produce MSY over the long term through impacts on spawning/breeding success. Therefore, the impact of habitat disturbance on the spawning/breeding success of Atka mackerel is minimal and temporary.

There is no evidence to suggest a link between habitat disturbance and growth to maturity of AI Atka mackerel. There is also no evidence to suggest that habitat disturbance impairs the stock's ability to produce MSY over the long term through impacts on growth to maturity. Analyses of growth data do not indicate any detectable adverse impacts on the growth to maturity for Atka mackerel due to habitat disturbance. Therefore, the impact of habitat disturbance on the growth to maturity of Atka mackerel is minimal and temporary.

The adults feed mainly on pelagic euphausiids followed by calanoid copepods, which are not one of the affected habitat features. As euphausiids and copepods are pelagic rather than benthic in their distribution and are too small to be retained by any fishing gear, fishing probably has a minimal and/or temporary effect on the availability of prey to Atka mackerel. There is no evidence to suggest that the diet or feeding distributions of Atka mackerel have changed. Overall, there is no evidence that habitat disturbance has affected feeding success of Atka mackerel. Therefore, the impact of habitat disturbance on the feeding success of Atka mackerel is minimal and temporary.

Stock assessment data do not show a negative trend in spawning biomass and recruitment or evidence of chronic low abundance and recruitment. There is no evidence that the cumulative effects of fishing activities on habitat have impaired the stock's ability to produce MSY since 1977. Spawning biomass is at a peak level. The stock has produced several years of above average recruitment since 1977, and recent recruitment has been strong.

B.3.3.5 Yellowfin Sole (BSAI)

Habitat Connections

Spawning/Breeding
Yellowfin sole spawn pelagic eggs in nearshore areas. These eggs have been observed in the plankton (Nichol and Acuna 2000), but it is not known what role the seafloor habitat has in spawning success. (See Section 3.2.1.2.3 for further discussion and references.)

Adult Feeding
Adult feeding primarily occurs throughout the continental shelf on benthic infauna and epifauna during the summer. Adults feed upon infauna and epifauna such as clams, polychaete worms, amphipods, other marine worms, and tunicates (Lang et al. 2003).

Growth to Maturity
Within the first year of life, yellowfin sole undergo metamorphosis from a free-swimming larvae stage to the familiar asymmetrical morphological life form characteristic of flatfish. After settling in nearshore areas, juveniles exhibit size-dependent sediment preference suitable for feeding on meiofaunal prey and for burrowing to achieve protection from predators (Moles and Norcross 1995, Stoner and Abookire 2002). Laboratory experiments indicate that sediment choice and cryptic behavior are the first line of defense for juvenile flatfishes (Stoner and Ottmar 2002). These experiments further suggest that predators consume more age-zero flatfishes in sand than in sand with sponge or other emergent structure indicating that bioshelter may influence predator-prey behavior (Ryer et al. 2004). Growth from newly settled juveniles to mature adults is dependent on the infaunal and epifaunal supply of clams, polychaete worms, amphipods, other marine worms, and tunicates (Lang et al. 2003).

Evaluation of Effects

LEI Values Relative to Species Distribution
Spatial overlap exists between the areas with high fishing effects and the expansive yellowfin sole summer feeding habitat (Figure B.2-2a, Table B.3-3). This is particularly the case in the northernmost area identified as a high effort area because most of the trawling conducted there was in pursuit of yellowfin sole. The benthic habitat in this area is primarily sand and a sand/mud composite and is utilized by adult and late juvenile yellowfin sole during summer months for feeding on epifauna and infauna (Table B.3-1). The LEI table indicates that the reduction in epifauna and infauna prey is quite

low (2 to 3 percent), but may be as high as 18 percent for living structure in this habitat. The LEI model is, however, intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other.

Studies of flatfish responses to habitat disturbance have been conducted in other ecosystems. For North Sea plaice in size classes more than 35 cm, positive growth changes were significantly correlated with seabed disturbance and/or eutrophication in heavily fished offshore areas (Rijnsdorp and van Leeuwen 1996). It is unknown whether similar responses would be expected for a different species adapted to a different ecosystem.

It is unknown what the effects of the physical disturbance of the benthos have on the availability of prey for individual yellowfin sole in the high effects area. It is known, however, that the total feeding area utilized by this species on a population level extends well to the north, east, and south of the identified high fishing effort areas. Because the high fishing effects area does not overlap the spawning or early juvenile habitat areas, and only partially overlaps the summer feeding distribution, it is unlikely that these affected areas would impair the ability of the stock to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding
The shallow inshore areas of Bristol Bay and Kuskokwim Bay where yellowfin sole spawn (and where early juveniles live) do not overlap with the spatial distribution of fishing impacted areas. Resource assessment trawl surveys conducted annually at the time of spawning partially overlap the spawning area and have not detected a shift in the spatial component of spawning since surveys began in 1979. Temporal shifts do occur, however, and are believed to be linked to bottom water temperature. Trends in recruitment success do not correspond with the temporal patterns in fishing effort, further suggesting that there is no link between the existing level of habitat disturbance on the middle portion of the BS shelf and spawning/breeding success in nearshore areas. In the presence of light to moderate exploitation, the stock has sustained an abundance level well above the B_{MSY} level (Wilderbuer and Nichol 2004a).

Habitat Impacts Relative to Growth to Maturity
There is little geographic overlap between areas of high or low fishing effects and areas inhabited by early juvenile yellowfin sole. Figure B.2-2a indicates that fishing has not ranged into the nearshore shallow areas of Bristol Bay and Kuskokwim Bay to the extent that it would be classified as a high effects area. Thus, patterns in high or low juvenile survival cannot be linked to patterns in the reduction in habitat quality whereby the removal of living structure utilized as a refuge from predation resulted in increased juvenile mortality.

Yellowfin sole are considered late juveniles at sizes between 20 and 28 cm in length. The distribution of late juveniles ranges more offshore as they begin to be assimilated into the adult population. At this size/age some of their distribution overlaps with high fishing impact areas. To investigate the possible link between habitat disturbance and growth to maturity, diet data on file at the AFSC were examined for the period from 1984 to 1995 for both juvenile and adult yellowfin sole in the high-, low-, and no-fishing impact areas of stratum 3 (southern middle shelf). No trends were discernable in the proportion of empty stomachs encountered in any of the three areas over this period. For all fish examined (including those with empty stomachs) higher values of grams of epifauna/gram predator (averaged over all years) resulted from the low and high effort areas than from the no-fishing-effort area, for both juvenile and adult fish (Figure B.3.3.5-1).

This trend was reversed in the examination of grams infauna/gram predator where higher values were found in the no fishing area compared to the low and high effort areas (Figure B.3.3.5-2). The latter results were due to the high values of gram infauna/grams predator in both 1984 and 1985. After 1985, similar trends were found in all three areas. When total grams prey/grams predator were analyzed, no trends were evident between life-history stage and areas of fishing effort. These data suggest that there has not been an observable change in the diet of late juvenile stage fish or adult fish in high effort versus low effort areas to cause an undesirable effect on the growth to maturity. Furthermore, a comparison of the length and weight at age from fish collected during the 1987, 1994, and 1999 to 2001 trawl surveys indicates that there are only small differences in length and weight at age from 1987 to 2001 for fish 4 to 14 years old (Wilderbuer and Nichol 2004a).

Habitat Impacts Relative to Feeding

Survey size and weight data collected in lightly, moderately, and heavily impacted areas were examined for evidence that fishing induced impacts to fish habitat triggered changes in the growth of adult fish. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to discern if differences in growth were discernable between geographical areas. For yellowfin sole, it was determined that 6 years (1994, 1999, and 2001 to 2004) provided adequate sample sizes to ensure the necessary contrast. Results indicated that statistically significant differences in weight-at-length were only found in 1 year out of the 6 examined (2003), where the higher values were found in the high fishing effort treatment group. This result, combined with the results of the diet study described in the previous section (for adult fish, Figures B.3.3.5-1 and B.3.3.5-2), indicates that current levels of fishing impacts on yellowfin sole habitat do not produce detectable effects on the growth and/or diet of yellowfin sole.

Patterns of the annual distribution and abundance of the summertime feeding distribution of yellowfin sole (available from trawl surveys) relative to the three fishing effort areas also do not indicate a shift away from the heavily fished area (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). Stations with highest CPUE values are typically broadly dispersed over the middle shelf and upper/northern Bristol Bay and do not exhibit a spatial trend relative to the aggregated commercial fishing effort.

Stock Status and Trends

Stock information for yellowfin sole is available from fisheries catch and catch at age since 1964 and trawl survey estimates of abundance and age composition since 1982 and 1979, respectively. Stock assessment model estimates indicate that the yellowfin sole female spawning biomass was at low levels during most of the 1960s and early 1970s after a period of high exploitation (Figure B.3.3.5-3). Sustained above average recruitment from 1967 to 1976 combined with light exploitation resulted in a biomass increase to a peak in 1985 of 708,000 t. The female spawning biomass has since been in a slow decline, as the strong 1981 and 1983 year classes have passed through the population, and only the 1991 and 1995 years classes have been at levels observed during the 1970s. The 2004 female spawning biomass is estimated at 540,000 t (76 percent of the peak 1985 level).

The female spawning biomass has been sustained well above B_{MSY} for the past 20 years, and the annual fishing mortality rate has been below F_{MSY} during this period (Figure B.3.3.5-3). There is no evidence that the cumulative effects of fishing activity on habitat have impaired the stocks ability to produce MSY over this time period.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas, where spawning occurs and where early juveniles reside, are mostly unaffected by past and current fishery activities. Adult and late juvenile yellowfin sole concentrations primarily overlap with the EBS sand (61 percent and sand/mud 39 percent) habitats on the inner- and mid-shelf areas (Table B.3-3). Projected equilibrium reductions in epifauna and infaunal prey in those overlaps were less than 1 percent for sand and 3 percent for sand/mud. The reduction in living structure is estimated at a range of 5 (sand) to 18 (sand/mud) percent for the summer distribution (relevant because 10 percent of the yellowfin sole diet consists of tunicates). Given this level of disturbance, it is unlikely that late-juvenile and adult feeding would be negatively impacted. The diet and length-weight analysis presented in the preceding sections supports this assertion. The trawl survey CPUE analysis also did not provide evidence of spatial shifts on the population level in response to areas of high fishing impacts.

The yellowfin sole stock is currently at a high level of abundance (Wilderbuer and Nichol 2004a) and has been consistently above the B_{MSY} and MSST for the past 20 years. No declines in weight and/or length at age have been documented in this stock for year classes observed over the past 22 years. Such declines might be expected if the quality of the benthic feeding habitat was degraded or essential habitat were reduced. Therefore, the combined evidence from diet analysis, individual fish length-weight analysis, examination of recruitment, stock biomass, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are either minimal or temporary for BS yellowfin sole.

B.3.3.6 Greenland Turbot (BSAI)

Habitat Connections

Spawning/Breeding
Eggs are bathypelagic, and spawning is widespread throughout the EBS slope. It is not known what role the seafloor habitat has in spawning success. See Section 3.2.1.2.4 for further discussion and references.

Adult Feeding
Adult Greenland turbot feed primarily on pollock, squid, and deep water fish species during the summer throughout the deep slope waters and, to a lesser extent, on the upper slope/shelf margins (see Appendix F for reference). Most of the Greenland turbot feeding behavior is observed to take place off the bottom and is not related to benthic food availability.

Growth to Maturity
Within the first year of life, Greenland turbot undergo metamorphosis from a free-swimming larvae stage to the familiar asymmetrical morphological life form characteristic of flatfish. Upon settlement in nearshore areas, juvenile flatfish preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing to achieve protection from predators (Moles and Norcross 1995). Although the Moles and Norcross (1995) studies did not evaluate Greenland turbot juveniles, they may be relevant for this species. Growth from newly settled juveniles to mature adults is dependent on the infaunal supply of polychaete worms, amphipods, and other marine worms.

Evaluation of Effects

LEI Values Relative to Species Distribution
Greenland turbot are a deep water species that inhabit shallow areas of the BS shelf as juveniles. They are primarily associated with BS sand/mud habitat and do not overlap areas identified as high fishing impact areas (Figure B.2-2a, Table B.3-3). The LEI table indicates that the reduction in epifauna prey (2 percent), as well as living structure (12 to 14 percent) is estimated to be low in this habitat. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. Because the high fishing effects area does not overlap the spawning, feeding, or juvenile distributions, these affected areas would not impair the ability of Greenland turbot to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding
Impacted habitat from fishing effects does not overlap with Greenland turbot spawning areas in the deep waters of the BS slope and the AI or shallow juvenile nursery habitat. Although trends in recruitment have been declining since the high levels attained in the mid to late 1970s, these reductions cannot be linked to trends in disturbed habitat over this time period due to the non-overlap. Greenland turbot have been above B_{MSY} for the past 20 years.

No information is available on annual winter spawning concentrations of Greenland turbot to discern if there have been spatial or temporal shifts in spawning distributions.

Habitat Impacts Relative to Growth to Maturity
Habitat impacts related to fishing do not occur in areas where early juvenile Greenland turbot reside and, thus, are not a source of early juvenile mortality. Late juveniles may be found on the BS shelf up to about age 4 before joining the adult population in deeper waters, but these fish are primarily distributed on the northern region of the shelf in areas designated as low- or no-fishing-effort areas. It is, therefore, unlikely that any of the documented disturbances on the middle to the southern areas of the shelf would impact their growth to maturity. It is unknown if changes in growth to maturity have occurred.

Habitat Impacts Relative to Feeding
Greenland turbot have not been aged to the extent that it is possible to discern if changes in length or weight at age have occurred over the past 25 years of trawl survey sampling. Given the lack of overlap in distributions discussed above, it is unlikely that the present level of habitat disturbance would be a factor relative to feeding success. Greenland turbot diet is primarily composed of pelagic or semi-pelagic species, which are encountered off-bottom and, thus, would be less likely to be affected by benthic habitat disturbance. The eight trawl surveys conducted on the continental slope over a 25-year period (first in 1979, last in 2004) do not indicate a shift in the summer feeding distribution of Greenland turbot.

Stock Status and Trends
The stock assessment model indicates that the biomass of Greenland turbot increased during the 1970s from the early 1960s level and has since declined to the current level (about 43 percent of the unfished level). The 2004 total biomass estimate is about 98,300 t (Ianelli et al. 2004b). The female spawning biomass is above the B_{MSY} level (Figure B.3.3.6-1). Recruitment of young Greenland turbot has been poor since the late 1970s, based on EBS shelf trawl surveys. Moderate recruitment during the 1980s was followed by poor recruitment during the 1990s. Some signs of improved recruitment beginning in 2000 may be evident.

Summary

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of Greenland turbot are mostly unaffected by current fishery activities. Greenland turbot adult and late juvenile concentrations primarily overlap (65 percent with sand/mud habitats in the BSAI) (Table B.3-3). Infaunal prey reductions would affect growth to maturity for late juvenile Greenland turbot. Infaunal prey reductions in the concentration areas in sand/mud habitats of the EBS are predicted to be 2 percent. This benthic disturbance is not thought to be relevant to adult Greenland turbot feeding success because fish species found in their diet are not directly associated with the seafloor.

The lack of overlap with shelf areas exhibiting effects from the reductions in habitat features from fishing indicate that their effect on Greenland turbot are minimal or temporary for the BSAI area.

B.3.3.7 Arrowtooth Flounder (BSAI and GOA)

Habitat Connections

Spawning/Breeding
Eggs are semi-demersal, and spawning is widespread throughout the outer shelf. In the GOA, spawning occurs in deep water (Blood et al. In prep.). It is not known what role the seafloor habitat has in spawning success. See Section 3.2.1.1.5 for further discussion and references.

Adult Feeding
Adults feed primarily on fish, squid, pandalid and cragonid shrimp, and euphausiids during the summer throughout the outer continental shelf and upper slope areas (see Appendix F for references). Therefore, benthic epifauna is important in their diet.

Growth to Maturity
Within the first year of life, arrowtooth flounder undergo metamorphosis from a free-swimming larvae stage to the familiar asymmetrical morphological life form characteristic of flatfish. Upon settlement in nearshore areas, juvenile flatfish preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing to achieve protection from predators (Moles and Norcross 1995, Stoner and Abookire 2002). Laboratory experiments using rock sole and Pacific halibut indicate that sediment choice and cryptic behavior are the first line of defense for rock sole and other juvenile flatfishes (Stoner and Ottmar 2002). These experiments further suggest that predators consume more age-zero flatfishes in sand than in sand with sponge or other emergent structure, indicating that bioshelter may influence predator-prey behavior (Ryer et al. 2004, Stoner and Abookire 2002). Laboratory experiments indicate that sediment choice and cryptic behavior are the first line of defense for juvenile flatfishes (Stoner and Ottmar 2002). Although these studies did not evaluate arrowtooth flounder juveniles, they may be relevant for other juvenile flatfish. Growth from newly settled juveniles to mature adults is dependent on the infaunal supply of polychaete worms, amphipods, and other marine worms.

Evaluation of Effects

LEI Values Relative to Species Distribution

In the BS, spatial overlap exists between the areas with high fishing effects and the arrowtooth flounder summer feeding habitat (Figure B.2-2a, Table B.3-3). Because they are primarily distributed on the outer shelf area during summer, overlap mostly occurs in the southernmost high effort area. The benthic habitat in this area is primarily sand and a sand/mud composite and is utilized by adult and late juvenile arrowtooth flounder during summer months for feeding on epifauna and a diverse diet including crab, fish, and shrimp species (Table B.3-1). Most of the arrowtooth flounder distribution is located outside of these high effort areas in the summer, and there has not been a detectable shift in this seasonal distribution into or away from these areas from 1982 to 2004.

In the GOA, arrowtooth flounder have a widespread distribution with concentrations in the gullies that bisect the continental shelf. Thus, they overlap most high effort fishing areas as well as low- or no-fishing areas. During winter, the distribution moves more offshore, but there is no evidence of shifts in any seasonal distribution relative to high or low fished areas. The LEI table indicates that the reduction in epifauna and infauna prey is quite low (3 to 4 percent), but may be as high as 20 percent for living structure in this habitat. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other.

Studies of flatfish responses to habitat disturbance have been conducted in other ecosystems. For North Sea plaice in size classes more than 35 cm, positive growth changes were significantly correlated with seabed disturbance and/or eutrophication in heavily fished offshore areas (Rijnsdorp and van Leeuwen 1996). It is unknown whether similar responses would be expected for a different species adapted to a different ecosystem.

It is unknown what the effects of the physical disturbance of the benthos have on the availability of prey for individual arrowtooth flounder in the high effects area. It is known, however, that the total feeding area utilized by this species on a population level extends well beyond the identified high fishing effort areas. Because the high fishing effects area only partially overlaps the winter spawning area in both the BS and the GOA, does not overlap the early juvenile habitat areas, and only partially overlaps the summer feeding distribution, it is unlikely that these affected areas would impair the ability of the stock to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding

Arrowtooth flounder move into deeper waters of the BS shelf and the GOA in the winter for spawning and avoidance of cold water. Their distribution during this season partially overlaps the southernmost high effort area in the BS and the deeper parts of the high effort areas identified for the GOA. The effect of habitat disturbance has on the spawning ability or egg viability of arrowtooth flounder is unknown in this area. The inshore areas of Bristol Bay and Kuskokwim Bay and the bays along the Alaska Peninsula and Kodiak Island, where arrowtooth flounder larvae settle and develop into early juveniles, do not overlap with the spatial distribution of fishing impacted areas. Lacking a target fishery for arrowtooth flounder and a winter survey, it is unknown how their spawning distribution may have changed over time, if at all.

Trends in recruitment success also do not correspond with the temporal patterns in fishing, further suggesting that there is no link between the existing level of habitat disturbance on the middle and southern portions of the BS shelf or in the GOA and spawning/breeding success. In the presence of light exploitation, the stock has sustained an abundance level well above the B_{MSY} level in both sea areas (Wilderbuer and Sample 2004b, Turnock et al. 2003a).

Habitat Impacts Relative to Growth to Maturity

There is little geographic overlap between areas of high or low fishing effects and areas inhabited by early juvenile arrowtooth flounder. Figures B.2-2a and B.2-5b indicate that fishing has not ranged into the nearshore shallow areas of Bristol Bay and Kuskokwim Bay to the extent that it would be classified as a high effects area. Similarly, the nearshore areas of Kodiak Island and the Alaska Peninsula have remained areas of low impact. Thus, patterns in high or low juvenile survival cannot be linked to patterns in the reduction in habitat quality whereby the removal of living structure utilized as a refuge from predation resulted in increased juvenile mortality.

Arrowtooth flounder are considered late juveniles when they attain sizes between 20 and 42 cm in length. Fish in this size range move offshore, and they begin to be assimilated into the adult population. At this size/age, some of their distribution overlaps with high fishing impact areas. However, because their distribution covers such a broad geographical area, the proportion that overlaps these areas is small.

Comparison of length at age over the past two decades in the GOA does not indicate a change in growth for juveniles or adults (Figures B.3.3.7-1 and B.3.3.7-2). Therefore, there is no evidence of a change in growth to maturity.

Habitat Impacts Relative to Feeding

Survey size and weight data collected in lightly, moderately, and heavily impacted areas were examined for evidence that fishing-induced impacts to fish habitat triggered changes in the growth of adult fish. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to discern if differences in growth could be detected between geographical areas. For arrowtooth flounder, it was determined that 2 years (1996 and 2004) provided adequate sample sizes in the BS to ensure the necessary contrast. Results indicated that statistically significant differences in weight-at-length were found in 1 year (1996), where the higher values were found in the low fishing effort treatment group. Because it is unknown to what extent site fidelity persists for arrowtooth flounder (individual fish move between areas), and only 2 years of data were available, this analysis cannot lead to a conclusion.

Patterns of the annual distribution and abundance of the summertime feeding distribution of arrowtooth flounder (available from trawl surveys) relative to the three fishing effort areas in both the BS and the GOA do not indicate a shift away from the heavily fished areas (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm), but rather an expansion of the distribution during the late 1980s from the early part of the decade due to strong year classes and increased abundance. Stations with highest CPUE values typically are broadly dispersed over the outer BS shelf and throughout the central and western GOA, and they do not exhibit a spatial trend relative to the aggregated commercial fishing effort.

Stock Status and Trends

The stock assessment model for the BSAI stock estimates that arrowtooth flounder total biomass increased more than 2.5 times from 1976 to the 1996 value of 759,400 t. The biomass has declined 7 percent since then to the 2004 estimate of 710,000 t (Figure B.3.3.7-3). Female spawning biomass is also estimated to be at a high level, 532,000 t in 2004, a 4 percent decline from the 1996 peak level. Increases in abundance from 1983 to 1995 were the result of five strong year classes spawned in 1980, 1983, 1986, 1987, and 1988. Since 1989, recruitment is estimated to be at or below the average from 1989 to 1993 and then stronger in 1995 and 1998. The 2001 year class also appears strong from small fish observed in the 2003 survey.

For the GOA, the stock assessment model estimates of age 3+ biomass increased from a low of 327,622 t in 1961 to a high of 2,391,550 t in 2003. The 2003 biomass estimate is higher than the estimated 2003 biomass from the 2002 assessment (about 1,800,000 t) due to the large increase in the 2003 survey biomass estimate. The model estimates of age 3 recruits have an increasing trend since the 1970s, providing the present high level of abundance.

The female spawning biomass has been sustained well above B_{MSY} for the past 20 years in both sea areas, and the annual fishing mortality rate has been well below F_{MSY} during this period. There is no evidence that the cumulative effects of fishing activity on habitat have impaired the stocks ability to produce MSY over this period. Both stocks are above B_{MSY} and are harvested well below F_{MSY}.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by arrowtooth flounder early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile concentrations primarily overlap the EBS sand/mud habitat (34 percent) and the GOA deep shelf habitat (35 percent) (Table B.3-3). Overall, epifaunal prey reduction in those overlaps is predicted to be 3 percent for EBS sand/mud and 1 percent for GOA deep shelf habitats. Given this level of disturbance, and the large percentage of the diet of arrowtooth flounder not including epifauna prey, it is unlikely that the adult feeding would be negatively impacted. The arrowtooth flounder stock is currently at a high level of abundance due to sustained above-average recruitment in the 1980s and 1990s (Turnock et al. 2002). No change in weight and length at age has been observed in this stock from bottom trawl surveys conducted from 1984 through 2003.

The BS arrowtooth flounder stock is currently at a high level of abundance due to sustained above-average recruitment in the 1980s (Wilderbuer and Sample 2004b). The productivity of the stock is currently believed to correspond to favorable atmospheric forces in which larvae are advected to nearshore nursery areas (Wilderbuer et al. 2002). The GOA stock has increased steadily since the 1970s and is at a very high level. Therefore, the combined evidence from individual fish length-weight analysis, length at age analysis, examination of recruitment, stock biomass, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are minimal or temporary for BSAI and GOA arrowtooth flounder.

B.3.3.8 Rock Sole (BSAI)

Habitat Connections

Spawning/Breeding
Although eggs are demersal and adhesive (specific gravity of 1.047, Hart 1973), it is not known what role the habitat has in spawning success. See Section 3.2.1.2.6 for further discussion and references.

Adult Feeding
Adults feed primarily on the infaunal supply of polychaete worms, amphipods, other marine worms, and sandlance (Lang et al. 2003) during the summer throughout the continental shelf.

Growth to Maturity
Within the first year of life, rock sole undergo a metamorphosis from free-swimming larvae to the familiar asymmetrical morphological life form characteristic of flatfish. Upon settlement in nearshore areas, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and burrowing to achieve protection from predators (Moles and Norcross 1995, Stoner and Abookire 2002). Laboratory experiments indicate that sediment choice and cryptic behavior are the first line of defense for rock sole and other juvenile flatfishes (Stoner and Ottmar 2002). These experiments further suggest that predators consume more age-zero flatfishes in sand than in sand with sponge or other emergent structures, indicating that bioshelter may influence predator-prey behavior (Ryer et al. 2004, Stoner and Abookire 2002). Growth from newly settled juveniles to mature adults is dependent on the infaunal supply of polychaete worms, amphipods, other marine worms, and sandlance (Lang et al. 2003).

Evaluation of Effects

LEI Values Relative to Species Distribution
Spatial overlap exists between the areas with high fishing effects and the widespread rock sole summer feeding habitat (Figure B.2-2a, Table B.3-3). They are commonly caught in the northernmost area identified as a high effort area as bycatch in the yellowfin sole fishery. The benthic habitat in this area is primarily sand and a sand/mud composite and is utilized by adult and late juvenile rock sole during summer months for feeding on epifauna and infauna (Table B.3-1). Most of the rock sole are distributed outside of these high effort areas in the summer, and there has not been a detectable shift in this seasonal distribution into or away from these areas from 1982 to 2004. During winter, rock sole distributions partially overlap the southernmost high effort area. The LEI table indicates that the reduction in epifauna and infauna prey are quite low (2 to 3 percent), but may be as high as 18 percent for living structure in this habitat. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other.

Studies of flatfish responses to habitat disturbance have been conducted in other ecosystems. For North Sea plaice in size classes more than 35 cm, positive growth changes were significantly correlated with seabed disturbance and/or eutrophication in heavily fished offshore areas (Rijnsdorp and van Leeuwen 1996). It is unknown whether similar responses would be expected for a different species adapted to a different ecosystem.

The effects of the physical disturbance of the benthos on availability of prey for individual rock sole are unknown in the high effects area. It is known, however, that the total feeding area utilized by this species on a population level extends well to the north, east, and south of the identified high fishing effort areas. Because the high fishing effects area only partially overlaps the winter spawning area, does not overlap the early juvenile habitat areas, and only partially overlaps the summer feeding distribution, it is unlikely that these effected areas would impair the ability of the stock to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding
Rock sole move into deeper waters of the BS shelf in the winter for spawning and to avoid cold water. Their distribution during this season partially overlaps the southernmost high effort area. The effect of habitat disturbance on the spawning ability or egg viability of rock sole is unknown in this area. The

shallow inshore areas of Bristol Bay and Kuskokwim Bay where rock sole larvae settle and develop into early juveniles do not overlap with the spatial distribution of fishing impacted areas. Observer sampling of the rock sole roe fishery, which occurs in southernmost high effort area, does not indicate a shift in spawning away from this area. Trends in recruitment success also do not correspond with the temporal patterns in fishing effort, further suggesting there is no link between the existing level of habitat disturbance on the middle and southern portions of the BS shelf and spawning/breeding success. In the presence of light exploitation, the stock has sustained an abundance level well above the B_{MSY} level (Wilderbuer and Walters 2004c).

Habitat Impacts Relative to Growth to Maturity
There is little geographic overlap between areas of high or low fishing effects and areas inhabited by early juvenile rock sole. Figure B.2-2a indicates that fishing has not ranged into the nearshore shallow areas of Bristol Bay and Kuskokwim Bay to the extent that it would be classified as a high effect area. Thus, it is unlikely that patterns in high or low juvenile survival could be linked to patterns in the reduction in habitat quality whereby the removal of living structure utilized as a refuge from predation resulted in increased juvenile mortality.

Late juvenile rock sole sizes are from 20 to 34 cm long, and their distribution ranges more offshore as they begin to be assimilated into the adult population. At this size/age, some of their distribution overlaps with high fishing impact areas. To investigate the possible link between habitat disturbance and growth to maturity, diet data on file at the AFSC were examined from 1984 to 1995 for both juvenile and adult rock sole in the high-, low-, and no-fishing-impact areas of stratum three (southern middle shelf). No trends were discernable in the proportion of empty stomachs encountered in any of the three areas over this period. For all fish examined (including those with empty stomachs), higher values of grams of epifauna/gram predator (averaged over all years) resulted from the high effort area than from the low and no-fishing-effort areas for juvenile fish and were highest in the low fishing effort area for adults (Figure B.3.3.8-1).

The trend was different for grams infauna/gram predator where higher values were found for juveniles in the high and no-fishing-effort areas, and no discernable differences were present for adults (Figure B.3.3.8-2). When total grams prey/grams predator were analyzed, no trends were evident between life-history stage and areas of fishing effort. These data suggest that there has not been an observable change in the diet of late juvenile stage fish or adult fish in high effort versus low effort areas to cause an undesirable effect on the growth to maturity. A decline in weight and length at age has been documented in this stock for year classes between 1979 and 1987 (Walters and Wilderbuer 2000), but was hypothesized to be a density dependent response to a rapid increase in an expanding population and does not coincide with spatial and temporal patterns of trawl effort in the BS.

Habitat Impacts Relative to Feeding
Survey size and weight data collected in lightly, moderately, and heavily impacted areas were examined for evidence that fishing induced impacts to fish habitat triggered changes in the growth of adult fish. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to discern if differences in growth were discernable between geographical areas. For rock sole, it was determined that 3 years (2001, 2002, and 2003) provided adequate sample sizes to ensure the necessary contrast. Statistically significant differences in weight-at-length were found in only 1 year out of the 3 years examined (2001), where the higher values were found in the high fishing effort treatment group. The combination of this result and results of the diet study in the previous section (for adult fish, Figures B.3.3.8-1 and B.3.3.8-2) indicates that fishing-induced changes to habitat do not result in detectable changes in growth and/or diet trends of rock sole.

Patterns of the annual distribution and abundance of the summertime feeding distribution of rock sole (available from trawl surveys) relative to the three fishing effort areas also do not indicate a shift away from the heavily fished area (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm), but rather an expansion of the distribution during the late 1980s from the early part of the decade due to strong year classes and increased abundance. Stations with the highest CPUE values are typically broadly dispersed over the middle shelf and upper/northern Bristol Bay and the Pribilof Island area, and they do not exhibit a spatial trend relative to the aggregated commercial fishing effort.

Stock Status and Trends

Stock information for rock sole is available from fisheries catch (since 1975), catch at age (since 1980), and trawl survey estimates of abundance and age composition since 1982 and 1980, respectively. The stock assessment model indicates that rock sole total biomass was at low levels from the mid 1970s through 1982 (200,000 to 500,000 t). From 1982 to 1995, a period characterized by sustained above-average recruitment (1980 to 1988 year classes) and light exploitation, the estimated total biomass rapidly increased at a high rate to nearly 2.0 million t by 1995. Since then, the model indicates that the population biomass has declined 38 percent to 1.23 million t in 2004. This decline is attributable to the below-average recruitment to the adult portion of the population during the 1990s. The female spawning biomass is estimated to be at a high, but slowly declining, level of 432,500 t in 2004 (Figure B.3.3.8-3).

The female spawning biomass has been sustained well above B_{MSY} for the past 15 years, and the annual fishing mortality rate has been well below F_{MSY} during this period. There is no evidence that the cumulative effects of fishing activity on habitat have impaired the stock's ability to produce MSY over this time period.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by rock sole early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile rock sole in the BSAI are primarily concentrated in sand/mud (41 percent) and sand (37 percent) habitats and are affected by levels of infaunal prey (Table B.3-3). Predicted reductions of infaunal prey in those concentration overlaps are 3 percent (sand/mud) and less than 1 percent (sand). Given this level of disturbance, it is unlikely that adult feeding would be negatively impacted. The diet and length-weight analysis presented in the preceding sections supports this assertion. The trawl survey CPUE analysis did not provide evidence of spatial shifts on the population level in response to areas of high fishing impacts.

The rock sole stock is currently at a high level of abundance due to sustained above-average recruitment in the 1980s (Wilderbuer and Walters 2004). The productivity of the stock is currently believed to correspond to favorable atmospheric forces in which larvae are advected to nearshore nursery areas (Wilderbuer et al. 2002). A decline in weight and length at age has been documented in this stock for year classes between 1979 and 1987 (Walters and Wilderbuer 2000), but was hypothesized to be a density dependent response to a rapid increase in an expanding population. Individual rock sole may have been displaced beyond favorable feeding habitat, rather than by a reduction in the quality of habitat. Therefore, the combined evidence from diet analysis, individual fish length-weight analysis, examination of recruitment, stock biomass, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are minimal or temporary for BS rock sole.

B.3.3.9 Flathead Sole (BSAI)

Habitat Connections

Spawning/Breeding
Flathead sole spawn large pelagic eggs in deeper waters near the continental shelf margin. These eggs develop into planktonic larvae. The role the habitat has in spawning success is currently unknown. See Section 3.2.1.2.7 for further discussion and references.

Adult Feeding
Adult feeding primarily occurs during summer on the middle and outer continental shelf areas on benthic infauna, epifauna, and certain fish species. Flathead sole are dependent upon an infaunal and epifaunal supply of polychaete worms, mysids, brittle stars, shrimp, and hermit crabs (Lang et al. 2003).

Growth to Maturity
Within the first year of life, flathead sole undergo metamorphosis from a free-swimming larvae state to the familiar asymmetrical morphological life form characteristic of flatfish. After settling in nearshore areas, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing to achieve protection from predators (Moles and Norcross 1995, Stoner and Abookire 2002). Laboratory experiments indicate that sediment choice and cryptic behavior are the first line of defense for rock sole and other juvenile flatfishes (Stoner and Ottmar 2002). These experiments further suggest that predators consume more age-zero flatfishes in sand than in sand with sponge or other emergent structures, indicating that bioshelter may influence predator-prey behavior (Ryer et al. 2004). Although these studies did not evaluate flathead sole juveniles, they may be relevant for other juvenile flatfish. Growth from newly settled juveniles to mature adults is dependent on the infauna supply of polychaete worms, amphipods, and other marine worms (Lang et al. 2003).

Evaluation of Effects

LEI Values Relative to Species Distribution
Spatial overlap exists between the areas with high fishing effects and the widespread flathead sole summer feeding habitat (Figure B.2-2a, Table B.3-3). The benthic habitat in this area is primarily sand and a sand/mud composite and is utilized by adult and late juvenile flathead sole during summer months for feeding on epifauna and infauna (Table B.3-1). Flathead sole are mostly distributed outside of these high effort areas in the summer, and there has not been a detectable shift in this seasonal distribution into, or away from, these areas from 1982 to 2004. During winter, flathead sole distributions contract to the outer margins of the shelf and partially overlap the southernmost high effort area. The LEI table indicates that the reduction in epifauna and infauna prey are quite low (2 to 3 percent), but may be as high as 18 percent for living structure in this habitat. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other.

Studies of the response of other flatfish species to habitat disturbance have been conducted in other ecosystems. For North Sea plaice in size classes more than 35 cm, positive growth changes were significantly correlated with seabed disturbance and/or eutrophication in heavily fished offshore areas

(Rijnsdorp and van Leeuwen 1996). It is unknown whether similar responses would be expected for a different species adapted to a different ecosystem.

The effects of physical disturbance of the benthos on the availability of prey for individual flathead sole are unknown in the high effects area. It is known, however, that the total feeding area utilized by this species on a population level extends well to the north, east, south, and west of the identified high fishing effort areas. Because the high fishing effects area only partially overlaps the winter spawning area, does not overlap the early juvenile habitat areas, and only partially overlaps the summer feeding distribution, it is unlikely that these affected areas would impair the ability of the stock to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding

Flathead sole move into deeper waters of the BS shelf in the winter for spawning and to avoid cold water. Their distribution during this season partially overlaps the southernmost high effort area. The effect of habitat disturbance on the spawning ability or egg viability of flathead sole is unknown in this area. The shallow inshore areas of Bristol Bay and Kuskokwim Bay, where flathead sole larvae settle and develop into early juveniles do not overlap with the spatial distribution of fishing impacted areas. Trends in recruitment success also do not correspond with the temporal patterns in fishing effort, further suggesting that there is no link between the existing level of habitat disturbance on the middle and southern portions of the BS shelf and spawning/breeding success. In the presence of light exploitation, the stock has sustained an abundance level well above the B_{MSY} level (Spencer et al. 2004a).

Habitat Impacts Relative to Growth to Maturity

There is little geographic overlap between areas of high or low fishing effects and areas inhabited by early juvenile flathead sole. Figure B.2-2a indicates that fishing has not ranged into the nearshore shallow areas of Bristol Bay and Kuskokwim Bay to the extent that it would be classified as a high effects area. Thus, patterns in high or low juvenile survival cannot be linked to patterns in the reduction in habitat quality whereby the removal of living structure utilized as a refuge from predation resulted in increased juvenile mortality.

Late juvenile flathead sole between 20 and 34 cm long have a distribution that ranges more offshore as they begin to be assimilated into the adult population. At this size/age, some of their distribution overlaps with high fishing impact areas. To investigate the possible link between habitat disturbance and growth to maturity, diet data on file at the AFSC were examined from 1984 to 1995 for both late juvenile and adult flathead sole in the high-, low-, and no-fishing-impact areas of stratum 3 (southern middle shelf). No trends were discernable in the proportion of empty stomachs encountered in any of the three areas over this period. For all fish examined (including those with empty stomachs), there was a trend toward higher values of grams of epifauna/gram predator (averaged over all years) resulting from the higher fished areas than from the no-fishing-effort area for adult fish. The values were highest in the high- and no-fishing-effort areas for juveniles (Figure B.3.3.9-1).

The trend was similar for grams infauna/gram predator where higher values were found for juveniles in the low and high fishing effort areas and trended to higher values in the low and high fished areas for adults (Figure B.3.3.9-2). When total grams of prey/grams predator were analyzed, no trends were evident between life-history stage and areas of fishing effort. These data suggest that there has not been an undesirable change in the diet of late juvenile stage fish or adult fish in high effort versus low effort areas to cause an undesirable effect on the growth to maturity.

Habitat Impacts Relative to Feeding
Survey size and weight data collected in lightly, moderately, and heavily impacted areas were examined for evidence that fishing induced impacts to fish habitat triggered changes in the growth of adult fish. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to discern if differences in growth were discernable between geographical areas. For flathead sole it was determined that 7 years (1997 and 1999 to 2004) provided adequate sample sizes to ensure the necessary contrast. Results indicated that statistically significant differences in weight-at-length were found in 3 years out of the 7 years examined (2001, 2002, and 2004), where the higher values were found in the high fishing effort treatment group in 2001 and in the low fishing area in 2003 and 2004. The combination of this variable result with the diet study described in the previous section (for adult yellowfin sole, Figures B.3.3.5-1 and B.3.3.5-2) indicates that changes in growth and/or diet trends are not detectable among the high-, low-, and no-fishing-effort areas.

Patterns of the annual distribution and abundance of the summertime feeding distribution of flathead sole (available from trawl surveys) relative to the three fishing effort areas also do not indicate a shift away from the heavily fished area (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm), but rather an expansion of the distribution during the late 1980s from the early part of the decade due to strong year classes and increased abundance. Stations with highest CPUE values are typically broadly dispersed over the middle shelf and outer shelf and around the Pribilof Island area, and they do not exhibit a spatial trend relative to the aggregated commercial fishing effort.

Stock Status and Trends
The stock assessment model uses trawl survey information since 1982 and fisheries catch since 1975 and indicates that the estimated total biomass (ages 3+) increased from a low of 122,374 t in 1977 to a peak of 941,919 t in 1993 (Figure B.3.3.9-3). Since 1993, estimated total biomass has declined to an estimated value of 577,628 t for 2004. Female spawning biomass shows a similar trend, although the peak value (313,028 t) occurred in 1997. The model indicates that the stock has remained above B_{MSY} the past 20 years.

The changes in stock biomass are primarily a function of recruitment, as fishing pressure has been relatively light. This decline is attributable to the below-average recruitment to the adult portion of the population during the 1990s, relative to the high level observed during the 1980s. There is no evidence that the cumulative effects of fishing activity on habitat have impaired the stock's ability to produce MSY over this period.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by flathead sole early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile flathead sole in the BSAI are primarily concentrated in sand/mud habitat (41 percent) and would be affected by reductions in infaunal and epifaunal prey (Table B.3-3). The predicted reductions for infaunal and epifaunal prey in the concentration overlap for EBS sand/mud habitat are 3 and 2 percent, respectively. Given this level of disturbance, it is unlikely that the adult feeding would be negatively impacted. The diet and length-weight analysis presented in the preceding sections supports this assertion. The trawl survey CPUE analysis also did not provide evidence of spatial shifts on the population level in response to areas of high fishing effort impacts.

The flathead sole stock is currently at a high level of abundance due to sustained above-average recruitment in the 1980s (Spencer et al. 2002). The productivity of the stock is currently believed to correspond to favorable atmospheric forcing whereby larvae are advected to nearshore nursery areas (Wilderbuer et al. 2002). A decline in weight and length at age has not been documented in this stock during the 22-year time horizon of the trawl surveys (Spencer et al. 2002). Therefore, the combined evidence from diet analysis, individual fish length-weight analysis, examination of recruitment, stock biomass, and CPUE trends indicate that effects of the reductions in habitat features from fishing are either minimal or temporary for BS flathead sole.

B.3.3.10 Flathead Sole (GOA)

Habitat Connections

Spawning/Breeding
Flathead sole spawn large pelagic eggs in deeper waters near the continental shelf margin. The eggs then develop into planktonic larvae. The role the habitat has in spawning success is currently unknown. See Section 3.2.1.1.7 for further discussion and references.

Adult Feeding
Adult feeding primarily occurs during summer on the middle and outer continental shelf areas on benthic infauna, epifauna, and certain fish species. Flathead sole are therefore dependent on the infaunal and epifauna supply of polychaete worms, mysids, brittle stars, shrimp, and hermit crabs.

Growth to Maturity
Within the first year of life, flathead sole undergo metamorphosis from a free-swimming larvae stage to the familiar asymmetrical morphological life form characteristic of flatfish. After settling in nearshore areas, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing to achieve protection from predators (Moles and Norcross 1995). Although flathead sole have not been examined in laboratory experiments for sediment preference, they are likely to exhibit similar behavior to other flatfish species and select sediment suitable for burrowing. Growth from newly settled juveniles to mature adults is dependent on the supply of infauna prey such as polychaete worms, amphipods, and other marine worms (Lang et al. 2003).

Evaluation of Effects

LEI Values Relative to Species Distribution
Some spatial overlap exists between the areas with high fishing effects and the distribution of flathead sole during the summer feeding season. Flathead sole are associated with shallow areas of the GOA in the summer and the deep shelf area during the winter. The LEI table indicates that the reduction in epifauna and infauna prey are low in these areas (1 to 2 percent), but reductions in living structures may range higher (10 percent, Table B.3-3). However, the highest summertime CPUE values have resulted from trawl stations inshore of the high fishing impact areas, indicating that the total feeding area utilized by this species extends well beyond areas of high fishing effort. Thus, it is unlikely that these effected areas (with perceived low LEI scores) would impair the ability of flathead sole to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding

Flathead sole are known to settle from free-swimming larvae to the bottom in near-shore nursery areas. These areas do not overlap with the spatial distribution of fishing impacted areas, so there is no connection between juvenile mortality and habitat disturbance (removal of living structure utilized for predation protection) from fishing effort. During late fall and winter, flathead sole migrate to the deeper waters of the shelf/slope area for spawning and overwinter protection from extreme cold temperatures. These areas also do not overlap with the high fishing effect areas. There is little fishing for flathead sole during the spawning season in the GOA. Therefore, it is unknown whether any spatial or temporal shift in the spawning distributions has occurred. The stock is estimated to be above the B_{MSY} level (Turnock et al. 2003b). Therefore, there is no evidence that past and current trends in habitat disturbance from fishing impair flathead sole spawning/breeding from producing MSY.

Habitat Impacts Relative to Growth to Maturity

Flathead sole early juvenile habitat is inshore of the high fishing impact areas, generally in bays around Kodiak Island and along the Alaska Peninsula. A reduction in juvenile survival due to degradation in habitat quality from fishing effects is, therefore, unlikely. Late juvenile flathead sole are between 20 and 32 cm long (size at 50 percent maturity is 32 cm), and their distribution ranges more offshore as they begin to be assimilated into the adult population. At this size/age, some of their distribution overlaps with high fishing impact areas. As discussed in a previous section, highest CPUE values from summer surveys (when most growth occurs) did not occur in the high fishing effort areas and were widely distributed throughout the GOA relative to these areas. It is unknown if juvenile growth has changed over the past 20 years, but it is unlikely that the spatial and temporal trends in fishing effort have negatively impacted the growth to maturity.

Habitat Impacts Relative to Feeding

Survey size and weight data collected in lightly, moderately, and heavily impacted areas were examined for evidence that fishing-induced impacts to fish habitat triggered changes in the growth of adult fish. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to determine if differences in growth were discernable between geographical areas. For flathead sole it was determined that 5 survey years (1984, 1987, 1999, 2001, and 2003) provided adequate sample sizes to ensure the necessary contrast. Results indicated that statistically significant differences in weight-at-length existed in all years examined, where the higher values were found in the high fishing effort treatment group for 3 years (1999, 2001, and 2003) and in the lower fishing effort group for 2 years (1984 and 1987). These results, and the attendant assumption requiring site fidelity between years, which is most likely violated, do not allow for the conclusion that changes in growth have occurred due to changes in feeding in the high-, low-, and no-fishing-effort areas.

Patterns of the annual distribution and abundance of the summertime feeding distribution of flathead sole (available from trawl surveys) relative to the three fishing effort areas do not indicate a shift away from the heavily fished area (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). Stations with the highest CPUE values are typically nearshore and did not exhibit a temporal shift in location over the survey time horizon.

Stock Status and Trend

The stock assessment model estimates that age 3+ biomass increased from about 256,600 t in 1984 to about 298,900 t in 1996, decreased slightly to about 287,000 mt in 2000 before increasing to 291,400 t in 2003 (Figure B.3.3.10-1). The projected 2004 female spawning biomass is estimated at 109,980 mt, well above the B_{MSY} level for this stock estimated at 47,700 t.

Summary

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by flathead sole early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile flathead sole concentrations in the GOA primarily overlap with the deepwater shelf during winter (15 percent) and shallow water habitats during summer (14 percent, Table B.3-3). This species would be affected by reductions in the availability of infaunal and epifaunal prey. Both infaunal and epifaunal prey are predicted to be reduced 1 percent in concentration overlaps with deepwater shelf areas and less than 1 percent in shallow water habitat. Given this level of disturbance, it is unlikely that the adult feeding would be negatively impacted. Additionally, stock assessment modeling indicates that flathead sole have been at a stable level above B_{MSY} for the past 20 years.

The combined evidence from individual fish length-weight analysis, examination of recruitment, stock biomass, adult and juvenile distribution, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are minimal or temporary for GOA flathead sole.

B.3.3.11 Rex Sole (GOA)

Habitat Connections

Spawning/Breeding
Rex sole spawn pelagic eggs, and the role the habitat has in spawning success is unknown. See Appendix F for further discussion and references.

Adult Feeding
Adult feeding occurs primarily during summer on the continental slope and to a lesser extent on the outer shelf area. They are thought to be dependent on the infauna supply of polychaete worms, amphipods, and other marine worms (see Appendix F for references).

Growth to Maturity
Within the first year of life, rex sole undergo metamorphosis from a free-swimming larval stage to the familiar asymmetrical morphological life form characteristic of flatfish. After settling in nearshore areas, juvenile flatfish preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing for protection from predators (Moles and Norcross 1995, Stoner and Abookire 2002). Laboratory experiments using rock sole and Pacific halibut indicate that sediment choice and cryptic behavior are the first line of defense for juvenile flatfishes (Stoner and Ottmar 2002, Stoner and Titgen 2003). These experiments further suggest that predators consume more age-zero flatfishes in sand than in sand with sponge or other emergent structures, indicating that bioshelter may influence predator-prey behavior (Ryer et al. 2004, Stoner and Abookire 2002). Although these experiments were not conducted using rex sole, they may be informative regarding the importance of habitat for juvenile flatfish. Growth from newly settled juveniles to mature adults is dependent on the infauna supply of polychaete worms, amphipods, and other marine worms.

Evaluation of Effects

LEI Values Relative to Species Distribution
Some spatial overlap exists between the areas with high fishing effects and the distribution of rex sole during the summer feeding season. Rex sole are associated with mid- to outer-shelf areas of the GOA in the summer and the deep shelf area during the winter. The LEI table indicates that the reduction in epifaunal and infaunal prey is low in these areas (1 to 2 percent), but reductions in living structures may range higher (8 percent, Table B.3-3). The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. Summertime CPUE from survey trawl stations indicates a widespread distribution, mostly outside of the high trawl effort areas, indicating that the total feeding area utilized by this species extends well beyond areas of high fishing effort. Thus, it is unlikely that these affected areas (with perceived low LEI scores) would impair the ability of rex sole to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding
Rex sole are known to settle from free-swimming larvae to the bottom in nearshore nursery areas. These areas do not overlap with the spatial distribution of fishing impacted areas, so it is unlikely that there is a connection between juvenile mortality and habitat disturbance (removal of living structure utilized for predation protection) from fishing effort. During late fall and winter, rex sole migrate to the deeper waters of the shelf/slope area for spawning and overwinter protection from extreme cold temperatures. These areas also do not overlap with the high fishing effect areas. It is unknown if any shifts in the spawning distributions of rex sole have occurred in the GOA, but the stock is estimated to be above the B_{MSY} level (Turnock et al. 2003b). Therefore, there is no evidence that trends in habitat disturbance from fishing impair rex sole spawning/breeding from producing MSY.

Habitat Impacts Relative to Growth to Maturity
Rex sole early juvenile habitat is inshore of the high fishing impact areas, generally in bays around Kodiak Island and along the Alaska Peninsula. A reduction in juvenile survival due to degradation in habitat quality from fishing effects is, therefore, unlikely. Late juvenile stages of rex sole grow to sizes between 20 and 35 cm long (size at 50 percent maturity is 35 cm, Abookire in review). Late juvenile rex sole are distributed more offshore as they begin to be assimilated into the adult population. At this size/age, some of their distribution overlaps with high fishing impact areas. As discussed in a previous section, most of the widespread summer feeding distribution (when most growth occurs) is located outside of the high fishing effects area. It is unknown if juvenile growth has changed over the past 20 years, but it is unlikely that the spatial and temporal trends in fishing effort have negatively impacted the growth to maturity.

Habitat Impacts Relative to Feeding
Survey size and weight data collected in lightly, moderately, and heavily impacted areas were examined for evidence that fishing-induced impacts to fish habitat triggered changes in the growth of adult fish. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to determine if differences in growth were discernable between geographical areas. For rex sole, it was determined that 6 survey years (1984, 1987, 1990, 1993, 1999, and 2003) provided adequate sample sizes to ensure the necessary contrast. Results indicated that statistically significant differences in weight-at-length existed in 2 of the years examined (1987 and 1993), where the higher values were found in the low fishing effort treatment group. These results, and the attendant assumption requiring site fidelity between years, which is most likely violated,

do not allow for the conclusion that changes in growth have occurred due to changes in feeding in the high-, low-, and no-fishing-effort areas.

Patterns of the annual distribution and abundance of the summertime feeding distribution of rex sole (available from trawl surveys) relative to the three fishing effort areas do not indicate a shift away from the heavily fished area (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). Stations with the highest CPUE values were typically broadly distributed over the shelf and did not exhibit a temporal shift in location over the survey time horizon.

Stock Status and Trend

The stock assessment model estimates of age 3+ biomass increased from 78,200 t in 1982 to about 102,000 t in 1991, decreased to 73,500 t in 1998, then increased to 82,000 t in 2004. This abundance level is well above the $B_{35\%}$ level of 16,300 t (Figure B.3.3.11-1). Recruitment (estimated at age 3) was high in the mid to late 1980s before declining to below average levels from 1992 to 1996. Since 1998, rex sole recruitment has been above average (Turnock et al. 2004b).

Summary

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by rex sole early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile rex sole concentrations in the GOA primarily overlap with deepwater shelf habitat (51 percent) and slope habitat (14 percent) (Table B.3-3). These fish would be affected by reductions in infaunal prey. However, the predicted reductions in these concentration overlaps are 1 percent for deepwater shelf habitat and 1 percent for slope habitat. Given this level of disturbance, it is unlikely that the adult feeding would be negatively impacted. Additionally, stock assessment modeling indicates that rex sole have been at a stable level above B_{MSY} for the past 20 years. The combined evidence from individual fish length-weight analysis, examination of recruitment, stock biomass, adult and juvenile distribution, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are minimal or temporary for GOA rex sole.

B.3.3.12 Alaska Plaice (BSAI)

Habitat Connections

Spawning/Breeding

Alaska plaice spawn eggs that are transparent and pelagic (Zhang et al. 1998), and the role the seafloor habitat has in spawning success is unknown. See Section 3.2.1.2.8 for further discussion and references.

Adult Feeding

Adult feeding primarily occurs on benthic infauna throughout the continental shelf during summer and is, therefore, dependent on the infaunal supply of polychaete worms, marine worms and, to a lesser extent, bivalves (see Appendix F for reference).

Growth to Maturity
Within the first year of life, Alaska plaice undergo a metamorphosis from a free-swimming larval stage to the familiar asymmetrical morphological life form characteristic of flatfish. After settling in nearshore areas, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing to achieve protection from predators (Moles and Norcross 1995, Stoner and Abookire 2002). Laboratory experiments indicate that sediment choice and cryptic behavior are the first lines of defense for rock sole and other juvenile flatfishes (Stoner and Ottmar 2002). These experiments further suggest that predators consume more age-zero flatfishes in sand than in sand with sponge or other emergent structures, indicating that bioshelter may influence predator-prey behavior (Ryer et al. 2004, Stoner and Abookire 2002). Growth from newly settled juveniles to mature adults is dependent on the infauna supply of polychaete worms, other marine worms, and bivalves.

Evaluation of Effects

LEI Values Relative to Species Distribution
Spatial overlap exists between the northernmost area with high fishing effects and the Alaska plaice summer feeding habitat, which is widely spread over the middle and northern parts of the EBS shelf (Figure B.2-2a, Table B.3-3). They occur as bycatch in the yellowfin sole fishery, which takes place in the northernmost high effort area. The benthic habitat in this area is primarily sand and a sand/mud composite and is utilized by adult and late juvenile stage Alaska plaice during summer months for feeding on epifauna and infauna (Table B.3-1). Most of the Alaska plaice are distributed outside of these high effort areas in the summer, and there has not been a detectable spatial or temporal shift in this seasonal distribution into, or away from, these areas from 1982 to 2004 (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). During winter, Alaska plaice distributions partially overlap these high effort areas although less is known regarding their distribution in this season. The LEI table indicates that the reduction in epifauna and infauna prey are quite low (2 to 3 percent), but may be as high as 18 percent for living structure in this habitat. It is important to recognize that the LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other.

Studies of flatfish responses to habitat disturbance have been conducted in other ecosystems. For North Sea plaice in size classes more than 35 cm, positive growth changes were significantly correlated with seabed disturbance and/or eutrophication in heavily fished offshore areas (Rijnsdorp and van Leeuwen 1996). It is unknown whether similar responses would be expected for a different species adapted to a different ecosystem.

The effects of the physical disturbance of the benthos on the availability of prey for individual Alaska plaice in the high effects area are currently unknown. It is known, however, that the total feeding area utilized by this species on a population level extends well to the north, east, and south of the identified high fishing effort areas. Because the high fishing effects area only partially overlaps the spring spawning area, the high impact area does not overlap the early juvenile habitat areas, and the high impact area only partially overlaps the summer feeding distribution, it is unlikely that fishing-induced impacts to habitat areas would impair the ability of the stock to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding
Less is known of Alaska plaice winter distributions relative to other shelf flatfish, as they occur less often in commercial catches during winter, and there are no surveys at this time of year. However, it is known that they spawn in springtime, probably over a broad range of the middle shelf. Therefore, it is likely that their distribution may partially overlap the northernmost high fishing effort area during this season. The effect of habitat disturbance on the spawning ability or egg viability of Alaska plaice in this area is

unknown. The shallow inshore areas of Bristol Bay and Kuskokwim Bay, where Alaska plaice larvae settle and develop into early juveniles, do not overlap with the spatial distribution of fishing-impacted areas. There is insufficient information to detect whether a shift in spawning areas has occurred for Alaska plaice because they are seldom captured during the winter months. Trends in recruitment success also do not correspond with the temporal patterns in fishing effort, further suggesting that there is no link between the existing level of habitat disturbance on the middle and southern portions of the BS shelf and spawning/breeding success. In the presence of light exploitation, the stock has sustained an abundance level well above the B_{MSY} level (Spencer et al. 2004b).

Habitat Impacts Relative to Growth to Maturity

There is little geographic overlap between areas of high or low fishing effects and areas inhabited by early juvenile Alaska plaice. Figure B.2-2a indicates that fishing has not ranged into the nearshore shallow areas of Bristol Bay and Kuskokwim Bay to the extent that it would be classified as a high effects area. Thus, patterns in high or low juvenile survival cannot be linked to patterns in the reduction in habitat quality whereby the removal of living structure utilized as a refuge from predation resulted in increased juvenile mortality.

Late juvenile stages of Alaska plaice grow to 20 to 34 cm long, and their distribution ranges more offshore as they begin to be assimilated into the adult population. At this size/age, some of their distribution overlaps with high fishing impact areas. To investigate the possible link between habitat disturbance and growth to maturity, diet data on file at the AFSC were examined from 1984 to 1995 for both juvenile and adult Alaska plaice in the high-, low-, and no-fishing-impact areas of stratum 3 (southern middle shelf). No trends were discernable in the proportion of empty stomachs encountered in any of the three areas over this period. For all fish examined (including those with empty stomachs), higher values of grams of epifauna/gram predator (averaged over all years) resulted from the high effort area than from the low- and no-fishing-effort areas for juvenile fish and were equal among all areas for adults (Figure B.3.3.12-1).

The trend was the same for grams infauna/gram predator where higher values were found for juveniles in the high fishing effort areas, and no discernable differences were present for adults (Figure B.3.3.12-2). When total grams prey/grams predator were analyzed, juveniles had higher weight per stomach in fished areas than in the unfished areas. No trends were evident for adults. These figures show that the 95 percent confidence intervals of these estimates overlap, indicating no significant trends exist. These data suggest that there has not been an observable change in the diet of late juvenile stage fish or adult fish in high effort versus low effort areas sufficient to cause an undesirable effect on growth to maturity.

Habitat Impacts Relative to Feeding

Survey size and weight data collected in lightly, moderately, and heavily impacted areas were examined for evidence that fishing-induced impacts to fish habitat triggered changes in the growth of adult fish. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to determine if differences in growth were discernable between geographical areas. For Alaska plaice, it was determined that 6 years (1999 to 2004) provided adequate sample sizes to ensure the necessary contrast. Results indicated that no statistically significant differences in weight-at-length were found at the 95 percent level between the treatment groups. The combination of this result with the diet study described in the previous section (for adult fish, Figures B.3.3.12-1 and B.3.3.12-2) indicate that changes in growth and/or diet trends are not detectable between the high-, low-, and no-fishing-effort areas.

Patterns of the annual distribution and abundance of the summertime feeding distribution of Alaska plaice (available from trawl surveys) relative to the three fishing effort areas do not indicate a shift away from the heavily fished area (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm), but rather show an expansion of the distribution during the late 1980s from the early part of the decade due to strong year classes and increased abundance. Stations with highest CPUE values are typically broadly dispersed over the middle shelf and upper/northern Bristol Bay and do not exhibit a spatial trend relative to the aggregated commercial fishing effort.

Stock Status and Trends

The model results show that estimated total Alaska plaice biomass (ages 3+) increased from 1,114,960 t in 1975 to a peak of 1,731,090 t in 1983 (Figure B.3.3.12-3). Since 1984, estimated total biomass has declined to 908,057 t in 2004, and the estimated 2005 total biomass is 912,872 t. The estimated survey biomass also shows a rapid increase to a peak biomass of 744,281 t in 1985 and a subsequent decline to 405,457 t in 2004.

The changes in stock biomass are primarily a function of recruitment variability, as fishing pressure has been relatively light. The fully selected fishing mortality estimates, although trending upward, show a maximum value of 0.11 in 1988 and have averaged 0.03 from 1975 to 2004. Estimated age-3 recruitment has shown high levels from 1975 to 1984, averaging 1.9 billion. From 1985 to 2003, estimated recruitment has declined, averaging 1.0 by 10^9. The Alaska plaice female spawning biomass has been above the B_{MSY} level for the past 20 years.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by Alaska plaice early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile Alaska plaice concentrations in the BSAI primarily overlap with the EBS sand habitat (42 percent) and the EBS sand/mud habitat (52 percent) (Table B.3-3). These fish would be affected by reductions in infaunal prey. However, the levels of reduction in those concentration overlaps are predicted to be less than 1 percent for EBS sand and 2 percent for EBS sand/mud habitat. Given this level of disturbance, it is unlikely that the adult feeding has been or would be negatively impacted. The diet and length-weight analysis presented in the preceding sections supports this assertion. The trawl survey CPUE analysis also did not provide evidence of spatial shifts on the population level in response to areas of high fishing effort impacts.

The Alaska plaice stock is currently at a high level of abundance (Spencer et al. 2004b) and well above the MSST. There have been no observations of a decline in length or weight at age for this stock over the 22 years of trawl survey sampling. Therefore, the combined evidence from diet analysis, individual fish length-weight analysis, examination of recruitment, stock biomass, and CPUE trends indicate that effects of the reductions in habitat features from fishing are either minimal or temporary for BS Alaska plaice.

B.3.3.13 Shallow Water Flatfish (GOA)

Habitat Connections

Eight species of flatfish comprise the shallow water management complex: Alaska plaice, starry flounder, yellowfin sole, southern rock sole, northern rock sole, sand sole, butter sole, and English sole. Southern and northern rock sole are the dominant species in this complex, both in terms of biomass and harvest. For this discussion of habitat relating to life history and biology of shallow water flatfish, the southern rock sole is used to characterize the group of species. The two species of rock sole are, by far, the dominant species in this group, both in terms of biomass and harvest. The habitat requirements of rock sole are not expected to be so different from other species in this group as to require separate analysis. The seafloor habitat is associated with southern rock sole settlement, growth to maturity, and adult feeding.

Spawning/Breeding
Although eggs are demersal and adhesive (specific gravity of 1.047, Hart 1973), it is not known what role the habitat has in spawning success. See Appendix F for further discussion and references.

Adult Feeding
Adult feeding occurs primarily during summer throughout the continental shelf on benthic infauna and is, therefore, dependent on the infauna supply of polychaete worms, amphipods, other marine worms, and sandlance (Lang et al. 2003).

Growth to Maturity
Within the first year of life, rock sole undergo a metamorphosis from a free-swimming larval stage to the familiar asymmetrical morphological life form characteristic of flatfish. After settling in nearshore areas, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing to achieve protection from predators (Moles and Norcross 1995, Stoner and Abookire 2002). Laboratory experiments indicate that sediment choice and cryptic behavior are the first lines of defense for rock sole and other juvenile flatfishes (Stoner and Ottmar 2002). These experiments further suggest that predators consume more age-zero flatfishes in sand than in sand with sponge or other emergent structures, indicating that bioshelter may influence predator-prey behavior (Ryer et al. 2004, Stoner and Abookire 2002). Growth from newly settled juveniles to mature adults is dependent on the infauna supply of polychaete worms, amphipods, other marine worms, and sandlance (Lang et al. 2003).

Evaluation of Effects

LEI Values Relative to Species Distribution
Spatial overlap exists between the areas with high fishing effects and the wide-spread rock sole summer feeding habitat (Figure B.2-2a, Table B.3-3). Since the first comprehensive surveys began in 1984, there has been a presence of southern rock sole in these high fishing effort areas. However, this species is broadly distributed over the GOA shelf, particularly in the western GOA and around Kodiak Island in areas that are outside the high effort areas. The benthic habitat in this area is primarily sand or sand and mud and is utilized by adult and late juvenile rock sole during summer months for feeding on epifauna and infauna (Table B.3-1). There has not been a detectable shift in this seasonal distribution into, or away from, these areas from 1984 to 2003 (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). During winter, rock sole move into deeper waters, and their distributions may partially overlap some of the high effort area. The LEI table indicates that the reduction in epifauna and infauna prey is quite low (1 percent), but it may be as high as 6 percent for living structures in this habitat. The LEI model is

intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other.

Studies of flatfish responses to habitat disturbance have been conducted in other ecosystems. For North Sea plaice in size classes more than 35 cm, positive growth changes were significantly correlated with seabed disturbance and/or eutrophication in heavily fished offshore areas (Rijnsdorp and van Leeuwen 1996). It is unknown whether similar responses would be expected for a different species adapted to a different ecosystem.

The effects of the physical disturbance of the benthos on the availability of prey for individual rock sole in the high effects area are unknown. It is known, however, that the total feeding area utilized by this species on a population level extends well inshore and to the west end of the identified high fishing effort areas. Because the high fishing effects area only partially overlaps the winter spawning area, does not overlap the early juvenile habitat areas, and only partially overlaps the summer feeding distribution, it is unlikely that these affected areas would impair the long-term productivity of the stock.

Habitat Impacts Relative to Spawning/Breeding

Rock sole move into deeper waters of the GOA shelf in the winter for spawning and to avoid cold water. Their distribution during this season most likely partially overlaps some of the high effort areas, although the extent of their winter distribution is unknown. The effect of habitat disturbance has on the spawning ability or egg viability of rock sole in this area is currently unknown. The shallow inshore areas of the GOA, where rock sole larvae settle and develop into early juveniles do not overlap with the spatial distribution of fishing impacted areas. There is no available information regarding whether there has been a shift in spawning away from these areas. Due to the lack of a stock assessment model for this species, it is unknown if trends in recruitment correspond with the temporal patterns in fishing effort. In the presence of light exploitation, the stock has been in an increasing trend from 1984 to 2003. The biomass point estimates from the trawl surveys have ranged from 137,000 t in 1984 to a high of 207,000 t in 1993 (Turnock et al. 2004).

Habitat Impacts Relative to Growth to Maturity

There is little geographic overlap between areas of high or low fishing effects and areas inhabited by early juvenile rock sole. Figure B.2-5b indicates that fishing has not ranged into the nearshore shallow areas of the GOA, and they have remained areas of low impact. Patterns in high or low juvenile survival cannot be linked to reduction in habitat quality resulting from removal living structure utilized as a refuge from predation.

As rock sole reach 20 to 32 cm in length, they are considered late juveniles, and their distribution ranges offshore as they begin to be assimilated into the adult population. At this size/age, some of their distribution overlaps with high fishing impact areas. However, because their distribution covers such a broad geographical area, the proportion that overlaps these areas is small. It is unknown whether there is a change in length at age for rock sole in the GOA.

Habitat Impacts Relative to Feeding

Changes in growth in adult fish due to habitat destruction could impact the productivity of spawners and the long-term yield from the stock. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to determine if differences in growth were discernable between geographical areas. For rock sole, it was determined that 4 years (1984, 1990, 1999, and 2001) provided adequate sample sizes in the GOA to ensure the necessary contrast. Results indicated that statistically significant differences in weight-at-length were found in 3 years (1990, 1999, and 2001), where the higher values were found in the low fishing effort treatment group for 2 years (1990 and 2001) and in the high fishing effort area in 1999. Because the extent to which site fidelity persists for rock sole (individual fish move between areas) and variable growth results between areas, it cannot be concluded that habitat impacts have had an effect relative to feeding.

Stock Status and Trends
The biomass point estimates from the trawl surveys have ranged from 137,000 t in 1984 to a high of 207,000 t in 1993 (Turnock et al. 2004). Size composition estimates from the trawl surveys indicate a mode of small fish entering the population in 1999 and again in 2003.

Summary

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of GOA shallow water flatfish are mostly unaffected by current fishery activities. Adult and late juvenile rock sole concentrations, as a proxy for GOA shallow water flatfish, primarily overlap with shallow water habitats (13 percent) (Table B.3-3). The predicted reduction of infaunal prey in this overlap is 1 percent. Given this level of disturbance, it is unlikely that adult feeding would be negatively impacted, and effects are believed to be minimal or temporary for rock sole. It is unknown, however, for the other seven species of the shallow water flatfish complex.

The level of information available for rock sole and the other species of the shallow water complex are insufficient to estimate the stock size relative to B_{MSY}, although trawl survey abundance estimates indicate a stable to increasing level of biomass since 1984. Because the population biomass level required to produce long-term sustainability is unknown, the impacts of the effects of fishing on the habitat required for spawning, adult feeding, or juvenile survival and growth to maturity are unknown.

B.3.3.14 Deep Water Flatfish (GOA)

Habitat Connections

Three species comprise this management group: Greenland turbot, Dover sole, and deep sea sole. For this discussion of habitat relating to life history and biology, Dover sole is used to characterize the group of species. Dover sole are, by far, the dominant species in this group, both in terms of biomass and harvest. Their habitat requirements are not expected to be so different from other species in this group that they require separate analysis. The seafloor habitat is associated with Dover sole settlement, growth to maturity, adult feeding, and spawning.

Spawning/Breeding
Dover sole spawn pelagic eggs in the deep waters of the continental shelf and slope. It is not known what role the habitat has in spawning success. See Appendix F for further discussion and references.

Adult Feeding
Adult feeding primarily occurs during summer on the continental slope and, to a lesser extent, on the outer shelf area. The species are thought to be dependent on the infauna supply of polychaete worms, amphipods, and other marine worms.

Growth to Maturity
Within the first 2 years of life, Dover sole undergo metamorphosis from a free-swimming larval stage to the familiar asymmetrical morphological life form characteristic of flatfish. After settling in nearshore areas, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and for burrowing for protection from predators (Moles and Norcross 1995). Although this cited research did not include Dover sole, it is suspected that sediment selection is also important for Dover sole. Growth from newly settled juveniles to mature adults is dependent on the infauna supply of polychaete worms, amphipods, and other marine worms.

Evaluation of Effects

LEI Values Relative to Species Distribution
Dover sole are primarily a deep water species that inhabit shallow areas of the BS shelf as juveniles, but they are also found mid-self as adults during the summer (the 100 to 200 m depth interval has the highest proportion of biomass in each survey. They are primarily associated with GOA deep shelf and slope habitat and overlap some of the high fishing impact areas (Figure B.2-5b, Table B.3-3). The LEI table indicates that the reduction in epifauna prey (1 percent), as well as living structure (6 percent) is estimated to be low in this habitat. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. Dover sole are distributed throughout the GOA on the deep shelf during summer, and most of the biomass is not located in the high fishing effect areas. Because the high fishing effects area only partially overlaps the spawning, feeding, or late juvenile distributions, these affected areas are not likely to impair the ability of Dover sole to produce MSY over the long term.

Habitat Impacts Relative to Spawning/Breeding
Impacted habitat from fishing effects is not likely to overlap the Dover sole spawning areas, which are located in the deep waters of the GOA slope and deep shelf during winter and also the shallow juvenile nursery habitat. Trends in recruitment do not correspond with the trend in fishing effort in the GOA such that years of below average recruitment (1988 to 1996) cannot be linked to trends in disturbed habitat. Dover sole have been above B_{MSY} for the past 20 years (Turnock and A'mar 2004a).

Habitat Impacts Relative to Growth to Maturity
Habitat impacts related to fishing do not occur in areas where early juvenile Dover sole reside and, thus, are not a source of early juvenile mortality. Late juveniles may be found on the GOA shelf with the adult population and in deeper waters, but these fish are primarily distributed on the shelf in areas designated as low- or no-fishing-effort areas. It is, therefore, unlikely that any of the documented disturbances in the GOA would impact their growth to maturity. It is unknown if changes in growth to maturity have occurred.

Habitat Impacts Relative to Feeding
Changes in growth in adult fish due to habitat destruction could impact the productivity of spawners and the long-term yield from the stock. Length-weight observations collected from individual fish during the summertime trawl surveys were identified from the high-, low-, and no-fishing areas to discern if differences in growth were discernable between geographical areas. For Dover sole, it was determined that only 1 year (2003) provided adequate sample sizes in the GOA to ensure the necessary contrast. Results indicated that no statistically significant differences in weight-at-length were found between treatment groups. Given the lack of information on weight or length at age by area for Dover sole, it is unknown if growth changes have occurred over the past 20 years. Due to fish movements and the lack of overlap with high fishing areas, it is unlikely that impacts in these areas have had a negative impact relative to feeding.

Stock Status and Trends
The stock assessment model estimates of age 3+ biomass decreased from a high of about 168,000 t in 1986 to about 1,000,000 t in 2001, then increased slightly to 102,000 t in 2004. Female spawning biomass increased from about 55,000 t in 1984 to 62,000 t in 1990 before declining to about 37,000 t in 2004 (Table B.3-4).

The model estimates of age 3 recruits decrease from 1984 to the mid-1990s, then increase and fluctuate about the mean recruitment in recent years.

Summary

Issue	**Evaluation**
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of GOA deepwater flatfish are mostly unaffected by current fishery activities. Adult and late juvenile Dover sole concentrations in the GOA, as a proxy for GOA deepwater flatfish, primarily overlap with deepwater shelf habitat (58 percent), slope habitat (19 percent), and shallow water habitat (21 percent) (Table B.3-3). This species is dependent on infaunal prey. However, reductions of infaunal prey in those concentration overlaps are predicted to be 1 percent for each of those habitats. Given this level of disturbance, it is unlikely that the adult feeding would be negatively impacted.

The level of information available for the species other than Dover sole is insufficient to estimate the stock size relative to B_{MSY}. Because these levels are unknown for most of the species in this complex, the impacts of the effects of fishing on the habitat required for spawning, adult feeding, or juvenile survival and growth to maturity for the deep water complex are unknown.

B.3.3.15 Pacific Ocean Perch (BSAI)

Habitat Connections

Pacific ocean perch (*Sebastes alutus*) are distributed on the outer continental shelf from southern California, north to the GOA and the EBS, and west to the Aleutian and Kuril Islands (Major and Shippen, 1970). In Alaskan waters, concentrations of abundance occur in the GOA and the AI, with smaller concentrations along the EBS slope. Adult Pacific ocean perch occur at depths from 150 m to 460 m (Major and Shippen 1970); mean depths observed in recent summer AI trawl surveys have been approximately 200 m.

Pacific ocean perch exhibit viviparous reproduction, which is marked by three critical points in the reproduction process: mating (the transferring of spermatozoa from males to females), fertilization of ova, and parturition (the release of larvae). Seasonal migrations from deeper water in winter to shallower water in summer affect the habitats in which these events occur. Gunderson (1971) found that Pacific ocean perch off British Columbia were in the shallower water (approximately 200 m) from June to August and deeper water (approximately 325 m) from December to May. Gunderson (1971) concluded that mating occurred in September to October for British Columbia Pacific ocean perch, near the time of migration to deeper water, and estimated that the peak period of parturition occurred in March. Lyubimova (1965) also estimated that for GOA Pacific ocean perch 3 to 4 months passed between mating and fertilization. Observations of larval rockfish in ichthyoplankton surveys are consistent with a spring period of parturition (Matarese et al. 2003).

Larval Pacific ocean perch are pelagic and are thought to become demersal within the first year of life (Carlson and Haight 1976, Carlson and Straty 1981). Little is known about the feeding habits of Pacific ocean perch during the planktonic stage, in part due to the difficulty of identifying larval rockfish to species. Pacific ocean perch are plankton feeders, with juveniles eating calanoid copepods and adults eating largely euphausiids (Yang 1993, 1996). Brodeur (2001) found that adult Pacific ocean perch in Pribilof Canyon feed on swarms of euphausiids that are not associated with benthic habitat, but rather are thought to result from onshore advection to upstream areas of canyons.

Information on the habitat of juvenile Pacific ocean perch (Table B.3-1) is available primarily from a limited number of submersible studies. In an early study using trawl gear in southeast Alaska coastal areas, Carlson and Haight (1976) found that 1- to 2-year-old fish resided in substrates consisting of cobbles, pebbles, and sand, although later studies using submersibles have documented the use of more rugged habitat by juveniles. Carlson and Straty (1981) found juvenile nursery grounds off southeast Alaska to occur at depths of 90 to 100 m over rough bottom (pinnacles and boulder fields interspersed with gravel and invertebrate shells). Straty (1987) found that juvenile Pacific ocean perch occupied rocky coastal areas off southeast Alaska at depths of 134 to 171 m; the ranges in age and size of these juveniles were 1 to 3 years and 78 to 164 mm. These juvenile Pacific ocean perch and other juvenile rockfish took refuge in rocky areas when alarmed by the movement of the submersible. Straty (1987) also noted that juvenile rockfish were associated with stands of large white anemones. Kreiger (1993) conducted transects with a submersible in southeast Alaska waters over a depth range of 188 to 292 m and noted the use of rugged habitat (cobble, boulders, and ledges with coral) by small (less than 25 cm) Pacific ocean perch, with the highest densities occurring over untrawlable areas. Thus, there is evidence relating living and non-living structures to juvenile habitat use and growth to maturity. Based upon the existing studies cited above, these linkages occur in the BS slope (200 to 1,000 m) and in both shallow (less than 200 m) and deep (more than 200 m) in the AI and in soft (sand to gravel) and hard (pebble to rock) habitat types.

Adult Pacific ocean perch occupy deeper waters than juvenile Pacific ocean perch, and adults are generally associated with smoother substrates than juveniles (Table B.3-1). Kreiger (1993) found that adult Pacific ocean perch (more than 25 cm) have been found in pebble substrates with little relief. The 2002 and 2004 trawl surveys in the AI indicate the modal lengths of Pacific ocean perch in the 0 to 100 m depth range is approximately 20 cm, and the modal lengths progressively increase with increasing depths. Adult Pacific ocean perch have been associated with sea whips (Broduer 2001) and sea pens (Kreiger 1993). Thus, there is evidence relating living (sea whips and sea pens) and non-living structure (pebble substrates) to adult habitat use. Based upon the existing studies cited above, these linkages occur in the BS slope (200 to 1,000 m), in both shallow (less than 200 m) and deep (more than 200 m) water in the AI, and in soft (sand to gravel) and hard (pebble to rock) habitat types.

Evaluation of Effects

LEI Values Relative to Species Distribution

The general distribution (95 percent distribution) of the adult Pacific ocean perch population within BSAI waters occurs primarily within the AI deep and the AI shallow habitat types, contributing 21 and 10 percent of the total Alaska Pacific ocean perch distribution, respectively (Table B.3-3). The potential reductions in living structure and non-living structure in the AI deep habitat (200 to 1,000 m) in the general distribution of Pacific ocean perch were projected to be 5 and 3 percent, respectively. In the AI shallow areas, the potential reductions in living and non-living habitat features were projected to be 13 and 8 percent, respectively. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. In addition, such percentages pertain the entire stock over large spatial scales, and examination of the LEI maps indicates that localized areas of higher impacts do occur south of Adak Island, near Seguam Pass, and northeast of Atka Island. Although these areas have not contributed a large portion of the total BSAI biomass in recent surveys, such maps are difficult to interpret (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). The projected impacts on hard corals in the AI deep and AI shallow habitat areas were 12 and 28 percent, respectively. However, Pacific ocean perch generally have not been found to be associated with hard corals. For example, Kreiger and Wing (2002) conducted 11 submersible dives in the GOA at depths from 161 to 365 m and did not find that Pacific ocean perch were associated with *Primnoa*, a gorgonian coral.

Habitat Impacts Relative to Spawning/Breeding
Little information exists on the spawning and breeding behavior of BSAI Pacific ocean perch. Based upon studies conducted in the GOA, mating is expected to occur in the fall and parturition in the spring. The distribution of mating and spawning fish is not available from current data, as both the research surveys and directed fishery for Pacific ocean perch occur in the summer months when Pacific ocean perch are neither mating nor spawning. Summer survey data are not a useful proxy for spawning distributions, as Gunderson (1971) noted seasonally dependent depth changes associated with spawning activity.

Maturity at age studies have not been completed for the BSAI Pacific ocean perch, so it is not possible to state whether changes in maturity at age can be related to habitat impacts. Field specimens collected in 2004 will provide the basis of initial studies on maturity for AI Pacific ocean perch.

For BS Pacific ocean perch, Moiseev and Paraketsov (1961) noted that parturition does not appear to be related to benthic habitat, as spawning females released larvae from 25 to 30 m off the bottom over depths of approximately 400 m. Similarly, the processes of mating and parturition for rockfish have not been observed to critically depend upon benthic habitat features (Love at al. 2002). There is no evidence that suggests that habitat impacts have affected the ability of BSAI Pacific ocean perch to conduct the mating and spawning processes, although it should be noted that very little is known regarding these processes.

Habitat Impacts Relative to Growth to Maturity
The information available on the habitat preferences on juvenile Pacific ocean perch is limited to the few references cited above that relied upon submersible research. As mentioned above, these studies indicate that juvenile Pacific ocean perch use rocky habitats as refuge areas, and Straty (1987) noted that juvenile red rockfish were captured in stands of large white anemones.

Habitat linkages between juvenile Pacific ocean perch and living (anemones) and non-living (rocky habitats) habitat structures were detected; therefore, fishing impacts on living and non-living habitats were evaluated with respect to their potential impact on Pacific ocean perch growth and survival. Based upon the LEI analysis, long-term reductions in either the living or non-living habitat features in the AI deep or shallow habitat types are not expected to exceed 13 percent. However, as mentioned above, localized areas of higher intensity impacts to living and non-living structures occur in the regions south of Adak Island, near Seguam Pass, and northeast of Atka Island. As mentioned above, analysis of summer survey CPUE revealed that only a small fraction of the Pacific ocean perch population utilizes these higher impact areas (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). The uncertainty in the data should also be noted, as the LEI maps in the AI are only a relative indicator of impact (see Sections B.2.5 and B.2.6). They are also difficult to interpret because the pattern of impacts may occur at finer spatial scales than presented in this analysis, and the trawl surveys typically do not sample juvenile rockfish very well.

Distribution maps were examined to evaluate whether habitat impacts resulting from intense fishing may have impacted the growth and survival of juvenile Pacific ocean perch, as revealed by changes in distribution. The distribution of small AI Pacific ocean perch does not appear to have changed substantially in recent surveys, with centers of abundance consistently located in the Buldir Island/Agattu Island areas and south of Amchitka Island. Given the rather large sampling variability in rockfish biomass estimates from trawl surveys, changes in distribution, particularly over small spatial scales, will be difficult to detect.

Length-weight data were examined to evaluate whether habitat impacts resulting from intense fishing may have reduced weight at length. A statistical analysis was conducted to examine this potential effect; data are available in 1986, 1997, and 2000, with the sample size in the high fished areas not exceeding 90 fish for any year. In 1986 and 2000, the weight at lengths were greater in highly fished areas, whereas in 1997 the weight at lengths were greater in low fish areas. The results are inconclusive, as no consistent pattern emerged between the years, and the statistical power is expected to be low due to the small sample size.

No direct evidence suggests that the growth to maturity of BSAI Pacific ocean perch has been affected by habitat disturbance, although the reliance of juvenile Pacific ocean perch upon both living and non-living habitat features and the potential for fishing to affect these habitats raises concerns. For example, if Pacific ocean perch show spatial heterogeneity related to timing of parturition, as proposed by Berkeley et al. (2004), then impacts on growth to maturity on smaller spatial scales could affect the BSAI stock. The extent to which habitat impacts occur at smaller spatial scales and the importance of these impacts to the overall BSAI population are unknown.

Habitat Impacts Relative to Feeding

The major prey items for Pacific ocean perch are calanoid copepods (as juveniles) and euphausiids (as adults). Because both of these prey items reside in pelagic habitats and are not associated with benthic environments, there is no reason to suspect a link between benthic habitat disturbance and prey availability or feeding success.

Information from a recent AI survey does not suggest major changes in the distribution of Pacific ocean perch. Because the prey of Pacific ocean perch occur within pelagic habitats and are not associated with benthic habitats, any changes in the distribution of prey are more likely to occur from changes in oceanographic conditions than from benthic habitat impacts. For example, Brodeur (2001) proposed that euphausiid populations within Pribilof Canyon resulted from advection from areas off the continental slope.

Although limited information exists on diet, no direct evidence suggests that diet of Pacific ocean perch has changed substantially over time. The diet studies of Yang (1993, 1996) for AI Pacific ocean perch are consistent with the results on Carlson and Haight (1976) for Pacific ocean perch off southeast Alaska.

Stock Status and Trends

Estimates of spawning biomass from population assessment models indicate that BSAI Pacific ocean perch spawning biomass has fluctuated dramatically in response to fishing pressure. The spawning stock biomass, as estimated in the 2004 Pacific ocean perch stock assessment (Spencer and Ianelli 2004), was approximately 109,000 t in 1960, decreased to 24,000 in 1979, and increased to 134,000 t in 1998 and has remained at approximately that level (Figure B.3.3.15-1). These changes in spawning biomass are consistent with high exploitation rates of Pacific ocean perch in the 1960s and early 1970s and the rebuilding of Pacific ocean perch beginning in the early 1980s.

Estimated recruitment of BSAI Pacific ocean perch has varied considerably, and the strong recruitment of the 1981, 1984, and 1986 year classes has allowed stock increases from the low levels in the late 1970s. With the exception of the 1962 year class, the strong recruitment in the early 1980s is comparable to that estimated for the early 1960s.

Trends in recruitment success also do not correspond with the temporal patterns in fishing effort (Figure B.3.315-2) and recruitment for Pacific ocean perch, further suggesting that if a relationship exists between local regions of heavy fishing and future recruitment, this impact does not manifest itself at the population scale.

Information on stock status does not suggest that the cumulative effects of fishing have impaired the ability of BSAI Pacific ocean perch to produce MSY. Recruitment was strong for several year classes in the early 1980s, resulting in the increase in biomass.

Summary

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Growth to Maturity	U (Unknown)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of BSAI Pacific ocean perch are rated as either unknown or minimal and temporary. The percent reduction in living and non-living substrates in the areas most commonly inhabited by BSAI Pacific ocean perch (the AI deep and AI shallow habitats) do not exceed 13 percent. Although larger percent reductions for hard corals are estimated, studies on habitat associations have not associated Pacific ocean perch with hard coral (Kreiger and Wing 2002). There is little information to suggest that these habitat reductions would affect spawning/breeding or feeding in a manner that is more than minimal or temporary, although much is unknown for these processes for BSAI Pacific ocean perch.

Regarding growth to maturity, the available literature does indicate that juvenile red rockfish do use living (anemones) and non-living (rocky areas) habitat features, with one specific use being the ability to find refuge from predators. Trawling would be expected to have negative impacts for these life stages, although the extent to which the BSAI Pacific ocean perch stock is dependent upon these habitat features is not well known. Although the LEI percentages do not exceed 13 percent for the living and non-living substrates, these figures should be interpreted as rough guidelines that are estimated with some error and relate to entire BSAI stock. Examination of LEI maps indicates that finer scale impacts do occur and could be important for stocks such as Pacific ocean perch, which are thought to show population structure on small spatial scales (Withler et al 2001). Similarly, although the current population level data do not indicate declining trends in spawning biomass or recruitment, it is not clear what effects may have occurred at finer spatial scales.

B.3.3.16 Pacific Ocean Perch (GOA)

The Pacific ocean perch is the most abundant GOA rockfish and the most important commercially. The species was fished intensely in the 1960s by foreign factory trawlers (350,000 mt at its peak in 1965), and the population declined drastically due to this pressure. The domestic fishery began developing in

1985. Quotas climbed rapidly, and the species was declared overfished in 1989. A rebuilding plan was put into place, and quotas were small in the early 1990s. After some good recruitments and high survey biomass estimates, the stock was declared to be recovered in 1995. Data showing effects of fishing on habitat for Pacific ocean perch are sparse. Most associations with particular habitats, living and non-living structures, are tenuous. Catch-per-unit-effort data are limited for the small amounts of area that are considered high-intensity trawling areas in the GOA. Very little is known regarding the reproductive behavior of Pacific ocean perch. Additionally, only several hundred individual specimens were collected over the entire GOA in the high-intensity trawl area, which results in low-power analyses on growth changes. The potential linkages between habitat disturbance by fishing and the health of the Pacific ocean perch population in the GOA are described below.

Habitat Connections

Though more is known about the life history of Pacific ocean perch than about other rockfish species (Kendall and Lenarz 1986), much uncertainty still exists about specific habitat preferences (Table B.3-1). Pacific ocean perch is primarily a demersal species that inhabits the outer continental shelf and upper continental slope regions of the North Pacific Ocean and the EBS from southern California to northern Honshu Island, Japan (Allen and Smith 1988). The species appears to be most abundant in northern British Columbia (Schnute et al. 2001), the GOA (Hanselman et al. 2003), and the AI (Spencer and Ianelli 2003). As adults, they most commonly live on or near the sea floor at depths ranging from about 150 to 420 m, with summer surveys revealing high density patches between 180 and 225 m (Hanselman et al. 2001). Following insemination, females appear to migrate into deeper waters to overwinter (500 to 700 m), often near the mouths of submarine gullies, and stay there until the time of larval release (Love et al. 2002).

Spawning/Breeding

Similar to other rockfish, Pacific ocean perch have internal fertilization and release live young. There is little information on reproductive behavior for Pacific ocean perch, except that insemination occurs in the fall, and larvae release occurs in April or May. A number of studies have examined length-at-maturity and age-at-maturity of Pacific ocean perch for different regions. Although studies prior to 1983 used surface reading of otoliths, the bias of ages from surface reading was not large until well after the average age at 50 percent maturity. Westrheim (1975) estimated an age at 50 percent maturity of 10 for the western GOA and 15 for the eastern GOA. Chikuni (1975) estimated an age at 50 percent maturity of 7 for the overall GOA. Lunsford (1999) conducted the largest study that resulted in an age at 50 percent maturity of 10.5 for the GOA. Other areas south of the GOA had estimated ranges for age at 50 percent maturity between 7 and 12 (Gunderson 1976, Westrheim 1975, Gunderson 1977, Gunderson 1997, Richards and Olsen 1996). Little is known about the location or behavior of spawning in Pacific ocean perch. Consequently, there is no evidence that links habitat features with the ability of Pacific ocean perch to accomplish the spawning/breeding process.

Feeding

Pacific ocean perch are mostly planktivorous (Carlson and Haight 1976, Yang 1993, 1996, Yang and Nelson 2000, Yang 2003). In a sample of 600 juvenile perch stomachs, Carlson and Haight (1976) found that juveniles fed on an equal mix of calanoid copepods and euphausiids. Larger juveniles and adults fed primarily on euphausiids and, to a lesser degree, on copepods, amphipods, and mysids (Yang and Nelson 2000). In the AI, myctophids have increasingly comprised a substantial portion of the Pacific ocean perch diet and also compete for euphausiid prey (Yang 2003). Habitat for euphausiids has been more commonly related to oceanographic conditions like sea surface temperature, currents, and chlorophyll *a* than bottom structure (Mackas and Tsuda 1999, Siegel 2000, Yoon et al. 2000). Based on remote operating vehicle (ROV) observations of Pacific ocean perch feeding in the BS, Brodeur (2001) suggested that copepods and euphausiids are not directly associated with bottom habitat. Instead, they are advected onshore near the bottom at the upstream ends of underwater canyons where they become easy prey for planktivorous fishes. Predators of Pacific ocean perch are likely sablefish, Pacific halibut, sperm whales (Major and Shippen 1970), seabirds (Ainley et al. 1993), and other rockfish (Hobson et al. 2001). There is no evidence that links the habitat features with the ability of Pacific ocean perch to accomplish the feeding process.

Growth to Maturity

Pacific ocean perch larvae are thought to be pelagic and drift with the current. Oceanic conditions may sometimes cause advection to suboptimal areas (Ainley et al. 1993) resulting in high recruitment variability. However, larval studies of rockfish have been hindered by difficulties in species identification because many larval rockfish species share the same morphological characteristics (Kendall 2000). Genetic techniques using allozymes (Seeb and Kendall 1991) and mitochondrial DNA (Li 2004) are capable of identifying larvae and juveniles to species, but are expensive and time-consuming. Post-larval and early young-of-the-year Pacific ocean perch have been positively identified in offshore, surface waters of the GOA (Gharrett et al. 2002). Because larval and early young-of-the-year Pacific ocean perch are thought to be pelagic, there is no evidence that links sea floor habitat features with the ability of Pacific ocean perch to accomplish the growth to maturity process during the post larval or early juvenile stages.

Later stage juveniles of reddish rockfish have been observed in an inshore, demersal habitat (Carlson and Haight 1976, Carlson and Straty 1981, Straty 1987, Pearcy et al. 1989, Krieger 1993). Carlson and Haight (1976) collected juvenile Pacific ocean perch during 3 years in Southeast Alaska fjords. They found that age 1- and 2-year-old fish were found demersally over high relief habitat including walls and boulders, while older juveniles from 3 to 6 years old were found on smoother, unbroken substrate, both at a median depth of 70 m. These juveniles were most commonly found with brittle stars, basket stars, and sponges. Carlson and Straty (1981) observed small reddish rockfish believed to be juvenile Pacific ocean perch with a submersible at 90 to 100 m in offshore Southeast Alaska. The reddish rockfish were observed along rocky areas exposed to open sea conditions that ranged from rugged, steep, rocky pinnacles to boulder fields interspersed with gravel beds (Carlson and Straty 1981). Krieger (1993) observed small reddish rockfish believed to be juvenile Pacific ocean perch with a submersible at 188 to 290 m in offshore Southeast Alaska. The highest densities of these small reddish rockfish were observed at untrawlable sites over rugged habitat, including cobble, cobble and boulders, and among ledges and coral (the type of coral was not specified) (Krieger 1993). Other species of rockfish in submarine canyons have been associated with high-relief structures such as vertical rock walls, ridges, and boulder fields, which may act as natural refugia from trawling (Yoklavich et al. 2000). Large schools of juvenile Pacific ocean perch have also been found on the shelf in other areas of the GOA, including Albatross Bank and Shumagin Bank (Westrheim 1970). Submersible work in California detected a strong association for juvenile rockfish with untrawlable bottom (Nasby-Lucas et al. 2002). Another study using a submersible in the eastern GOA observed other species of rockfish associated with *Primnoa* spp. corals (Krieger and Wing 2002). Freese and Wing (2004) also used a submersible in the GOA, and in a single dive they observed 82 juvenile red rockfish, suspected to be Pacific ocean perch, closely associated with boulders that had attached sponges. No rockfish were observed near boulders without sponges. Rooper and Boldt (2004) noted a relatively strong positive relationship with the catch of sponges and the catch of juvenile Pacific ocean perch.

As they mature into adults, juvenile Pacific ocean perch move to progressively deeper waters of the continental shelf/slope (approximate 3 m deeper per cm of length), ranging from an average depth of 125 m at 7 cm in length, to an average depth of 270 m at 50 cm in length (unpublished NMFS survey data). They also shift into smoother, more trawlable bottom (Carlson and Haight 1976, Krieger 1993). Length frequencies of Pacific ocean perch captured in NMFS bottom trawl surveys and observed in commercial fishery bottom trawl catches, indicate that older juveniles are often found, together with adults at shallower locations of the continental slope in the summer months (unpublished NMFS survey data). Commercial fishing data indicate that adult Pacific ocean perch are most prevalent on the shelf break (100 to 200 m), slope (more than 200 m), and inside major gullies and trenches (200 to 500 m) running perpendicular to the shelf break (Lunsford 1999, Lunsford et al. 2001). Krieger (1993) noted that most large (longer than 25 cm) rockfish identified as adult Pacific ocean perch were associated with pebble substrates on flat or low-relief bottom. Other studies with trawl and sunken gill nets have found Pacific ocean perch predominantly over relatively smooth, trawlable bottoms (bottom type was not identified) (Westrheim 1970, Matthews et al. 1989). In the EBS and GOA, Pacific ocean perch have also been observed associated with forests of epibenthic sea whips (*Halipteris willemoesi*, Brodeur 2001) and sea pens (possibly misidentified sea whips) (Krieger 1993). Scott (1995) reports that adult Pacific ocean perch habitat can be defined using physical variables such as sea surface temperatures, coastal wind patterns, and steep bathymetry.

Consequently, there is evidence that links the habitat features, living structure, and non-living structure with the ability of Pacific ocean perch to accomplish the growth to maturity process during the demersal juvenile and adult stages. Based upon the depth distributions and substrate types described above, these links most likely occur in deeper shelf areas (100 to 300 m) and slope (200 to 1,000 m) habitat types over soft (sand and gravel) and hard (pebble to rock) substrates and are included as such in the GOA Pacific ocean perch connections table (Table B.3-1).

Evaluation of Effects

LEI Values Relative to Species Distribution
The habitat information that is available for Pacific ocean perch indicates they are associated with living structure and non-living structure (Table B.3-1). Pacific ocean perch are present in the slope and shallows, but are predominant in deep shelf habitats (Table B.3-3). The LEI shows a potential 7 to 10 percent equilibrium reduction in living structure features of habitat in areas where Pacific ocean perch are found (Figure B.2-3B, Table B.3-3). LEI maps in the GOA are difficult to interpret, however, because of the irregularity and patchiness in the distribution of habitat features. This is especially true for living structure features such as sponges and corals, which may be patchily distributed and occur on a finer scale than presented in this analysis. The reduction in non-living structure is likely quite low (less than 2 percent) because Pacific ocean perch appear to be associated with hard substrates such as rocks and boulders, which are not greatly affected by fishing (Figure B.2-4B, Table B.3-3). The extent of association between Pacific ocean perch and living and non-living structures as habitat is uncertain. There is evidence that juvenile red rockfish use coral habitat, but it is not known whether these rockfish are juvenile Pacific ocean perch. Thus, there is no direct evidence of an association of Pacific ocean perch with hard corals. If information becomes available that suggests that coral is important habitat, it will be a concern because of the potential large reduction (46 percent) in hard corals in the GOA, as indicated by the LEI index. This may be even more important because it is unknown how much coral there presently is in the GOA, or how much there was prior to fishing effects. The loss of hard corals may be even more critical if juvenile life stages are more dependent on coral than adults. Further research investigating the importance of hard corals as Pacific ocean perch habitat is necessary to determine the effect of coral loss on these fish.

Habitat Impacts Relative to Spawning/Breeding
There is no information on reproductive behavior for Pacific ocean perch, except that spawning likely occurs in deep depths in the winter and parturition occurs in the spring. The rockfish fishery in the GOA

and the NMFS trawl surveys occur in the summer months. Information regarding distribution patterns in the winter and spring months when spawning is thought to occur comes from non-target fisheries, which do not offer accurate comparisons of distribution. Studies have shown no temporal changes in maturity at age, but different methods of assessing maturity-at-age may be too variable to detect changes.

There is no direct evidence that links habitat features with the ability of Pacific ocean perch to accomplish spawning/breeding. Because very little is known regarding the requirements for reproduction, however, caution is warranted.

Habitat Impacts Relative to Feeding

After 1 year of age, the major prey of Pacific ocean perch appears to be euphausiids, based on the limited food information available for this species (Carlson and Haight 1976, Yang 1993, Yang and Nelson 2000, Yang 2003). Because euphausiids are pelagic rather than benthic in their distribution and are too small to be retained by any fishing gear, fishing probably has a minimal or temporary effect on the availability of prey to Pacific ocean perch.

No direct evidence is available that indicates the feeding distributions have changed. Euphausiids are not believed to be directly associated with the bottom, but are more commonly related to oceanographic conditions like sea surface temperature, currents and chlorophyll *a* (Mackas and Tsuda 1999, Siegel 2000, Yoon et al. 2000). This would indicate that any change in feeding distribution is most influenced by oceanographic factors, rather than benthic habitat disturbance.

No direct evidence is available that indicates any change in the diet of Pacific ocean perch. Because euphausiid distributions are widespread (Mackas and Tsuda 1999) and are likely not affected by benthic habitat disturbances, it is doubtful that diet changes would be detectable between heavily fished and lightly fished regions. In summary, there is no evidence that habitat disturbance has affected feeding success.

Habitat Impacts Relative to Growth to Maturity

In the past, juveniles (less than 30-cm fork length) made up a considerably proportion of the catch, but recently contribute less than 8 percent in numbers. It is possible that fishing does not occur and, thus, has no direct effect on the primary habitat of juveniles. However, older juveniles and adults have been observed in association with sponges (Krieger and Wing 2002, Freese and Wing 2004) and possibly coral (Heifetz 2002), and both juvenile and adult life stages may prefer the rocky substrate inhabited by such epifauna. Adult rockfish seem to be more influenced by oceanographic conditions and prey availability and are usually found on smoother, more trawlable habitat than juveniles (Krieger 1993, Scott 1995, Nasby-Lucas et al. 2002).

Growth analyses of length-at-age, weight-at-age, and weight-at-length of Pacific ocean perch caught in low trawl intensity (less than 50 percent of the area swept) areas versus high trawl intensity (more than 50 percent of the area swept) areas have been computed and show significant differences. The data were pooled over time and area due to lack of adequate samples to parse into smaller comparisons. For von Bertalanffy (LVB) length-at-age models, the Brody growth parameter (κ) and the intercept (t_0) were significantly higher for the high-intensity fishing areas than for the low-intensity areas. Weight-at-age parameters were not significantly different among the different effort-intensities. For the allometric weight-length relationship, which had the most data, both the α and β parameters were significantly different for high-intensity effort compared with low-intensity effort areas.

In another approach, the mean difference between individual weights and mean weights for each length were compared over survey years that had data in high and low fishing-effort areas. This approach yielded significant effects for both year and fishing intensity under an analysis of variance (ANOVA) unequal sample size design. The differences were in both directions depending on the year, with the grand mean of residuals showing a small positive effect on weight-at-age in the high-intensity fishing samples.

The general results of the first analysis were that the fish in the high-intensity areas grew slightly heavier and faster, but had a smaller maximum length. The second analysis had contradictory results between years with both positive and negative effects on growth. These results are based on fairly small sample sizes in the high-intensity area and could be caused by a number of confounding factors. Possible explanations are as follows: (1) the high-intensity effort areas are likely areas with the highest density of fish, so fishery removals are easing intraspecific competition for food resources, allowing faster growth, and/or (2) areas are subject to low-intensity trawling are poor habitat for Pacific ocean perch due to prey availability or oceanographic conditions.

No direct evidence exists that indicates habitat disturbance affects the growth to maturity of Pacific ocean perch. However, the potential reduction of living substrates such as sponge evidenced by the LEIs in Pacific ocean perch habitat raises concern regarding the growth requirements of younger Pacific ocean perch. Associations between juvenile red rockfish and living structure have been established, and impacts to sponge habitat may affect survival of juveniles because they may become more vulnerable to predation without adequate refugia. Juvenile survival is essential, but virtually nothing is known about it. The growth analysis showed some significant differences in growth between high and low intensity trawl groups, but the cause is uncertain.

Stock Status and Trends

Stock status for the Pacific ocean perch has been assessed with an age-structured model since the early 1990s. The model incorporates survey biomass estimates, age data from the fishery and trawl survey, and length data from the fishery (Hanselman et al. 2003).

Model estimates of spawning biomass in the 1960s were high and were subsequently depleted by large catches by foreign trawlers. Biomass increased rapidly in the 1990s due to some large recruitment events in the late 1980s, as indicated by several large survey biomass estimates. Biomass has remained relatively steady since then (Hanselman et al. 2003). During this time, there have been no major declines in estimated abundance. Little data beyond catch and fishery lengths are available prior to the 1980s, but presumably the bulk of habitat impacts would have occurred in the 1960s when trawl effort was much higher.

Since 1989, there has been a considerable decrease in effort, and catch-per-unit-effort has been increasing in the fishery since the mid-1990s. Effort analysis has shown that the fishery has moved since the early 1980s from shallower areas that are no longer targeted in rockfish fisheries to deeper areas along the outer shelf and upper slope. The overall number of hauls targeting rockfish has decreased by more than 80 percent since 1989, even though the current quota is similar to that of 1989, indicating both an increase in abundance and an increase in fleet efficiency. The fishery was taking a larger proportion of juvenile rockfish between 1989 and 1992, probably due to lower abundance of adults. Survey catch-per-unit effort increased from 1993 to 2001 and leveled off in 2003. The NMFS survey in 2003 did not have any extraordinary hauls of Pacific ocean perch like those in previous surveys, but showed a more uniform distribution of moderate catches along the continental slope. This may indicate a decrease in aggregating behavior or an increase in abundance.

Model estimates of recruitment vary greatly, which is typical of rockfish in the GOA. Most researchers agree that a climatic regime shift occurred around 1977 that reorganized the biotic community in Alaskan waters (Francis et al. 1998), so recruitment estimates are generally compared after 1977. No obvious trend in recruitment is discernable since 1977. Recruitments in the late 1980s appear stronger than average, and recent recruitments appear to be average.

Between 1977 and the mid-1990s, the spawning biomass was below B_{MSY}. Spawning biomass has since surpassed B_{MSY} and the target biomass of $B_{40\%}$ and has appeared to stabilize. In recent years, however, the estimate of B_{MSY} has shifted downward with a slight decrease in spawning biomass. This is because no new above-average recruitments have appeared. Therefore, the estimated stock size is above the current MMST, B_{MSY}, and $B_{40\%}$, but these reference points are not static and have been both higher and lower in the past.

Overall, the stock status seems to be good compared to the recent past, and it is unlikely that habitat impacts are affecting the stock's ability to maintain MSY in the near future.

Summary

Issue	Evaluation
Spawning/Breeding	U (Unknown effect)
Growth to Maturity	U (Unknown effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of Pacific ocean perch are either unknown or negligible; however, caution is warranted. There is some information to suggest that bottom trawling has a negative impact on benthic habitat, especially sponges. The LEI analysis indicates that there is a potential for minor reductions in living substrates inhabited by Pacific ocean perch. Whether the potential loss of these substrates would have an effect on spawning/breeding of Pacific ocean perch is unknown. Any effect on their ability to feed would likely be negligible. Very little information is available on these aspects of their life history, however, and further investigation may prove otherwise. A reduction in living structure may jeopardize these fishes' ability to grow to maturity. Several observations have shown juvenile red rockfish to be associated with sponges. The extent of this association is largely unknown, but it may be important if these substrates increase survival rates by acting as refugia to juveniles or adults. Significant differences in growth were found between heavily trawled and lightly trawled areas, but the cause is unknown. Current stock status trends show no indications of fishing impacting the ability of the stock to maintain MSY.

B.3.3.17 Shortraker and Rougheye Rockfish (BSAI)

Rougheye (*Sebastes aleutianus*) and shortraker (*Sebastes borealis*) rockfish are distributed from southern California, north to GOA and the EBS, and west to the Aleutian and Kuril Islands and the Okhotsk Sea (Love et al. 2002). In Alaskan waters, concentrations of abundance occur in the GOA and the AI, with smaller concentrations along the EBS slope. The mean depth at which shortraker and rougheye rockfish appear in recent AI summer trawl surveys is approximately 400 and 375 m, respectively.

Habitat Connections

Very little is known about the spawning and breeding behavior of rougheye and shortraker rockfish. Reproduction is viviparous, which is marked by three critical points in the reproduction process: mating (the transferring of spermatozoa from males to females), fertilization of ova, and parturition (the release of larvae). McDermott (1994) examined specimens from the United States continental west coast, the GOA, and the AI and found that for rougheye rockfish, fertilization predominated in November and December and peak parturition occurred anywhere between December and April. For shortraker rockfish, fertilization appeared to occur in January and parturition between February and August. Shortraker rockfish appeared to show a longer developmental period than rougheye rockfish.

The larval and early juvenile stages of rougheye and shortraker rockfish are pelagic, but little is known of the duration of this stage or the extent to which pelagic juveniles are distributed by ocean currents. One source of difficulty is identifying larval rockfish to species.

Pandalid and hippolytid shrimp are the largest components of the rougheye rockfish diet (Yang 1993, 1996, Yang and Nelson 2000). In a study of diet data collected from specimens from the AI trawl survey, Yang (2003) found that the diet of large rougheyes had proportionally more fish (e.g., myctophids) than small rougheye, whereas smaller rougheye consumed proportionally more shrimp. The diet of shortraker rockfish consists largely of squid and shrimp. From specimens collected in the 1990 and 1993 GOA trawl surveys, Yang and Nelson (2000) observed that squid was the most important prey item in 1990, whereas shrimp was the most important prey item in 1993. From data collected in the 1994 and 1997 AI trawl surveys, Yang (2003) also found that the diet of large shortrakers had proportionally more fish (e.g., myctophids) than small shortrakers, whereas smaller shortrakers consumed proportionally more shrimp.

Information on the habitat use of juvenile rockfish is available primarily from a limited number of submersible studies. Carlson and Straty (1981) found juvenile nursery grounds off southeast Alaska to occur at depths of 90 to 100 m over rough bottom (pinnacles, boulder fields interspersed with gravel, and invertebrate shells). Although this study was focused upon Pacific ocean perch, juvenile rockfish of other species (including rougheye rockfish) were observed to follow similar patterns. Other studies using submersibles have indicated that several species of rockfish appear to use rocky, shallower habitats during their juvenile stage (Straty 1987, Kreiger 1993). Straty (1987) noted that juvenile red rockfish were associated with stands of large white anemones, and juvenile rockfish took refuge in rocky areas when alarmed by the movement of the submersible. Although these studies did not specifically observe rougheye/shortraker rockfish, it is reasonable to suspect that juvenile rougheye and shortraker rockfish also use these shallower habitats as refuge areas. Length frequency distributions from AI summer trawl survey indicate that small rougheye rockfish (less than 35 cm) are found throughout a range of depths but primarily in shallower water (200 to 300 m) than larger fish. Based upon the existing studies cited above, juvenile shortraker and rougheye rockfish are expected to occur in the BS slope (200 to 1,000 m), in both shallow (less than 200 m) and deep (more than 200 m) water in the AI, and in soft (sand to gravel) to hard (pebble to rock) habitat types.

Adult rougheye/shortraker rockfish have been found at depths of 300 to 500 m in AI trawl surveys. In a submersible study designed to examine the spatial distribution and habitats of shortraker and rougheye rockfish off southeast Alaska, Kreiger and Ito (1999) found that rougheye/shortraker rockfish were associated with habitats containing frequent boulders, steep slopes (more than 20°), and sand-mud substrates. Based upon this information, linkages between habitat features and adult shortraker and rougheye rockfish are expected to occur on the BS slope (200 to 1,000 m) and in deep (more than 200 m) water in the AI in soft (sand to gravel) to hard (pebble to rock) habitat types.

Evaluation of Effects

LEI Values Relative to Species Distribution

The general distribution (95 percent distribution) of the adult shortraker and rougheye population within BSAI waters occurs primarily within the AI deep and the AI shallow habitat types, contributing 22 and 16 percent of the total Alaska rougheye and shortraker distribution, respectively. The potential reduction in living structure and non-living structure in the AI deep habitat (200 to 1,000 m) was projected to be 3 and 2 percent, respectively. In the AI shallow areas, the potential reduction in living structure and non-living structure was projected to be 7 and 4 percent, respectively. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. Furthermore, these percentages pertain to the entire stock over large spatial scales, and examination of the LEI maps indicates that localized areas of higher impacts do occur in areas such as south of Adak Island, Seguam Pass, and northeast of Atka Island. Analysis of survey CPUE shows that during summer months these areas have not contributed a high portion of the AI biomass in recent surveys. However, the LEI maps are difficult to interpret because the pattern of impacts may occur at finer spatial scales than presented in this analysis, and the extent to which these localized impacts may affect the entire population is unclear. The projected impacts on hard corals in the AI deep and AI shallow habitat areas were 8 and 17 percent, respectively. Kreiger and Wing (2002) used a submersible to examine *Primnoa*, a deepwater gorgonian coral, in the GOA at depths from 161 to 365 m and found that 85 percent of large rockfish (including rougheye and shortraker rockfish) occurred next to boulders with coral, although less than 1 percent of the observed boulders contained coral. Kreiger and Wing (2002) also found that several species of rockfish, including rougheye, showed a depth-size relationship in their association with *Primnoa*, with smaller rockfish (less than 40 cm) generally occurring at stations less than 263 m, whereas large rockfish (40 to 70 cm) occur at depths more than 340 m.

Habitat Impacts Relative to Spawning/Breeding

Little information is available from fisheries or survey data regarding the distribution and habitat use during the breeding and spawning processes. The trawl research surveys are conducted in the summer months when the bulk of the spawning activity is expected to be completed. Summer survey data may not be a useful proxy for spawning distributions if rougheye and shortraker rockfish undergo seasonally dependant depth changes associated with spawning activity, as observed for Pacific ocean perch (Gunderson 1971). Rougheye and shortraker rockfish are captured as bycatch in the Pacific ocean perch fishery, which began in July in recent years. Fishery catches of rougheye and shortraker captured during other months are also obtained from bycatch fisheries and, thus, may not be representative of total species distribution and habitat use.

Maturity at age studies have not been completed for the BSAI rougheye and shortraker rockfish, and future collections and analysis would be necessary to determine if changes in maturity at age occur.

There is no evidence that suggests that habitat impacts have affected the ability of BSAI shortraker and rougheye rockfish to conduct the mating and spawning processes, although very little is known regarding these processes. For rockfish in general, the processes of mating and parturition have not been observed to depend critically upon benthic habitat features (Love et al. 2002).

Habitat Impacts Relative to Growth to Maturity

The information available on the habitat preferences on juvenile rockfish is limited to the few references cited above that relied upon submersible research. As mentioned above, these studies indicate that juvenile rockfish use rocky habitats as refuge areas, and Carlson and Straty (1981) noted that juvenile red rockfish, including rougheye rockfish, were captured in rough habitats in relatively shallow water.

Habitat linkages between juvenile rougheye and shortraker rockfish and living and non-living (rocky habitats) habitat types could potentially affect growth and survival. Based upon the LEI analysis, the long-term reduction in either the living or non-living habitat features in the AI deep or shallow habitat types is not expected to exceed 7 percent. As mentioned above, the localized areas of higher impacts for living and non-living substrates have not occurred in locations where the highest survey CPUE levels have been found (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). The expected long-term reduction in hard corals is higher, reaching 8 and 17 percent for the AI deep and shallow areas, respectively, and rougheye and shortraker rockfish have been associated with hard corals at various life stages. The interpretations of the data from the LEI maps in the AI are uncertain because the pattern of impacts may occur at finer spatial scales than presented in this analysis, and the trawl surveys typically do not sample juvenile rockfish very well.

Habitat impacts upon the growth and survival of juvenile rougheye and shortraker rockfish may be revealed by changes in juvenile distribution as a function of fishing intensity. To the extent that the summer trawl surveys sample juvenile rougheye and shortraker rockfish, their distribution does not appear to have changed substantially in recent years, with centers of abundance often located near Amlia Island and the Delarof Islands. Given the rather large sampling variability in rockfish biomass estimates from trawl surveys, any changes in distribution, particularly over small spatial scales, will be difficult to observe.

No direct evidence suggests that the growth to maturity of BSAI rougheye and shortraker rockfish has been affected by habitat disturbance, although the reliance of smaller rougheye and shortraker rockfish upon hard coral (such as *Primnoa*) and the potential for fishing to affect these habitats raise concerns. If, for example, rougheye and shortraker rockfish show spatial heterogeneity related to the timing of parturition, as proposed by Berkeley et al. (2004), then impacts on growth to maturity on smaller spatial scales could affect the BSAI stock. The extent to which habitat impacts occur at smaller scales and the importance of these impacts to the overall BSAI population are unknown.

Habitat Impacts Relative to Feeding

The extent to which bottom trawling may affect the main prey items for shortraker and rougheye rockfish (shrimp, squid, and small fish such as myctophids) is likely to be minimal because these organisms are generally too small to show high selectivities in trawl gear, as indicated by the low LEI values for epifaunal prey in shortraker and rougheye habitat.

Based upon summer survey data, no direct evidence suggests that BSAI shortraker and rougheye populations have changed their feeding distributions, although these species are somewhat patchily distributed, and the sampling variability of NMFS' survey data hinders the ability to infer spatial changes in population distributions.

Kreiger and Ito (1999) hypothesized that shortraker/rougheye rockfish may use boulders to avoid currents and/or capture prey. Kreiger and Wing (2002) also hypothesized that large rockfish associate with *Primnoa* because of the presence of several prey species, including shrimp. However, it is unclear the extent to which diet to rougheye and shortraker rockfish depends upon *Primnoa* or other habitat features.

Although limited information exists on diet, no direct evidence exists to suggest that diet of Pacific ocean perch has changed substantially over time. Yang's diet studies (1993 and 1996) are largely consistent with the results obtained in 2003 (Yang 2003), with differences largely due to sampling variability associated with small sample sizes.

No direct evidence suggests that the feeding of BSAI rougheye and shortraker rockfish has been affected by habitat disturbance, although data is limited in this area.

Stock Status and Trends

Information on rougheye and shortraker population status can be obtained from a non-age-structured population model. Estimates of spawning biomass and recruitment are not available, but total biomass has appeared to be relatively stable since 1991. The total rougheye biomass estimate was 11,000 t in the 1991 AI survey and 15,000 t in the 2004 survey; the corresponding numbers for shortraker rockfish were 23,700 t and 33,300 t. The range of variation in these point estimates are small relative to the sampling variability associated with the AI trawl surveys, indicating that, although the observed trend has been relatively flat, the biomass estimates are observed with considerable uncertainty. Lower levels of biomass were observed in cooperative United States/Japan AI surveys conducted in the 1980s, but these surveys are not directly comparable to the post-1991 United States surveys due to differences in sampling gear, vessels, and sampling design.

Information on stock status does not suggest that the cumulative effects of fishing has impaired the ability of BSAI rougheye and shortraker rockfish to maintain stable population sizes since the early 1990s.

Summary

Issue	**Evaluation**
Spawning/breeding	MT (Minimal, temporary, or no effect)
Growth to maturity	U (Unknown effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of BSAI rougheye and shortraker rockfish are rated as either unknown or minimal and temporary. There is little information to suggest that these habitat reductions would affect spawning/breeding or feeding in a manner that is more than minimal or temporary, although much is unknown about these processes for BSAI shortraker and rougheye rockfish.

Regarding growth to maturity, the available literature indicates that juvenile red rockfish use living (corals) and non-living (rocky areas) habitat features, with one specific use being the ability to find refuge from predators. Although several of these studies did not specifically observe shortraker or rougheye rockfish, it is reasonable to assume that their juvenile habitat use would follow a similar pattern. Trawling would be expected to have negative impacts for these life stages, although the extent to which the BSAI rougheye and shortraker stocks are related to these habitat features is not well known. The expected percent reduction in living and non-living habitat features does not exceed 7 percent in the AI deep and AI shallow habitats, suggesting that fishing impacts on these features are not likely to substantially affect BSAI rougheye and shortraker rockfish. However, larger percent reductions for hard corals are estimated, and studies on habitat associations have indicated that rougheye rockfish are associated with hard corals such as *Primnoa,* possibly due to the concentration of prey items in these habitats or for providing refuge for juveniles (Kreiger and Wing 2002). The extent to which habitat impacts occur at smaller scales and the importance of these impacts to the overall BSAI population are unknown.

B.3.3.18 Shortraker and Rougheye Rockfish (GOA)

Since 1991, shortraker rockfish (*Sebastes borealis*) and rougheye rockfish (*S. aleutianus*) have been managed as a separate group in the GOA within the slope rockfish assemblage. As adults, these two species often co-occur in trawl and longline hauls on the upper continental slope, and they are sometimes difficult to differentiate visually. For these reasons, they have been grouped together into a single management category in the GOA.

Habitat Connections

Except for adults, habitat preferences for shortraker and rougheye rockfish are either unknown or very poorly known (Table B.3-1). Similar to all other species of *Sebastes*, the egg stage is completed inside the female. The larval stage is pelagic, but larval studies are hindered because the larvae at present can only be positively identified by genetic analysis, which is both expensive and labor-intensive. The post-larval and early young-of-the-year stages also appear to be pelagic for both species (Matarese et al.1989; Gharrett et al. 2002). Very few small juvenile shortraker rockfish (less than 35-cm fork length) have ever been caught in the GOA, so the habitat for this life stage is completely unknown. However, it is presumed to be demersal, as there is no documentation of juvenile shortraker in midwater trawls. In contrast, juvenile rougheye rockfish (15- to 40-cm fork length) are frequently caught in GOA bottom trawl surveys. They are generally found at shallower, more inshore areas than adults and have been taken in variety of locations, ranging from inshore fiords to offshore waters of the continental shelf. In the categories in Table B.3-1, they occur in the shallow and deep shelf, but their habitat preference within this environment has not been documented. They certainly are found in reasonably flat, trawlable bottom areas, which suggests they inhabit relatively soft substrates. They may also occur in harder bottom areas that are trawlable. Studies using manned submersibles have found that large numbers of small, juvenile rockfish are frequently associated with rocky habitat on both the shallow and deep shelf of the GOA (Carlson and Straty 1981, Straty 1987, Krieger 1993). Another submersible study on the GOA shelf observed juvenile red rockfish closely associated with sponges that were growing on boulders (Freese and Wing 2004). Although these studies did not specifically identify shortraker or rougheye rockfish, it is reasonable to suspect that juvenile shortraker and rougheye rockfish may be among the species that utilize this habitat as refuge during their juvenile stage. Consequently, Table B.3-1 shows juvenile shortraker/rougheye in the GOA inhabiting soft and hard substrates on the shallow and deep shelf and possibly connected with three habitat features: epifaunal prey, living structure, and non-living structure.

The habitat preference for adults of both species has been fairly well documented. Adults are concentrated in a narrow band along the continental slope, with highest catch rates generally at depths of 300 to 400 m in longline surveys (Zenger and Sigler 1992) and at depths of 300 to 500 m in bottom trawl surveys and in the commercial trawl fishery (Ito 1999). In the GOA, these areas on the slope are known to be generally steep, rocky, and difficult to trawl. Observations from a manned submersible in this habitat indicate the fish prefer steep slopes where they are often associated with boulders (Krieger 1992, Krieger and Ito 1999). Submersible studies have also shown that adults of the two species are sometimes associated with *Primnoa* spp. coral (Krieger and Wing 2002). Therefore, Table B.3-1 shows adult shortraker and rougheye rockfish as occurring on hard substrate on the slope and associated with non-living structure and with corals. In addition, because of this preference for rocky habitat, it is likely that adult shortraker and rougheye rockfish are also associated with other living structure such as sponges that frequently grow on rocks. Hence, Table B.3-1 also shows a connection between adult shortraker/rougheye and living structure on hard substrate of the GOA slope.

Spawning/Breeding

There is no information on reproductive behavior for either species, except that parturition is believed to occur in February through August for shortraker rockfish and in December through April for rougheye rockfish (McDermott 1994). Because of this lack of knowledge, the effects of fishing on spawning/breeding of these fish are unknown.

Feeding

Food habit studies in Alaska indicate that the diet of rougheye rockfish is primarily shrimp (especially pandalids) and that various fish species such as myctophids are also consumed (Yang and Nelson 2000, Yang 2003). However, juvenile rougheye rockfish (less than 30-cm fork length) in the GOA also consume a substantial amount of smaller invertebrates such as amphipods, mysids, and isopods (Yang and Nelson 2000). The diet of shortraker rockfish in the GOA is not well known; however, based on a very small sample size in the Yang and Nelson (2000) study, the diet appears to be mostly squid, shrimp, and deepwater fish such as myctophids. A food study in the AI with a larger sample size of shortraker rockfish also found myctophids, squid, and shrimp to be major prey items (Yang 2003). In addition, gammarid amphipods, mysids, and miscellaneous fish were important food items in some years. Because the prey items for rougheye and shortraker rockfish are generally pelagic or semipelagic in their distribution, and most are also small in size, they are not generally not vulnerable to substantial impacts from bottom fishing gear. Consequently, fishing probably has little or no direct effect on prey availability to shortraker and rougheye rockfish.

Growth to Maturity

As previously discussed, habitat requirements for the various life stages of both species are mostly unknown. Small juvenile shortraker rockfish (less than 35-cm fork length) have almost never been caught on any fishing gear, so it is likely that fishing does not occur and, thus, has no direct effect on whatever habitat they do occupy. Juvenile rougheye rockfish are frequently taken in bottom trawls on the shelf, which indicates that trawling may have an impact on the habitat of these fish. Unidentified juvenile rockfish have been observed on the GOA shelf in association with rocky bottom and sponges (Carlson and Straty 1981, Straty 1987, Krieger 1993, Freese and Wing 2004), and some of these unidentified fish may have been rougheye rockfish. However, the preferred habitat of juvenile rougheye rockfish and whether they associate with certain habitat features are uncertain. In contrast, adults of both species are known to particularly inhabit steep, rocky areas of the continental slope, and they have been observed in association with boulders and corals (Krieger 1992, Krieger and Ito 1999, Krieger and Wing 2002). Bottom trawling is known to displace boulders and damage corals, and it could have a negative impact on growth and survival of these fish. However, to really evaluate this possible problem, additional research is needed to determine how essential these associations are to the health of the stocks and how much damage is actually occurring due to fishing gear. Taking into consideration all these factors, effects of fishing on growth to maturity for shortraker and rougheye rockfish are unknown.

Evaluation of Effects

LEI Values Relative to Species Distribution

The habitat information that is available for shortraker and rougheye rockfish in the GOA indicates that juveniles may be associated with epifauna prey, living structure, and non-living structure, whereas adults are associated with living structure, non-living structure, and hard corals (Table B.3-1). The LEI data in Table B.3-3 for GOA shortraker and rougheye rockfish show that for the habitat areas where the most of the fish live (GOA deep shelf and GOA slope), there is an especially large potential reduction in hard corals of 17 to 37 percent. This is of particular concern because, as previously noted, submersible observations have found shortraker and rougheye rockfish in association with coral. These observations, however, were limited to just a few sites, so the extent of this association is uncertain. The only other habitat feature in Table B.3-3 to show a potential concern for GOA shortraker and rougheye rockfish is living substrate. However, the possible reduction in living structure for shortraker and rougheye rockfish in the GOA is only 5 to 7 percent, so this habitat feature appears to be much less of a problem than hard corals. Epifauna prey and non-living structure, which were identified in Table B.3-1 as possibly having a connection with GOA shortraker and rougheye rockfish, had extremely low LEI values (1 to 2 percent).

Spatial overlap exists between areas in the GOA with high LEIs for hard corals (Figure B.2-6b) and localities with high catches of shortraker and rougheye rockfish in the commercial fishery (Fritz et al. 1998). For example, many blocks on the slope to the east and northeast of Kodiak Island show high coral LEIs of more than 75 percent in Figure B.2-6b, and most of these blocks correspond to areas with relatively high catch-per-unit-effort for shortraker and rougheye rockfish based on the trawl observer data in the Fritz et al. report. This geographic relationship between areas of high coral LEIs and areas of shortraker and rougheye rockfish abundance suggests that some negative impact upon these two species could occur if coral is present in these locations.

Habitat Impacts Relative to Spawning/Breeding
As discussed previously, there is virtually no information on spawning activities or spawning distributions for shortraker or rougheye rockfish. Shortraker rockfish have not been successfully aged, so information on age at maturity for this species is unknown. Estimates of age at maturity for rougheye rockfish are tenuous at best, as they have been indirectly computed from length at maturity data. Therefore, possible habitat impacts upon spawning and age at maturity of shortraker and rougheye rockfish are unknown.

Habitat Impacts Relative to Growth to Maturity
Information on habitat for juvenile shortraker and rougheye rockfish is very limited, except for the fact that juvenile rougheye are commonly caught in bottom trawls on the shelf. This indicates that at least a portion of the juvenile rougheye population is associated with relatively smooth, trawlable bottom. Studies are needed about the possible effects of trawling on habitat of these fish and on whether trawling degrades this habitat. In contrast to juvenile shortraker and rougheye rockfish, there is strong evidence that adults of these two species are primarily associated with rocky habitats on the slope (see "Habitat Connections" in this section), where the fish have also been observed in association with coral. There is no direct evidence to indicate that habitat disturbances due to fishing activities have affected growth to maturity of shortraker and rougheye rockfish. However, because adult shortraker and rougheye rockfish apparently utilize coral as shelter on some occasions, it is likely that bottom trawling damages this shelter and, therefore, could have an adverse effect on survival of these fish.

Growth analyses that compare fish length, weight, and age in low versus high intensity fishing areas of the GOA are one tool that could be used to evaluate possible effects of habitat perturbations caused by fishing. Unfortunately, such analyses are not possible at present for GOA shortraker and rougheye rockfish because of small sample sizes for each species in the fishing areas and the lack of age data for the fish.

Habitat Impacts Relative to Feeding
Pandalid shrimp, myctophids, and squid generally appear to be the major food items for adult shortraker and rougheye rockfish in Alaska (see summary of food habits in "Habitat Connections" in this section). As all these foods tend to be semipelagic in their distribution, bottom trawling probably has little effect on their abundance. The items are also small enough that relatively few are retained in pelagic trawls, which suggests that this latter gear type also has little effect on the availability of food to shortraker and rougheye rockfish. In common with most fish species, smaller shortraker and rougheye rockfish tend to eat smaller prey items, such as smaller-sized shrimp or mysids and amphipods, which are retained in trawls even less frequently than the larger food items. Sample sizes were quite small in the two diet studies that have been conducted for shortraker and rougheye rockfish in Alaska, which means comparisons of food habits in low versus high intensity fishing areas are not possible. Moreover, there is no available information on whether distribution and abundance of the major prey items have changed over time in response to fishing effort. In summary, there is no evidence that fishing activities have affected feeding success for shortraker and rougheye rockfish.

Stock Status and Trends

There is relatively little information available to determine the stock status and trends in abundance of shortraker and rougheye rockfish in the GOA. Because of this lack of information, past assessments of stock condition for both species have been based on biomass estimates from bottom trawl surveys of the GOA rather than modeling (Clausen et al. 2003). The assessments have been particularly hindered by an absence of age data. Shortraker rockfish have not yet been successfully aged, and age data have only recently become available for a limited sample of rougheye rockfish. A preliminary age-structured model has been developed for rougheye rockfish, but additional age data are needed before this model is actually used for assessments.

The biomass estimates are based on results of eight bottom trawl surveys conducted in the GOA between 1984 and 2003. The estimates for rougheye rockfish have been relatively constant over the years, and none of changes has been statistically significant. Biomass of shortraker rockfish has shown an increasing trend since 1990, and the estimate for 2003 was statistically more than that for 1990. Size composition data indicate there has been at least moderate recruitment of rougheye rockfish in the last five surveys, and that increased recruitment appears to be the cause of most of the biomass increase seen for shortraker rockfish in the recent surveys.

Although information on stock status is limited, the information that is available suggests that habitat effects due to fishing have not caused a decline in stock condition for either shortraker or rougheye rockfish. The biomass estimates for both species have been stable or increasing for the last 13 years, and recruitment has also been steady or increasing during this period. Therefore, it is unlikely that habitat impacts are affecting either species' ability to maintain MSY.

Summary

Issue	Evaluation
Spawning/Breeding	U (unknown effect)
Growth to Maturity	U (unknown effect)
Feeding	MT (minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of shortraker and rougheye rockfish in the GOA are either unknown or minimal. There is not enough information available to determine whether the habitat impacts of fishing affect spawning or growth to maturity of these fish. Virtually nothing is known about the spawning behavior of these fish, and information on the juvenile life history of shortraker rockfish is nil. However, adults of both species inhabit areas subject to bottom trawling, as do juveniles of rougheye rockfish, so fishing may be affecting the habitat of these fish. Of particular concern is the observed association of adult shortraker and rougheye rockfish with corals such as *Primnoa* spp. on rocky substrate of the slope. This coral is known to be easily damaged by bottom trawls, and it also may take years to recover from such damage. The fragile nature of corals and their long recovery time are reflected in the high values of LEI estimated for corals in this document. If corals are important to the long-term survival of adult shortraker and rougheye rockfish, damage to corals by fishing gear may have a negative impact on these fish. The habitat requirements of juvenile rougheye rockfish on the shelf are unknown. However, several studies have observed unidentified small juvenile rockfish on the shelf associated with rocks or sponges. If juvenile rougheye rockfish utilize this habitat, they could be adversely affected by trawling. Effects of fishing on the feeding of shortraker and rougheye rockfish appears to be negligible, as the major food items of these fish are relatively small and semipelagic; therefore, these items are generally not retained in large amounts by fishing gear.

B.3.3.19 Northern Rockfish (BSAI)

Northern rockfish (*Sebastes polyspinus*) are distributed from northern British Columbia north to the GOA and the EBS and west to the AI and the Kamchatka Peninsula (Love et al. 2002). Northern rockfish are poorly studied species, and little is known about their life history.

Habitat Connections

Very little is known about the spawning and breeding behavior of northern rockfish. Reproduction is viviparous, which is marked by three critical points in the reproduction process: mating (the transferring of spermatozoa from males to females), fertilization of ova, and parturition (the release of larvae). Specimen samples from the GOA indicate that parturition in this area occurs in the spring.

The larval and early juvenile stages of northern rockfish are pelagic, but little is known of the duration of this stage or the extent to which pelagic juveniles are distributed by ocean currents. One source of difficulty is identifying larval rockfish to species. Northern rockfish are plankton feeders, with juveniles eating calanoid copepods and adults eating largely euphausiids (Yang 2003). Brodeur (2001) proposed that euphausiids are advected to upstream areas of canyons, thus providing concentrations of prey.

Information on the habitat use of juvenile rockfish is available primarily from a limited number of submersible studies. Carlson and Straty (1981) found juvenile nursery grounds off Southeast Alaska to occur at depths from 90 to 100 m over rough bottom (pinnacles, boulder fields interspersed with gravel, and invertebrate shells); although this study was focused upon Pacific ocean perch, juvenile rockfish of other species were observed to follow similar patterns. Other studies using submersibles have indicated that several species of rockfish appear to use rocky, shallower habitats during their juvenile stage (Straty 1987, Kreiger 1993). Straty (1987) noted that juvenile red rockfish were associated with stands of large white anemones, and that juvenile rockfish took refuge in rocky areas when alarmed by the movement of the submersible. The extent to which juvenile rockfish showed a habitat preference for anemones over other types of habitat is unclear. Although these studies did not specifically observe northern rockfish, it is reasonable to suspect that juvenile northern rockfish also use these shallower habitats as refuge areas. Additionally, length frequency distributions from AI summer trawl survey indicate that small northern rockfish (less than 20 cm) are found primarily in shallow water (less than 100 m) whereas larger northern rockfish are primarily found between 100 and 200 m. Survey tows with the highest levels of northern rockfish catch appear to be located in relatively rough habitat (Clausen and Heifetz 2002), and information from submersible studies indicates that northern rockfish also occur in relatively smooth habitats of mixed sand/gravel as well. Based upon the existing studies cited above, juvenile northern rockfish are expected to occur in small amounts along the BS slope (200 to 1,000 m), in shallow water (less than 200 m) in the AI, and in soft (sand to gravel) to hard (pebble to rock) habitat types. Adult northern rockfish are expected to occur in small amounts along the BS slope (200 to 1,000 m), in primarily shallow water (less than 200 m) in the AI, and in both soft (sand to gravel) to hard (pebble to rock) habitat types.

Evaluation of Effects

LEI Values Relative to Species Distribution
The general distribution (95 percent distribution) of the adult northern rockfish population within BSAI waters occurs primarily within the AI deep and the AI shallow habitat types, contributing 19 and 27 percent of the total Alaska northern rockfish distribution, respectively (Table 3-3). The potential reduction in living structure and non-living structure in the AI deep habitat (200 to 1,000 m) were projected to be 6 and 4 percent, respectively (Table B.3-3). In the AI shallow areas, the potential

reduction in living structure and non-living structure is projected to be 8 and 5 percent, respectively. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other. Close examination of these percentages shows that localized areas of higher impacts do occur in areas such as south of Adak Island, Seguam Pass, and northeast of Atka Island. These areas have not contributed a high portion of the AI biomass in recent surveys, with the highest survey CPUEs being observed in the Tahoma Bank and Stalemate Bank areas (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). However, the LEI maps are difficult to interpret because the pattern of impacts may occur at finer spatial scales than presented in this analysis, and the extent to which these localized impacts may affect the entire population is unclear. The projected impacts on hard corals in the AI deep and AI shallow habitat areas were 16 and 19 percent, respectively. However, northern rockfish have not been found to be associated with hard corals. For example, Kreiger and Wing (2002) conducted submersible dives in the GOA at depths from 161 to 365 m and did not find that northern rockfish were associated with *Primnoa*, a deepwater gorgonian coral.

Habitat Impacts Relative to Spawning/Breeding

Little information is available from fisheries or survey data regarding the distribution and habitat use during the breeding and spawning processes. The trawl research surveys are conducted in the summer months when the bulk of the spawning activity is expected to be completed. Summer survey data may not be a useful proxy for spawning distributions if northern rockfish undergo seasonally dependant depth changes associated with spawning activity, as observed for Pacific ocean perch (Gunderson 1971). Northern rockfish are captured as bycatch in the AI Atka mackerel fishery and fishery catches of northern rockfish, thus, may not be representative of total species distribution and habitat use.

Maturity at age studies have not been completed for the BSAI northern rockfish, so it is not possible to state whether changes in maturity at age can be related to habitat impacts. Field specimens collected in 2004 will provide the basis for initial studies on the maturity of BSAI northern rockfish.

There is no evidence that suggests that habitat impacts have affected the ability of BSAI northern rockfish to conduct the mating and spawning processes, although very little is known regarding these processes. While there is little information on the process that northern rockfish use to select sites for spawning and parturition, the estimated recruitment (Figure B.3.3.19-1) from age-structured stock assessment models indicates that breeding and spawning have successfully occurred in recent years. For rockfish in general, the processes of mating and parturition have not been observed to depend critically upon benthic habitat features (Love et al. 2002).

Habitat Impacts Relative to Growth to Maturity

The information available on the habitat preferences on juvenile rockfish are limited to the few references cited above that relied upon submersible research. As mentioned above, these studies indicate that juvenile rockfish use rocky habitats as refuge areas, and Carlson and Straty (1981) noted that juvenile red rockfish were captured in rough habitats in relatively shallow water. Although these studies did not specifically observe northern rockfish, it is reasonable to assume that juvenile northern rockfish use similar habitats as other juvenile red rockfish.

Habitat linkages between juvenile northern rockfish and non-living habitat features (rocky habitats) were detected; therefore, fishing impacts on non-living habitats were evaluated with respect to their potential impact on northern rockfish growth and survival. Based upon the LEI analysis, the long-term reduction in either the living or non-living habitat features in the AI deep or shallow habitat types is not expected to exceed 8 percent. As mentioned above, the localized areas of higher impacts for living and non-living substrates have not occurred in locations where the highest survey CPUE levels have been found (http://www.afsc.noaa.gov/refm/stocks/EISEFH/maps.htm). The expected long-term reduction in hard corals is higher, reaching 16 and 19 percent for the AI deep and shallow areas, respectively. However, Kreiger and Wing (2002) did not find juvenile northern rockfish to be associated with *Primnoa* in submersible work off of southeast Alaska. The uncertainty in the data should also be noted, as the trawl surveys typically do not sample juvenile rockfish very well. The high variability in survey data prevents measurement of the contribution of impacts of small scale habitat disturbance on the growth and survival of northern rockfish at the population scale.

Habitat impacts upon the growth and survival of juvenile northern rockfish may be revealed by changes in juvenile distribution as a function of fishing intensity. However, the distribution of small AI northern rockfish does not appear to have changed substantially in recent surveys, with centers of abundance consistently located in the Tahoma Bank and Stalemate Bank areas. Given the rather large sampling variability in NMFS' rockfish biomass estimates from trawl surveys, any changes in distribution, particularly over small spatial scales, will be difficult to observe.

Habitat impacts may also be revealed by reduced weight at length in highly fished areas relative to low fished areas. A statistical analysis could potentially compare the relative weight at length between high and low fished areas. For AI northern rockfish, however, only 11 survey specimens occurred in the high fished area (all in 1997), so this analysis was not pursued further.

No direct evidence suggests that the growth to maturity of BSAI northern rockfish has been affected by habitat disturbance, although the reliance upon smaller northern rockfish upon rough habitat (such as *Primnoa*) and the potential for fishing to affect these habitats raise concerns. If, for example, northern rockfish show spatial heterogeneity related to the timing of parturition as a bet-hedging mechanism, as proposed by Berkeley et al. (2004), then impacts on growth to maturity on smaller spatial scales could affect the BSAI stock. The spatial boundaries of stock structure of BSAI northern rockfish, the extent to which habitat impacts occur at smaller scales, and the importance of these impacts to the overall BSAI population are unknown.

Habitat Impacts Relative to Feeding

The major prey items for northern rockfish are calanoid copepods (as juveniles) and euphausiids (as adults) (Yang 2003). Because both of these prey items reside in pelagic habitats and are not associated with benthic environments, there is no reason to suspect a link between benthic habitat disturbance and prey availability or feeding success.

Information from recent AI surveys does not suggest major changes in the distribution of northern rockfish. Because the prey of northern rockfish occur within pelagic habitats, any changes occurring in the distribution of prey are more likely due to changes in oceanographic conditions than benthic habitat impacts. For example, Brodeur (2001) proposed that euphausiid populations within Pribilof Canyon resulted from advection areas off the continental slope.

Although limited information exists on diet, no direct evidence exists to suggest that diet of northern rockfish has changed substantially over time. The diet study of Yang (2003) for AI northern rockfish from the 1994 and 1997 AI surveys is consistent with the results of Yang (1996) for the 1991 AI survey.

Stock Status and Trends

Estimates of spawning biomass from population assessment models indicate that BSAI northern rockfish spawning biomass has increased from low levels in the 1980s and has been relatively stable since the early 1990s, although observed with substantial observation error. The spawning stock biomass, as estimated in the 2004 stock assessment (Spencer et al. 2004) was approximately 45,000 in

1980, increased to 59,600 t in 1991, and increased gradually to the 2004 estimate of 66,900 t (Figure B.3.3.19-1). These changes in spawning biomass are consistent with several year classes of high recruitments in the 1980s, as the 1984, 1988, and 1989 year classes were all above average. Information on stock status does not suggest that the cumulative effects of fishing have impaired the ability of BSAI northern rockfish to produce MSY.

Trends in recruitment success also do not correspond with the temporal patterns in fishing effort (Figure B.3.3.19-2), which has been generally stable in the AI shallow habitat over the last 20 years. The lack of relationship between recruitment (Figure B.3.3.19-1) and fishing effort (Figure B.3.3.19-2) suggest that potential impacts from local regions of heavy fishing on future recruitment do not manifest themselves at the population scale.

Summary

Issue	**Evaluation**
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Growth to Maturity	U (Unknown)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of BSAI northern rockfish are rated as either unknown or minimal and temporary. The percent reduction in living and non-living substrates in the areas most commonly inhabited by BSAI northern rockfish (the AI deep and AI shallow habitats) do not exceed 8 percent. Although larger percent reductions for hard corals are estimated, studies on habitat associations have not associated northern rockfish with hard coral (Kreiger and Wing 2002). The diet of northern rockfish, copepods, and euphausiids is not associated with benthic habitats and would not be expected to be impacted by fishing gear. There is little information to suggest that these habitat reductions would affect spawning/breeding or feeding in a manner that is more than minimal or temporary, although much is unknown for these processes for BSAI northern rockfish.

Regarding growth to maturity, the available literature does indicate that juvenile red rockfish do use living (anemones) and non-living (rocky areas) habitat features, with one specific use being the ability to find refuge from predators. In particular, northern rockfish are associated with rough and rocky habitats (Clausen and Heifetz 2002). Trawling would be expected to have negative impacts for these life stages, although the extent to which the BSAI northern rockfish stock is related to these habitat features is not well known. The LEI percentages of habitat reduction should be interpreted as rough guidelines that are estimated with some error and relate to the entire BSAI stock. Examination of LEI maps indicates that finer scale impacts do occur, and the extent to which these finer scale impacts may be important for northern rockfish is dependent upon the spatial scale of their population structure, which is currently unknown. Similarly, although the current population level data do not indicate declining trends in spawning biomass or recruitment, it is not clear what effects may have occurred at finer spatial scales.

B.3.3.20 Northern Rockfish (GOA)

Habitat Connections

Northern rockfish (*Sebastes polyspinis*) in the northeast Pacific Ocean range from the EBS, throughout the AI and the GOA, to northernmost British Columbia (Allen and Smith 1988, Love et al. 2002, Mecklenburg et al. 2002). Little is known about the biology and life history of northern rockfish (Clausen and Heifetz 2003, Courtney et al. 2003).

There is anecdotal evidence that may link living and non-living structure with early juvenile (less than 20 cm) northern rockfish. Studies in the eastern GOA and Southeast Alaska using trawls and submersibles have indicated that several species of juvenile (less than 20 cm) red rockfish (*Sebastes* spp.) associate with benthic nearshore living and non-living structure and appear to use the structure as a refuge (Carlson and Haight 1976, Carlson and Straty 1981, Straty 1987, and Kreiger 1993). Freese and Wing (2004) also identified juvenile (5 to 10 cm) red rockfish (*Sebastes* sp.) associated with sponges (primarily *Aphrocallistes* sp.) attached to boulders 50 km offshore in the GOA at 148 m depth over a substrate that was primarily a sand and silt mixture. Only boulders with sponges harbored juvenile rockfish, and the juvenile red rockfish appeared to be using the sponges as shelter (Freese and Wing 2004). However, none of these studies specifically identified northern rockfish.

There is also anecdotal evidence that may link non-living structure with northern rockfish during the adult stage. Length frequencies of northern rockfish captured in NMFS bottom trawl surveys and observed in commercial fishery bottom trawl catches indicate that older juveniles (more than 20 cm) are found on the continental shelf, generally at locations inshore of the adult habitat. Trawl surveys and commercial fishing data indicate that the preferred habitat of adult northern rockfish in the GOA is relatively shallow rises or banks on the outer continental shelf at depths of approximately 75 to 150 m (Clausen and Heifetz 2003). The highest concentrations of northern rockfish from NMFS trawl survey catches appear to be associated with relatively rough (variously defined as hard, steep, rocky, or uneven) bottom on these banks (Clausen and Heifetz 2003). Heifetz (2002) identified rockfish (including *Sebastes* spp.) as among the most common commercial fish captured with gorgonian corals (primarily *Callogorgia, Primnoa, Paragorgia, Fanellia, Thouarella*, and *Arththrogorgia*) in NMFS trawl surveys of GOA and Aleutian waters. Krieger and Wing (2002) identified six rockfish species (*Sebastes* spp.) associated with gorgonian coral (*Primnoa* spp) from a manned submersible in the eastern GOA. However, neither Heifetz (2002) nor Krieger and Wing (2002) specifically identified northern rockfish in their studies, and more research is required to determine if northern rockfish are associated with living structure, including corals, in the GOA and the nature of those associations if they exist.

Based upon the existing studies cited above, juvenile northern rockfish are expected to occur with living and non-living structure along the shallow (0 to 100 m) and deeper shelf (100 to 300 m) habitat types over soft (sand and gravel) and hard (pebble to rock) substrates (Table B.3-1). Adult northern rockfish are expected to occur with non-living structure along the shallow (0 to 100 m), and deeper shelf (100 to 300 m) habitat types over soft (sand and gravel) and hard (pebble to rock) substrates (Table B.3-1).

Spawning/Breeding
There is no evidence (e.g., publications, field studies, etc.) that links habitat features with the accomplishment of the spawning/breeding process of northern rockfish. Like other members of the genus *Sebastes*, northern rockfish bear live young, and birth is believed to occur in the early spring (Clausen and Heifetz 2003). There is little information available on spawning/breeding biology and no information available on spawning/breeding habitat requirements.

Feeding
There is no evidence that links habitat features with northern rockfish accomplishing the feeding process. Northern rockfish are generally planktivorous. They eat mainly euphausiids, and calanoid copepods by weight in both the GOA and the AI (Yang 1993, 1996, 2003). There is no indication of a shift in diet over time or a difference in diet between the GOA and AI (Yang 1996, 2003). In the AI, calanoid copepods were the most important food of smaller-size northern rockfish, while euphausiids were the main food of larger sized fish (more than 25 cm) (Yang 1996). The largest size group also consumed myctophids and squids (Yang 2003). Arrow worms, hermit crabs, and shrimp have also been noted as

prey items in much smaller quantities (Yang 1993, 1996). Large offshore euphausiids are not directly associated with the bottom, but rather are thought to be advected onshore near the bottom at the upstream ends of underwater canyons where they become easy prey for planktivorous fishes (Brodeur 2001). Predators of northern rockfish are not well documented, but likely include larger fish such as Pacific halibut that are known to prey on other rockfish species.

Growth to Maturity
There is anecdotal evidence that links living and non-living structure with northern rockfish accomplishing the growth to maturity process, but no scientific studies have been conducted that specifically identify northern rockfish associations with living or non-living structures or the nature of those associations if they exist.

Evaluation of Effects

LEI Values Relative to Species Distribution
The habitat information that is available for northern rockfish indicates they may be associated with living and non-living structure in the shallow shelf (0 to 100 m) and deep shelf (100 to 300 m) habitats. The LEI predicts the potential percent reduction in living and non-living structure associated with northern rockfish EFH along the GOA shallow and deep shelves to range between 1 and 10 percent. The LEI predicts the potential percent reduction of hard corals in northern rockfish EFH in the GOA shallow and deep shelf regions to range between 22 and 42 percent. If northern rockfish are associated with hard corals, and if hard corals exist in northern rockfish EFH, then a 42 percent reduction in hard corals could be a cause for concern. However, further research is needed to determine if northern rockfish are associated with hard corals and the nature of the association if one exists.

Habitat Impacts Relative to Spawning/Breeding
There is no evidence (e.g., publications, field studies, etc.) that links habitat features with northern rockfish accomplishing the spawning/breeding process.

There are insufficient data to analyze changes in the spawning/breeding distribution of northern rockfish over time. Like other members of the genus *Sebastes*, northern rockfish bear live young, and parturition is believed to occur in the early spring (Clausen and Heifetz 2003). Because there are no NMFS GOA trawl surveys in the winter or early spring and no directed fisheries for northern rockfish in the winter or early spring, there is very little information available on northern rockfish reproductive behavior, habitat requirements, or distribution.

An analysis of northern rockfish trawl survey CPUE (used here as a proxy for spawning/breeding distribution) did not reveal any trends in the distribution of trawl survey CPUE over time. GOA northern rockfish are patchily distributed in the GOA and are not sampled effectively by NMFS (Courtney et al. 2003). Consequently, analysis of trawl survey CPUE in relation to commercial fishing intensity either in 5-by-5-km grids or smoothed into high, low, and no trawl zones also did not reveal any shifts in the distribution of trawl survey CPUE over time.

There are insufficient data to analyze changes in maturity at age. Age at 50 percent maturity (13 years) and size at 50 percent maturity (36.1-cm fork length) for northern rockfish in the GOA were estimated from a single sample of 77 females in the central GOA (Courtney et al. 2003).

Habitat Impacts Relative to Feeding
There is no evidence that links habitat features with northern rockfish accomplishing the feeding process.

Northern rockfish are generally planktivorous (eating mainly euphausiids and calanoid copepods by weight in both the GOA and the AI) (Yang 1993, 1996, 2003). There is no indication of a shift in diet over time or a difference in diet between the GOA and AI (Yang 1996, 2003). In the AI, calanoid copepods were the most important food of smaller-size northern rockfish, while euphausiids were the main food of larger sized fish (more than 25 cm) (Yang 1996). The largest size group also consumed myctophids and squids (Yang 2003). Arrow worms, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities (Yang 1993, 1996). Large offshore euphausiids are not directly associated with the bottom, but rather are thought to be advected onshore near the bottom at the upstream ends of underwater canyons where they become easy prey for planktivorous fishes (Brodeur 2001). Predators of northern rockfish are not well documented, but they likely include larger fish such as Pacific halibut that are known to prey on other rockfish species.

Habitat Impacts Relative to Growth to Maturity

Analysis of trawling effort (total number of trawl hauls, 1998 to 2002, 5-by-5-km blocks) in relation to northern rockfish catch showed that there is currently (1998 to 2002) little overlap between areas with high-intensity (more than 50 percent of the area swept per year) bottom trawling and adult northern rockfish habitat. This indicates that most bottom trawling is directed at catching other species. There is one high-intensity trawling effort area on Portlock Bank that is associated with high northern rockfish catches in the NMFS bottom trawl surveys.

A retrospective analysis of GOA rockfish targeted bottom trawling effort by year (1981 to 2002, similar to Conners et al. in press) showed that in the past (1981 to 1997) there may have been more trawling effort in areas that are not currently (1998 to 2002) trawled intensively or trawled at all. Some of these areas trawled more intensively in the past appeared to be on shallow (less than 100 m) offshore banks where older juvenile (more than 20 cm) northern rockfish occur. The effect of this past trawling on juvenile northern rockfish accomplishing the growth to maturity process is unknown.

Growth analyses of weight at length of northern rockfish caught in low (less than 50 percent of the area swept per year 1998 to 2002) trawl intensity areas versus high (more than 50 percent of the area swept) trawl intensity areas have been computed, but are inconclusive because of high variance associated with low sample size (123 individuals) in high trawl intensity areas. Growth analyses of length at age and weight at age were not conducted because of insufficient sample size (58 individuals) in high trawl intensity areas.

In a different approach, the average residuals at each length between weight and average weight for that length were compared at each length over survey years that had data in high and low fishing effort. Based on ANOVA with unequal sample size design, this approach yielded significant effects for fishing intensity during 1999 and 2001, but not 1987. In 1999 and 2001, the residuals were negative for high fishing effort and positive for low fishing effort, indicating that fish were smaller than average for a given length in high trawl intensity areas.

The results of the second analysis appear to indicate that fish in high-intensity areas are smaller than average for a given length. These results are based on fairly small samples in the high-intensity areas (123 individuals) and could also be caused by a number of confounding factors independent of habitat. Possible explanations are as follows: (1) the fishery in the high-intensity effort areas is removing the fastest growing component of the population and/or (2) the high-intensity effort areas are likely areas with the highest density of fish with intraspecific competition for food resources, resulting in slower growth.

There is no direct evidence that habitat disturbance affects the growth to maturity of northern rockfish. The growth analysis showed some significant differences in growth between high- and low-intensity trawl areas, but this is more likely a direct result of fishing or of intraspecific competition than of habitat degradation.

Stock Status and Trends
Stock status for the northern rockfish is assessed with an age-structured model. The model incorporates commercial catch, survey biomass, age data from the fishery and trawl survey, and length data from the fishery (Courtney et al. 2003).

Model estimates of spawning biomass increased during 1976 to 1991 as a result of two stronger than average year classes (1976 and 1984) and have slowly declined during 1991 to 2003 as a result of relatively low recruitment since 1984 (Courtney et al. 2003). There is evidence for a stronger than average recruitment in 1994, but this year class was not yet fully recruited during the last available survey year (2001). Recruitment varies greatly between years, which is typical of rockfish in the GOA. Most researchers agree that a climatic regime shift occurred around 1977 that reorganized the biotic community in Alaska waters (Francis et al. 1998), so recruitment estimates are generally compared after 1977. GOA northern rockfish spawning biomass has been above B_{MSY} ($B_{35\%}$) for all years modeled (1977 to 2003) and is not projected to fall below B_{MSY} under average recruitment (1977 to 1995) (Courtney et al. 2003).

Berkeley et al. (2004) suggest that maintenance of age structure and spatial distribution of recruitment are essential for long-term sustainability of exploited rockfish populations. Average age of northern rockfish from NMFS' trawl surveys in the GOA has increased from 13 (1984) to 18 (2001) (Courtney et al. 2003). While this is a result of two stronger than average year classes (1976 and 1984) moving through the population, it also indicates that, at least on a Gulf-wide scale, recent fishing effort (1984 to 2001) has not caused dramatic age truncation in northern rockfish. The commercial catch of northern rockfish is currently (1990 to 1998) concentrated on several geographically isolated relatively shallow (90 to 140 m) offshore banks (Clausen and Heifetz 2003). The concentrated nature of the northern rockfish fishery raises concern over localized depletion. However, there are insufficient survey age or length data from these offshore banks to conduct an analysis for localized depletion at this time.

Summary

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Although northern rockfish may eat some epifaunal prey, such as crabs and shrimp, the largest component of their diet is euphausiids; thus, the percent reductions in epifaunal prey would not be expected to have a significant impact on their feeding. There is no evidence that links habitat features with northern rockfish accomplishing the spawning/breeding process. Consequently, a reduction in living and non-living structure would not be expected to have an effect on spawning/ breeding of GOA northern rockfish. A reduction in living and non-living structure may reasonably jeopardize growth to maturity due to a reduction of refuge habitat for juvenile GOA northern rockfish. However, no scientific studies have been conducted that specifically identify northern rockfish associations with living or non-living structures or the nature of those associations if they exist. Consequently, the effect of a reduction in living or non-living structures on northern rockfish accomplishing the growth to maturity process is unknown. Current stock status trends show no indications of fishing impacting the ability of the stock to maintain MSY, and there is no evidence to suggest that the potential reductions in living and non-living structure on growth and survival to maturity affects the ability of GOA northern rockfish to fulfill its role in a healthy ecosystem.

B.3.3.21 Pelagic Shelf Rockfish (GOA)

The pelagic shelf rockfish management group in the GOA comprises four species: dusky rockfish (*Sebastes variabilis*), dark rockfish (*S. ciliatus*), yellowtail rockfish (*S. flavidus*), and widow rockfish (*S. entomelas*). The forms of dusky rockfish commonly named light dusky rockfish and dark dusky rockfish are now officially recognized as two species (Orr and Blackburn 2004). *Sebastes ciliatus* applies to the dark shallow-water species with a common name dark rockfish, and *S. variabilis* applies to variably colored deeper-water species with a common name dusky rockfish.

Dusky rockfish is much more abundant in Alaska than the other three species, and it supports a valuable trawl fishery in the GOA. Because of the abundance and commercial importance of dusky rockfish in the GOA, this section will focus exclusively on the EFH for this species. They are, by far, the dominant species in this group, both in terms of biomass and harvest. Their habitat requirements are not expected to be so different from other species in this group as to require separate analysis.

Habitat Connections

Habitat preferences for the life stages of dusky rockfish are either unknown or very poorly known (Table B.3-1). Similar to all other species of *Sebastes*, the egg stage is completed inside the female. The larval stage is pelagic, but larval studies are hindered because the larvae at present can only be positively identified by genetic analysis, which is both expensive and labor-intensive. Post-larval dusky rockfish have not been identified; however, the post-larval stage for other *Sebastes* is pelagic, so it is also likely to be pelagic for dusky rockfish. The habitat of young juveniles is completely unknown. At some point they are assumed to migrate to the bottom and take up a demersal existence, but virtually no juveniles (less than 25-cm fork length) have been caught in bottom trawl surveys (Clausen et al. 2002) or with other sampling gear. Older juveniles have been taken only infrequently in the trawl surveys, but when caught are often found at more inshore and shallower locations that adults. For this reason, they are noted in Table B.3-1 as occurring on both the shallow and deep shelf, whereas adults are listed for only the deep shelf.

Adult dusky rockfish are concentrated on offshore banks and near gullies on the outer continental shelf at depths of 100 to 200 m (Reuter 1999); therefore, they are assigned to the deeper shelf area in Table B.3-1. Anecdotal evidence from fishermen and from biologists on the trawl surveys suggests that dusky rockfish are often caught in association with a hard, rocky bottom on these banks or gullies. Also, during submersible dives on the outer shelf of the eastern GOA, dusky rockfish were observed in association with rocky habitats and in areas with extensive sponge beds where adults were seen resting in large vase sponges. Another study using a submersible in the eastern GOA observed small dusky rockfish associated with *Primnoa* spp. corals (Krieger and Wing 2002). A different submersible dive in the GOA observed 82 juvenile red rockfish closely associated with boulders that had attached sponges. No rockfish were observed near boulders without sponges (Freese and Wing 2004). Hence, Table B.3-1 shows both adults and older juveniles associated with living and non-living structure and older juveniles associated with corals.

Spawning/Breeding
There is no information on reproductive behavior for dusky rockfish, except that parturition is believed to occur in the spring, based on observations of ripe females sampled on a research cruise in April 2001 in

the central GOA. Because of this lack of knowledge, the effects of fishing on the habitat required for reproduction of dusky rockfish are unknown.

Feeding
The major prey of adult dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). As euphausiids are pelagic rather than benthic in their distribution and are too small to be retained by any fishing gear, fishing probably has a minimal or temporary effect on the availability of prey to adult dusky rockfish.

Growth to Maturity
As was previously discussed, habitat requirements for the various life stages of dusky rockfish are mostly unknown. Younger juveniles (less than 25-cm fork length) are almost never caught on any fishing gear, so it is likely that fishing does not occur (and thus has no direct effect) on whatever habitat they do occupy. However, older juveniles and adults have been observed in association with corals and sponges (Krieger and Wing 2002), and both life stages may prefer the rocky substrate inhabited by such epifauna. Although the importance of these associations is uncertain, bottom trawling is known to damage such living substrates and could have a negative impact on stocks of this species. Taking into consideration all these factors, a rating of unknown is given to the growth to maturity for dusky rockfish.

Evaluation of Effects

LEI Values Relative to Species Distribution
The habitat information that is available for dusky rockfish indicates they are associated with living structure, non-living structure, and hard corals (Table B.3-1). Dusky rockfish are present in the slope and shallows, but they are predominant in deep shelf habitat (Table B.3-3). The LEI indicates there may have been a 5 to 50 percent reduction in living structure features of habitat in areas where dusky rockfish are found (Figure B.2-3B, Table B.3-3). LEI maps in the GOA are difficult to interpret, however, because of the irregularity and patchiness in the distribution of habitat features. This is especially true for living substrate features such as sponges and soft corals that may be patchily distributed and occur on a finer scale than presented in this analysis. The reduction in non-living structure is likely quite low (less than 5 percent) because dusky rockfish appear to be associated with hard substrate such as rocks and boulders, which are not greatly affected by fishing (Figure B.2-4B, Table B.3-3). The LEI index for hard corals in areas where dusky rockfish occur is very high and in most areas is more than 50 percent (Figure B.2-6B, Table B.3-3). The extent of association between dusky rockfish and living and non-living substrate as habitat is unknown. If these substrates are desirable habitat features to these fish, there should be some concern considering the potential large reduction (more than 50 percent) in hard corals in the GOA, as indicated by the LEI index. This may be even more important because it is unknown how much coral there presently is in the GOA or, more important, how much there was prior to fishing effects. The loss of hard corals may be of even more importance if juvenile life stages are more dependent on coral than adults. Because most of the available data focuses on adult distribution, it is unknown what habitat features are important to juveniles. Further research investigating the importance of hard corals as dusky rockfish habitat is necessary to determine the effect of coral loss on these fish.

Habitat Impacts Relative to Spawning/Breeding
There is no information on reproductive behavior for dusky rockfish, except that parturition is believed to occur in the spring, based on observations of ripe females sampled on a research cruise in April 2001 in the central GOA.

Spawning behavior of dusky rockfish has not been documented. The rockfish fishery in the GOA and NMFS' trawl surveys occurs in the summer months. Information regarding distribution patterns in the winter and spring months when spawning is thought to occur comes from non-target fisheries, which do not offer accurate comparisons of distribution.

Only one study has estimated an age at maturity for dusky rockfish, and this consisted of 64 females collected near Kodiak. Additional collections are needed to discern any changes in maturity at age.

No direct evidence links habitat features with the ability of dusky rockfish to accomplish spawning/ breeding, but very little is known regarding the requirements for reproduction, so caution is warranted.

Habitat Impacts Relative to Growth to Maturity

The available data is limited and only describes the habitat requirements of adult dusky rockfish. Habitat requirements for the various life stages of dusky rockfish are mostly unknown. Younger juveniles (less than 25-cm fork length) are rarely caught on any fishing gear, so it is likely that fishing does not occur and, thus, has no direct effect on whatever habitat they do occupy. However, older juveniles and adults have been observed in association with corals and sponges (Krieger and Wing 2002, Freese and Wing 2004), and both life stages may prefer habitat created by such epifauna.

No direct evidence exists that indicates habitat disturbance affects the growth to maturity of dusky rockfish. However, the potential reduction of benthic habitat such as sponge and hard corals evidenced by the high LEIs in dusky rockfish habitat raises concern regarding the growth requirements of dusky rockfish. This is especially true because little information is available for younger juveniles that may be vulnerable to predation without adequate refugia. Juvenile survival is essential, but virtually nothing is known about it. If there are habitat impacts that would affect survival of juveniles to adults, then the reduction in coral and sponge as habitat is relevant. Growth analyses of length at age, weight at age, and weight at length of dusky rockfish caught in low trawl intensity areas versus high trawl intensity areas have been computed, but are inconclusive. The power of these tests is low due to the small sample sizes and must be improved to recognize any effects that might exist. Therefore, because the high LEI values for sponges and hard corals and the uncertainty surrounding their importance to dusky rockfish, it is unknown if growth to maturity has been affected by habitat disturbance.

Habitat Impacts Relative to Feeding

The major prey of adult dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). As euphausiids are pelagic rather than benthic in their distribution and are too small to be retained by any fishing gear, fishing probably has a minimal or temporary effect on the availability of prey to adult dusky rockfish.

No direct evidence is available that indicates the feeding distributions have changed. Euphausiids are the major prey of dusky rockfish, and it is believed euphausiids are not directly associated with the bottom, but rather are thought to be advected onshore near bottom at the upstream ends of underwater canyons where they become easy prey for planktivorous fishes (Brodeur 2001). This would indicate that any change in feeding distribution is caused by oceanographic influences rather than habitat disturbance.

No direct evidence is available that indicates any change in the diet of dusky rockfish. Because euphausiid distributions are likely not affected by habitat disturbances and known to be widespread in the GOA, it is doubtful that diet changes would be detectable between heavily fished and lightly fished regions. In summary, there is no evidence that habitat disturbance has affected feeding success.

Stock Status and Trends

Stock status information for dusky rockfish is limited. Prior to 2003, average trawl survey biomass estimates were used to estimate abundance. In 2003, an age-structured model was introduced using all available data from 1977 to present. The model output provides trends of spawning biomass from 1977 to the present, but does not estimate anything prior to 1977. Therefore, there is little stock structure information prior to 1977, and the information from the model is limited by the amount of data that are available for model input.

Model estimates indicate spawning biomass increased slightly between 1977 and 1987 and has remained relatively steady since then (Lunsford et al. 2004). During this period, there have been no major declines in estimated abundance. Information is not available for years prior to 1977, however, and it is unknown what the stock trends were before this date or what influence long-term impacts to the habitat have had on dusky rockfish abundance.

Model estimates of recruitment vary greatly, which is typical of rockfish in the GOA. No obvious trend in recruitment is discernable since 1977. Several recent year classes appear to be strong. However, historical recruitments prior to 1977 are not available for comparison.

There is no evidence that the cumulative effects of fishing activities on habitat have impaired the stock's ability to produce MSY since 1977. Spawning biomass appears relatively stable from 1977 to 2004, and recruitments have been variable and strong in recent years. Because of the 1977 starting point and the limited input data to the model, however, a decrease in MSY over the long term is difficult to detect.

Summary

Issue	**Evaluation**
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Growth to Maturity	U (Unknown effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of dusky rockfish are either unknown or negligible; however, caution is warranted. There is some information to suggest that bottom trawling may have a negative impact on the benthic habitat, especially corals and sponges. The LEI analysis indicates that there is a potential for large reductions in living substrates and hard coral habitats that dusky rockfish inhabit. The potential loss of these habitats would likely not have an effect on spawning/breeding of dusky rockfish or their feeding behavior. Very little information is available on these aspects of their life history, however, and further investigation may prove otherwise. A reduction in living structure and hard corals may impede these fishes' ability to reach growth to maturity. Several observations have shown rockfish to be associated with sponges and coral. The extent of this association is largely unknown, though, but may be of significance if these substrates increase survival rates by acting as refugia to juveniles or adults. An age-structured model has recently been developed for dusky rockfish and indicates no obvious trends in recruitment or spawning biomass. Data for this model are limited, however, and recruitment in the years prior to 1977 is not known, making long-term effects difficult to detect.

B.3.3.22 Thornyhead Rockfish (GOA)

While there was considerable new information to evaluate habitat effects for the major target groundfish species in Alaska, there were some species where information was either too sparse to evaluate, or simply did not exist. Such was the case for GOA thornyheads. Although thornyhead growth and catch per unit effort information was available from the NMFS surveys of the GOA, it was from habitats with the same type of impact (low); hence, it was impossible to evaluate differences in impact between areas. For this reason, the original GOA thornyhead evaluation described in the DEIS still represents the best available information, despite extensive inquiry to improve upon it.

Habitat Connections

Spawning/Breeding
Thornyheads spawn gelatinous pelagic egg masses. See Section 3.2.1.1.10.7 for further discussion and references.

Feeding
The adults feed mainly on epibenthic shrimp in the GOA; other prey includes small fish, benthic amphipods, and other benthic invertebrates and euphausiids. See Section 3.2.1.1.10.7 for further discussion and references.

Growth to Maturity
Larvae are pelagic for up to 15 months. Juveniles habits are generally unknown. Adults are demersal and are found in deep waters between 200 to 1,000 m. There is some evidence from studies of California and Oregon that younger individuals are found in shallower waters 200 to 600 m deep and that larger, older fish are found in deeper waters between 600 to 1,000 m. See Section 3.2.1.1.10.7 for further discussion and references.

Evaluation of Effects

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

GOA thornyhead eggs are presumed to be associated with pelagic habitats based on observations off the West Coast. GOA juveniles and adults are also associated with benthic habitats; specifically, on the deep shelf and slope in any type of non-living substrate, but they may prefer hard, non-living substrate according to limited studies in the eastern GOA. Overall, the GOA deep shelf and slope habitats comprise 33 and 22 percent, respectively, of the area designated as the thornyhead concentration distribution within the GOA (Table B.3-3). Of this 33 and 22 percent, 1 percent of the non-living substrate within the deep shelf and slope GOA habitat is projected to be reduced under status quo (Table B.3-3). It is assumed that this would have a negligible impact. Therefore, the ratings for the effects of spawning/breeding and growth to maturity for GOA thornyheads are no effect. The adults feed mainly on epibenthic shrimp and other benthic organisms which are included in epifaunal and infaunal features and are projected to be reduced by 1 percent in each habitat. It is assumed that the 1 percent reduction of epifauna and infauna within the GOA shallow and deep shelf habitats occupied by thornyheads would not have an impact and the rating for feeding is also no effect.

B.3.3.23 Other Rockfish Species (BSAI)

The other rockfish complex includes all species of *Sebastes* and *Sebastolobus* spp. other than Pacific ocean perch (*Sebastes alutus*) and those species in the other red rockfish complex (northern rockfish, *S. polyspinis*; rougheye rockfish, *S. aleutianus*; and shortraker rockfish, *S. borealis*). This complex is one of the rockfish management groups in the BSAI regions. Eight out of 28 species of other rockfish have been confirmed or tentatively identified in catches from the EBS and AI region; thus, these are the only species managed in this complex (Reuter and Spencer 2001, NMFS 2003). The two most abundant species for this complex are dusky rockfish (*Sebastes variabilis*) and shortspine thornyheads (*Sebastolobus alascancus*).

Dusky Rockfish

Habitat Connections

Habitat preferences for the life stages of dusky rockfish in the BSAI are either unknown or very poorly known (Table B.3-1). Adult dusky rockfish are thought to occur mainly in the middle and lower portions of the water column over areas of cobble, rock, and gravel along the outer continental shelf and upper slope region; thus, any adverse effects to this habitat type may influence the health of the dusky rockfish population. It is well documented that species under the genus *Sebastes* are viviporous, where the egg stage is completed within the female and the bears live larvae. In the larval stage, most *Sebastes* spp. can only be identified using genetics, but most, if not all, *Sebastes* larvae are pelagic until a certain age and then are believed to recruit to the bottom and become demersal. Most *Sebastes* have been documented to spend their early juvenile stages in depths shallower than the adult stage, but few juvenile dusky rockfish have been collected during the AFSC's trawl surveys. Table B.3-1 reflects this lack of data.

Spawning/Breeding
There is no information on the reproductive behavior of dusky rockfish in the BSAI. Thus, the effects of fishing on the habitat required for dusky rockfish reproduction are unknown.

Feeding
There is no information on the feeding behavior of dusky rockfish in the BSAI. In the GOA, though, they have been found to prey primarily on euphausiids (Yang 1993).

Growth to Maturity
Habitat requirements for the various life stages of dusky rockfish are unknown. In the BSAI, no juvenile specimens have been collected, and fishery data show that juveniles are not being caught (Reuter and Spencer 2004). Therefore, the habitat connections for dusky rockfish from growth to maturity are unknown.

Evaluation of Effects

LEI Values Relative to Species Distribution
Of the various BSAI habitats, only the AI deep and AI shallow habitats comprise 1 percent of the dusky concentrated distribution. Of this, living and non-living structures seem to be the most reduced habitat features for dusky rockfish in the BSAI, and hard coral is the most reduced in the AI (Table B.3-3). The LEI shows a 20 to 66 percent disturbance of the living and non-living habitat features within the concentrated distribution of dusky rockfish in the BSAI. The LEI shows that 55 to 63 percent of coral habitat is disturbed within the concentrated distribution area of dusky rockfish in the AI. The LEI maps and our current knowledge of the association of dusky rockfish with these habitats do not provide further information on the effect these proposed percentages of disturbance may have on the distribution of dusky rockfish. Given that only 1 percent of the area of dusky rockfish concentrated distribution is reflected in this analysis, the reductions in habitat features are probably no effect. The LEI model is intended to provide relative vulnerability of habitat features to fishing effort such that the absolute values of the estimated reductions are less important than their relation to each other.

Habitat Impacts Relative to Spawning/Breeding
The impacts of fishing on habitat relative to the spawning/breeding behavior of dusky rockfish are unknown.

Habitat Impacts Relative to Growth to Maturity
There is no information on the impacts of habitat disturbances to the growth to maturity of dusky rockfish. However, if information is gathered that strongly correlates growth to maturity of dusky rockfish to habitat such as living and non-living structure, then measures should be taken to limit the effects of fishing to those habitats. Currently, this impact is unknown.

Habitat Impacts Relative to Feeding
Although no studies have been conducted in the BSAI on the feeding behaviors of dusky rockfish, they feed mainly on euphausiids in the GOA. Being pelagic, it is more than likely that euphausiid distribution, thus availability of prey for dusky rockfish, is not affected by bottom habitat disturbances.

Stock Status and Trends
Stock status for dusky rockfish is unknown. Currently the other rockfish complex biomass is estimated mainly by the shortspine thornyheads (SST) biomass estimate.

Summary

Issue	**Evaluation**
Spawning/breeding	U (Unknown effect)
Feeding	MT (Minimal, temporary or no effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—In general the effects of fishing on the habitat of dusky rockfish are unknown or minimal. The main concern lies in the amount of habitat that has been estimated to be disturbed within the general distribution of dusky rockfish in the BSAI. If the loss of substrates, both living and non-living, is great due to the effects of fishing or as the result of a natural occurrence, then there is the potential that dusky rockfish growth to maturity may be affected. Many species of rockfish utilize rocky outcroppings and/or coral as a type of refugia during some or all of their life history stages. If this refugia is found to play an important role in the survival of this species, then loss of the substrate that makes up this refugia may decrease the survival rate of dusky rockfish.

BSAI Shortspine Thornyheads

Habitat Connections

Habitat preferences for the life stages of SST in the BSAI are either unknown or very poorly known (Table B.3-1). It is known that SST eggs are pelagic and float in masses of various sizes and shapes until larval stage is reached. The larval stage is also pelagic, and it is thought that after 14 to 15 months they begin settling to the bottom. Little information on the juvenile stage of SST is available. The juveniles and adults of this species are thought to occur over mud, sand, rock, cobble, and gravel substrate along the middle and outer continental shelf to the upper and lower slope of the EBS and AI; thus, any adverse effects to this habitat type may influence the health of the thornyhead rockfish population. Although the size of SST collected from both the AI survey and BS slope survey ranged from 15 to 50 cm, the majority of those collected were adults. Larger adults are found in deeper depths, suggesting that SST migrate deeper as they get older.

Spawning/Breeding

SST spawn gelatinous egg masses that are pelagic. No studies of SST spawning/breeding have been done for the BSAI.

Feeding

Analysis of SST stomach contents from the AI 1991 and 1994 trawl surveys showed that SST consume large amounts of fish (cottids, rajidae) and shrimp (pandalid) (Yang 2003, 1996). These prey items are mainly benthic and may be impacted by certain fishing gear such as bottom trawl. Yang 2003 noted that SST diet may be size-dependent, meaning that larger sized SST eat larger prey items; thus, those prey items large enough to be impacted by fishing gear may impact prey availability to SST.

Growth to Maturity

Larvae SST are thought to be pelagic for up to 15 months. Unfortunately, it is unknown when or how larvae recruit to the benthos. Adult SST are demersal and are found mainly at depths of 200 to 1,000 m. Similar to *Sebastes* spp., there is some evidence that younger/smaller SST are found shallower than the older/larger SST. It is not known whether SST prefer structured habitat, but they have frequently been collected from research surveys and fisheries using a variety of gear types (i.e., bottom trawl and longline).

Evaluation of Effects

LEI Values Relative to Species Distribution

Of the various BSAI habitat types, the AI deep comprised 23 percent of the concentrated distribution of SST (Table B.3-3). The BSAI slope comprised 12 percent of the SST concentrated distribution. The other habitat types comprised less than or equal to 5 percent of the concentrated distribution. Of the AI deep habitat, hard coral depletion was 9 percent in the areas where concentrated distribution of SST occurred, followed by living structure (4 percent of concentrated distribution). Given that no associations have been made to suggest that hard coral or living structures are the exclusive habitat type of SST, the projected depletion of these habitat types will have a minimal impact on SST species distribution.

Habitat Impacts Relative to Spawning/Breeding

Due to the pelagic nature of SST egg masses, impacts of habitat disturbances to the spawning/breeding behavior of SST are minimal.

Habitat Impacts Relative to Growth to Maturity

Impacts of habitat disturbances to the growth to maturity of SST are probably minimal. However, if information is gathered that strongly correlates survival success from growth to maturity of SST to habitat such as living and non-living structure, then measures should be taken to limit the effects of fishing to those habitats.

Habitat Impacts Relative to Feeding

SST prey are mainly epifauna, fish, and shrimp (Yang 2003, 1996). Table B.3-3 shows that a 14 percent reduction of epifauna is found in the BS sand habitat in the area of SST concentrated distribution. Fortunately, though, this habitat contributes to only 1 percent of the entire area where the concentrated SST distribution occurs. Therefore, habitat impacts relative to feeding are no effect.

Stock Status and Trends

Stock status for SST is good. The AI and BS slope bottom trawl surveys do a good job in assessing the biomass of SST. Currently, SST make up about 90 percent of the other rockfish complex. The average survey biomass of all rockfish within the complex is used to estimate abundance. Although an economically valuable fish, there is no directed fishery for SST in the BSAI; thus, there are no areas where SST have been consistently fished since our domestic fisheries began back in 1977. The general trend in the SST biomass is positive, gaining 4,000 mt in the AI alone from the 2002 survey to the 2004 survey (Reuter and Spencer 2004).

Summary

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—In general, the relationship between habitat and SST survival rates has not been established. Given current information, however, impacts to habitat that may support various life stages of SST are minimal to no effect. The main concern is prey availability to SST. Because epifauna are the main prey items for SST, the impacts to those habitats that support their various life stages are also important. Unfortunately, there are no good data to determine which epifauna are the most important in SST diet along the large area of the BSAI.

B.3.3.24 Other Species

While there was considerable new information to evaluate habitat effects for the major target groundfish species in Alaska, there were some species where information was either too sparse to evaluate, or simply did not exist. For other species, especially nontarget species such as skates, sculpins, sharks, squids, and octopi, growth information has not been collected historically, and species-specific catch per unit effort information may be unreliable. Information on nontarget species is improving, but it is currently insufficient to evaluate habitat specific impacts. For these reasons, the original evaluations for the following species groups presented in the DEIS still represent the best available information, despite extensive inquiry to improve upon it.

B.3.3.24.1 BSAI Sharks (sleeper sharks and salmon sharks)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the EBS or AI to determine whether fishing activities have an effect on the habitat of sleeper sharks or salmon sharks. Sleeper sharks are thought to occur mainly in the middle and lower portions of the water column along the outer continental shelf and upper slope region; thus, any adverse effects to this habitat type may influence the health of the sleeper shark population. Salmon sharks are thought to occur in pelagic waters along the outer continental shelf and upper slope region of the EBS. Thus, any adverse effects to this habitat type, including disruption or removal of pelagic prey by fisheries, may influence the health of the salmon shark population.

B.3.3.24.2 GOA Sharks (dogfish, sleeper sharks, and salmon sharks)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of dogfish, sleeper sharks, or salmon sharks. Dogfish are thought to occur in the middle and lower portions of the water column and appear to concentrate in gullies along the continental shelf in the GOA. Sleeper sharks are thought to occur mainly in the middle and lower portions of the water column along the outer continental shelf and upper slope region, as well as in similar depths in Shelikof Strait and other gully habitats. Salmon sharks are pelagic throughout the GOA and appear to concentrate in Prince William Sound as well as in Shelikof Strait. Thus, any adverse affects to these habitat types may influence the health of GOA shark populations.

B.3.3.24.3 BSAI Skates (between 8 and 15 species in the genus *Bathyraja*)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the EBS or AI to determine whether fishing activities have an effect on the habitat of skates. Skates are benthic dwellers. The Alaska skate dominates the skate complex biomass in the EBS and is distributed mainly on the upper continental shelf. The diversity of the group increases with depth along the outer continental shelf and slope, with several new species likely to be described in the near future. Therefore, any adverse affects to the shallow shelf habitat may influence the health of the Alaska skate populations, while any adverse affects to outer continental shelf and slope habitats may influence the health of multiple species of skates.

B.3.3.24.4 GOA Skates (two Raja species, Big and longnose skate, and 8-15 Bathyraja species)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of skates. Skates are benthic dwellers. The big skate, a new commercial species in the GOA, comprises just under half of the skate complex biomass in the GOA and is distributed mainly on the upper continental shelf. However, other skate species are found throughout that habitat as well. The diversity of the group increases with depth in the gullies within the continental shelf and along the outer continental shelf and slope. Therefore, any adverse affects to the shallow shelf habitat may influence the health of the big skate populations as well as other skate species, while any adverse affects to outer continental shelf and slope habitats may influence the health of multiple species of skates.

B.3.3.24.5 BSAI Sculpins (over 60 species identified in BSAI trawl surveys)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the EBS or AI to determine whether fishing activities have an effect on the habitat of sculpins. Sculpins are benthic dwellers. Some sculpin species guard their eggs, and at least one species, the bigmouth sculpin, lays its eggs in vase sponges in the AI, although it is not known whether a particular type of sponge, or sponges in general, are essential to reproductive success. There are so many diverse species in this category that almost all benthic areas in the EBS and AI are likely to be inhabited by at least one sculpin species. Therefore, any adverse affects to habitat may influence the health of species in the sculpin complex.

B.3.3.24.6 GOA Sculpins (48 species identified in GOA trawl surveys)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of sculpins. Sculpins are benthic dwellers. Some sculpin species guard their eggs, and at least one species, the bigmouth sculpin, lays its eggs in vase sponges, although it is not known whether a particular type of sponge, or sponges in general, are essential to reproductive success. There are so many diverse species in this category that almost all benthic areas in the GOA are likely to be inhabited by at least one sculpin species. Therefore, any adverse affects to habitat may influence the health of species in the sculpin complex.

B.3.3.24.7 BSAI Squids (5 or more species)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the EBS or AI to determine whether fishing activities have an effect on the habitat of squid. Squid are thought to occur in pelagic waters along the outer continental shelf and upper slope region of the EBS and AI, and concentrate over submarine canyons; thus, any adverse effects to this habitat may influence the health of the squid populations.

B.3 3.24.8 GOA Squid (10 or more species)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of squid. Squid are thought to occur in pelagic waters along the gullies within the continental shelf and the outer continental shelf, in the upper slope region of the GOA, and to concentrate over submarine canyons; thus, any adverse effects to this habitat may influence the health of the squid populations.

B.3.3.24.9 BSAI octopi (5 or more species)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the EBS or AI to determine whether fishing activities have an effect on the habitat of octopi. Octopi occupy all types of benthic habitats, extending from very shallow subtidal areas to deep slope habitats; thus, any adverse effects to this habitat may influence the health of octopus populations. Knowledge of octopi distributions are insufficient to allow comparison with fishing effects.

B.3.3.24.10 GOA Octopi (5 or more species)

Habitat Connections, Evaluation of Effects

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of octopi. Octopi occupy all types of benthic habitats, extending from very shallow subtidal areas to deep slope habitats; thus, any adverse effects to this habitat may influence the health of octopus populations. Knowledge of octopi distributions are insufficient to allow comparison with fishing effects.

B.3.4 Effects of Fishing on Essential Fish Habitat of Forage Species

The forage species category was created by Amendments 36 and 39 to the BSAI and GOA FMP. This category includes eight families of fish (Osmeridae, Myctophidae, Bathylagidae, Ammodytidae, Trichodontidae, Pholidae, Stichaeidae, and Gonostomatidae) and one order of crustaceans (Euphausiacea). The aforementioned amendments prohibit the directed fishery of any forage species. The species included in this category have diverse life histories and it is impractical to analyze the group as a whole. Therefore, for the purpose of this document, each family and order will be analyzed separately.

B.3.4.1 Family Osmeridae

Habitat Connections

Spawning/Breeding
Most of the Alaska species of Osmerids (or smelt) spawn on beaches, rivers, or estuaries. There is little to no fishing pressure in the habitat needed for spawning/breeding. Hence, the effects of fishing are anticipated to have no impact on essential spawning, nursery, or settlement habitat.

Feeding
Adult smelt feed on pelagic zooplankton. Most of the smelt diet is composed of euphausiids and copepods, which are not likely to be affected by fishing.

Growth to Maturity
Osmerids have pelagic larval, juvenile, and adult life stages. During these stages, there is no evidence that survival of smelt is dependent on habitat that is affected by fishing.

Evaluation of Effects

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—Most of the Alaska species of smelt spawn on beaches, rivers, or in estuaries. Certain species of smelt, such as capelin, have been shown to have an affinity towards spawning grounds with specific substrate grain size (coarse sand or fine gravel). Therefore, non-living substrate is assumed to be very important for spawning/breeding. However, smelt spawning areas do not overlap with areas of intensive fishing. There is little to no fishing pressure in the nearshore environment needed by these species. Hence, the effects of fishing are anticipated to have little impact on the stock. The rating for the effects of fishing on spawning and breeding of smelt is MT.

Juvenile and adult smelt feed primarily on neritic plankton. There is little evidence that survival or prey availability of smelt is dependent on habitat that is disturbed by fishing. Therefore, the effects of fishing on the feeding and growth to maturity of smelt are rated MT.

B.3.4.2 Family Myctophidae

Habitat Connections

Spawning/Breeding
Myctophids (or lanternfish) are small bathypelagic species of fish. Myctophids are broadcast spawners, and their eggs are pelagic. Hence, the effects of fishing are anticipated to have little impact on essential spawning, nursery, or settlement habitat.

Feeding
Adult Myctophids feed on pelagic zooplankton. The Myctophid diet is composed largely of euphausiids and copepods, which are not species likely to be affected by fishing.

Growth to Maturity
Myctophids have pelagic larval, juvenile, and adult life stages. During these stages, there is no evidence that survival of Myctophids is dependent on habitat that is affected by fishing.

Evaluation of Effects

Issue	**Evaluation**
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—Myctophids are pelagic throughout all life history stages. There is little evidence that Myctophid survival is dependent on habitat affected by fishing. Myctophids are broadcast spawners with pelagic eggs. Juvenile and adult Myctophids prey on neritic zooplankton and do not require physical structure for protection. Therefore, the effects of fishing on the spawning and breeding, feeding, and growth to maturity of Myctophids is rated MT.

B.3.4.3 Family Ammodytidae

Habitat Connections

Spawning/Breeding
Pacific sand lance (*Ammodytes hexapterus*) spawn on sand in shallow water. There is little to no fishing pressure in the nearshore habitat needed for spawning/breeding. Hence, the effects of fishing are anticipated to have no impact on essential spawning, nursery, or settlement habitat.

Feeding
Adult sand lance feed on pelagic zooplankton. Most of the sand lance diet is composed of copepods, which are not likely to be affected by fishing.

Growth to Maturity
Pacific sand lance have pelagic larval, juvenile, and adult life stages. During these stages, there is no evidence that survival of sand lance is dependent on habitat that is affected by fishing.

Evaluation of Effects

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—The sole member of family Ammodytidae found in Alaska is the Pacific sand lance (*Ammodytes hexapterus*). Sand lance have been shown to have an affinity towards spawning grounds with specific substrate grain size (coarse sand). Therefore, non-living substrate is assumed to be very important for spawning/breeding. However, smelt spawning areas do not overlap with known areas of intensive fishing. There is little to no fishing pressure in the nearshore habitat needed by these species. Hence, the effects of fishing on the EFH of sand lance is rated MT.

Juvenile and adult sand lance feed primarily on copepods. There is little evidence that survival or prey availability of sand lance is dependent on habitat disturbed by fishing. Therefore, the effects of fishing on the feeding and growth to maturity of smelt are rated MT.

B.3.4.4 Family Trichodontidae

Habitat Connections

Spawning/Breeding
Pacific sandfish (*Trichodon trichodon*) lay demersal adhesive egg masses in rocky intertidal areas. There is little to no fishing pressure in the nearshore habitat needed for spawning/breeding. Hence, the effects of fishing are anticipated to have no impact on essential spawning, nursery, or settlement habitat.

Feeding
Pacific sandfish are ambush predators that lay in wait for prey buried under the sand. They have been shown to consume some epifauna prey, but more than 95 percent of their diet consists of small fish. It is unknown how these prey species are affected by fishing.

Growth to Maturity
Pacific sandfish larvae are pelagic, but juveniles and adults are demersal. Little is known about sandfish distribution in the BSAI and GOA. The effect of fishing on the survival of Pacific sandfish is unknown.

Evaluation of Effects

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unknown)
Growth to maturity	U (Unknown)

Summary of Effects—Two members of the family Trichodontidae are found in the BSAI and GOA: the sailfin sandfish (*Arctoscopus japonicus*) and the Pacific sandfish (*Trichodon trichodon*). However, the sailfin sandfish is rarely encountered in Alaska waters. For the purposes of this document, attention will be focused on the Pacific sandfish.

Pacific sandfish lay demersal adhesive egg masses in rocky intertidal areas. The presence of the proper non-living substrate is important for the spawning/breeding of sandfish. However, there is little overlap of the spawning areas with known areas of intensive fishing. Hence, the effects of fishing on spawning/breeding of sandfish are rated MT.

Pacific sandfish are ambush predators that lay in wait for prey buried under the sand. They have been shown to consume some epifauna prey, but more than 95 percent of their diet consisted of small fish. It is unknown how these prey species are affected by fishing.

Pacific sandfish larvae are pelagic, but juveniles and adults are demersal. Little is known about sandfish distribution in the BSAI and GOA. The effect of fishing on the survival of Pacific sandfish is unknown due to lack of data.

B.3.4.5 Family Pholidae

Habitat Connections

Spawning/Breeding
There are several species of Pholids (or gunnels) found in Alaska waters. Most species of gunnels reside and breed in the shallow, nearshore habitat where there is little to no fishing effort. Hence, the effects of fishing are anticipated to have no impact on essential spawning, nursery, or settlement habitat.

Feeding
The diet of gunnels has been shown to rely heavily on epifaunal and infaunal prey. However, as stated above, there is little fishing in the shallow waters utilized by these species. For that reason, the effects of fishing are anticipated to have no impact on prey availability.

Growth to Maturity
There is little to no fishing pressure in the shallow, nearshore environment occupied by Pholids. Consequently, the effects of fishing are anticipated to have no impact on the survival of fish to maturity.

Evaluation of Effects

Issue	**Evaluation**
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—There are several species of Pholids (or gunnels) found in Alaska waters. Most species of gunnels reside, feed, and breed in the shallow, nearshore habitat, where there is little to no fishing effort. Due to the lack of fishing pressure in the environs used by Pholids, the effects of fishing on the spawning/breeding, feeding, and growth to maturity are all rated MT.

B.3.4.6 Family Stichaeidae

Habitat Connections

Spawning/Breeding
There are many species of Stichaeids (or pricklebacks) found in Alaska waters. Most species of pricklebacks reside and breed in the shallow, nearshore habitat where there is little to no fishing effort. Hence, the effects of fishing are anticipated to have no impact on essential spawning, nursery, or settlement habitat.

Feeding
The diet of pricklebacks has been shown to rely heavily on epifaunal and infaunal prey. However, as stated above, there is little fishing in the shallow waters used by these species. For that reason, the effects of fishing are anticipated to have no impact on prey availability.

Growth to Maturity
There is little to no fishing pressure in the shallow, nearshore environment occupied by pricklebacks. Consequently, the effects of fishing are anticipated to have no impact on the survival of fish to maturity.

Evaluation of Effects

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—Due to the lack of fishing pressure in the environs used by pricklebacks, the effects of fishing on the spawning/breeding, feeding, and growth to maturity are all rated MT.

B.3.4.7 Family Gonostomatidae

Habitat Connections

Spawning/Breeding
Gonostomatids (or bristlemouths) are small bathypelagic species of fish. Bristlemouths are broadcast spawners, and their eggs are pelagic. Hence, the effects of fishing are anticipated to have little impact on essential spawning, nursery, or settlement habitat.

Feeding
Adult bristlemouths feed on pelagic zooplankton (mostly copepods). Bristlemouth prey species are not likely to be affected by fishing.

Growth to Maturity
Bathylagids have pelagic larval, juvenile, and adult life stages. During these stages, there is no evidence that survival of bathylagids is dependent on habitat that is affected by fishing.

Evaluation of Effects

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—Bristlemouths are pelagic throughout all life history stages. There is little evidence that bristlemouths survival is dependent on habitat that is affected by fishing. Bristlemouths are broadcast spawners with pelagic eggs. Juvenile and adult bristlemouths prey on neritic zooplankton and do not require physical structure for protection. Therefore, the effects of fishing on the spawning/breeding, feeding, and growth to maturity of bristlemouths are rated MT.

B.3.4.8 Order Euphausiacea

Habitat Connections

Spawning/Breeding
Euphausiids are broadcast spawners and their eggs are pelagic. Hence, the effects of fishing are anticipated to have little impact on essential spawning, nursery, or settlement habitat.

Feeding
Euphausiids feed on phytoplankton and zooplankton. Euphausiid prey species are not likely to be affected by fishing.

Growth to Maturity
Euphausiids have pelagic egg, larval, and adult life stages. During these stages, there is no evidence that survival of euphausiids is dependent on habitat affected by fishing.

Evaluation of Effects

Issue	**Evaluation**
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—Euphausiids (or krill) are small, shrimp-like crustaceans which, along with copepods, make up the base of the food web in the BSAI and GOA. Euphausiids are pelagic throughout their entire life cycle and do not have a strong link to habitat that is affected by fishing. Euphausiids do not require habitat that is disrupted by fishing for spawning/breeding, feeding, or growth to maturity. Therefore, the effects of fishing for euphausiids is MT.

B.4 Conclusions

B.4.1 Species Evaluations

Evaluations were completed for 26 managed species (or species groups) and 8 forage species (Table B.4-1). See Sections B.3.2 to B.3.4 for more detailed information. Based on the available information, the analysis found no indication that continued fishing at the current rate and intensity would affect the capacity of EFH to support the life history processes of any species. In other words, the effects of fishing on EFH would not be more than minimal. Reasons for minimal ratings were predominantly either lack of a connection to affected habitat features, or findings from stock analyses that current fishing practices (including effects on habitat) do not jeopardize the ability of the stock to produce MSY over the long term. Other evaluations indicated that, even though a connection may exist between a habitat feature and a life-history process, the expected feature reductions were considered too small to make effects at the population level likely. There were also cases where the effects did not overlap significantly with the distribution of the species.

About one-third of the ratings were U (unknown effect). Most of unknown ratings were for species that have received relatively little study; hence, their life history needs and population status are poorly known. Most species with unknown ratings support small or no fisheries. Conversely, species that support significant fisheries have been studied more. In some cases, associations between the habitat features and life history processes were indicated, but the evaluator did not have enough information to assess whether the linkage and the amount of feature reduction would affect species welfare.

Even for well studied species, the knowledge to trace use of habitat features confidently for spawning, breeding, feeding, and growth to maturity to population level effects is not yet available. Several evaluators specifically cited uncertainty regarding the effect of particular noted linkages, and some urged caution. Most of these situations involved potential linkages between the growth-to-maturity of rockfish and Atka mackerel and habitat structure.

B.4.2 General Effects on Fish Habitat

While this evaluation identified no specific instances of adverse effects on EFH that were more than minimal and not temporary, the large number of unknown ratings and expressions of concern make it prudent to look for more general patterns across all of the species and habitat features (Table B.4-2).

Specific areas with high fishing effort, and hence high LEIs, were identified in the effects-of-fishing analysis. These included two large areas of the EBS, one north of Unimak Island and Unimak Pass and the other between the Pribilof Islands and Bristol Bay. Both of these areas have continued to be highly productive fishing grounds through decades of intensive fishing. While that may initially seem at odds with the LEI results, it is consistent with the evaluation that the habitat features affected by fishing either are not those important to the species fished in those areas, or are not being affected in a way that limits species welfare.

Fishing concentrations in other areas were smaller, but made up higher proportions of the GOA and EBS slopes. The largest effect rates were on living structure, including coral. The high reliance on limited areas for fishing production and their high estimated LEIs make it prudent to obtain better knowledge of what processes occur in those locations.

Table B.3-1 shows the habitat connections identified for each life stage of managed species and species groups. Each row represents a species life stage and each column one of the habitat types from the fishing-effects analysis. At their intersections, evaluators entered letters representing each of the habitat features (prey or structure classes) used by that life stage in that habitat. Most species of groundfish have pelagic larval and egg stages. Only one species, Atka mackerel, had a connection with a benthic habitat feature for its egg or larval stages. A combined tally at the bottom of the table notes how many species/life-stages were identified for each habitat feature in each habitat. Prey features represented about twice as many connections as structure features. The habitat feature/type combinations that had LEIs above 5 percent, outlined in the table, tended to have few connections. The highest number of connections (six) were for living structures on the GOA deep shelf, which had the lowest LEI of the outlined habitat feature/type combinations (6.2 percent). Connections with the highlighted blocks mostly involved rockfish species, with a few connections from Atka mackerel and blue king crab.

Cropping and summing effects on habitat features by distributions of the adults of each species (Table B.3-3) depicted how the fishing effects overlapped in the locations where each species is present. The general distribution values related to the broader areas occupied, while the concentration values related to areas of higher abundance. Concentration LEIs were generally higher than the estimates based on general distribution because adult species concentrations determine where fisheries operate. It is unfortunate that distributions were not available for juveniles because connections to the habitat feature with the highest LEIs (living structure) mostly involved the growth to maturity process. Characterizing juvenile distributions should be a high priority for future research.

Reductions across adult species distributions for the living structure were mostly between 10 and 17 percent. Higher values occurred for red king crab (29 percent for both coverages) and Atka mackerel (18 and 26 percent). The king crab evaluator noted that the distribution of juveniles was mostly outside of the affected areas. The evaluator for Atka mackerel emphasized use of non-living substrates by that species. Prey class effects by species distributions were all at or below 5 percent. In combination with negligible effects on habitat of forage species (Section B.3.5), this indicates that effects on availability of prey were minimal.

While LEIs for hard corals are subject to the limitations mentioned in Section B.2.6, they had the highest LEIs when considered by species distributions. Intersections where meaningful effects are most likely to occur are those between areas where hard corals are prevalent and species for which a significant portion of their distribution occurs in the same areas, including populations of golden king crab, Atka mackerel, sablefish, and the rockfish species. Coral LEIs at these points ranged from 23 to 59 percent. While few evaluators cited coral as specifically linked to life history functions, in some areas it may be an important component of the living structure that is potentially linked to growth to maturity for some of these species. Because of their very slow recovery, corals warrant particular consideration for protection and for the development of improved knowledge of their habitat functions and distribution.

B.5 Cumulative Effects of Fishing and Non-fishing Activities on EFH

This section discusses the cumulative effects of fishing and non-fishing activities on EFH. As identified in Section 4.4, historical fishing practices may have had effects on EFH that have led to declining trends in some of the criteria examined (Table 4.4-1). As described in earlier sections of Appendix B (Table B.4-2), the effects of current fishing activities on EFH are classified as minimal and temporary or unknown. Table B.4-2 identifies the rationale for the rating under each fishery.

A review of the effects of non-fishing activities on EFH is found in Appendix G and Table 3.4-37 of this EIS. Table 3.4-37 provides a summary of the detailed text descriptions found in Appendix G. The table identifies 29 non-fishing activities for which potential effects are described in Appendix G. However, the magnitude of these effects cannot currently be quantified with available information. Of the 29 activities, most are described as likely having less than substantial potential effects on EFH. Some of these activities such as urban/suburban development, road building and maintenance (including the placement of fill material), vessel operations/transportation/navigation, silviculture (including LTFs), and point source discharge may have potential cumulative impacts due to the additive and chronic nature of these activities. NMFS does not have regulatory authority over non-fishing activities, but frequently provides recommendations to other agencies to avoid, minimize, or otherwise mitigate the effects of these activities.

Fishing and each activity identified in the analysis of non-fishing activities may not significantly affect the function of EFH. However, the synergistic effect of the combination of all of these activities may be a cause for concern. Unfortunately, available information is not sufficient to assess how the cumulative effects of fishing and non-fishing activities influence the function of EFH on an ecosystem or watershed scale. The magnitude of the combined effect of all of these activities cannot be quantified, so the level of concern is not known at this point.

References

Abookire, A.A. In review. Reproductive biology, spawning season, and growth of female rex sole in the GOA.

Alaska Department of Fish and Game (ADF&G). 2000. A workshop examining potential fishing effects on population dynamics and benthic community structure of scallops with emphasis on the weathervane scallop *Patinopecten caurinus* in Alaska waters. ADF&G Special Publication 14.

Allen, M.J., and G.B. Smith. 1988. "Atlas and zoogeography of common fishes in the BS and northeastern Pacific." NOAA Technical Report, *NMFS 66*, U. S. Department of Commerce, NOAA. p. 151. *In* National Marine Fisheries Service 2001(a).

Andrews, A.H., E.E. Cordes, M.M. Mahoney, K. Munk, K.H. Coale, G.M. Cailliet, and J. Heifetz. 2002. Age, growth and radiometric age validation of a deep-sea, habitat-forming gorgonian (*Primnoa resedaeformis*) from the GOA. Hydrobiologia 471(1-3):101-110.

Ainley, D.G., W.J. Sydeman, R.H. Parrish, and W.H. Lenarz. 1993. Oceanic factors influencing distribution of young rockfish (Sebastes) in central California: A predator's perspective. CalCOFI Report 34: 133-139.

Bailey, K.M. 2000. Shifting control of recruitment of walleye pollock *Theragra chalcogramma* after a major climatic and ecosystem change. Mar. Ecol. Prog. Ser 198:215-224.

Bailey, K.M., T.J. Quinn II, P. Bentzen, and W.S. Grant. 1999. Population structure and dynamics of walleye pollock, *Theragra chalcogramma*. Advances in Mar. Biol. 37: 179-255.

Ball, B.J., G. Fox, and B.W. Munday. 2000. Long- and short-term consequences of a Nephrops trawl fishery on the benthos and environment of the Irish Sea. ICES Journal of Marine Science. 57(5):1,315-1,320.

Balsiger, J.W. 1974. A computer simulation model for the EBS king crab population. Ph.D. dissertation, University of Washington. 198 p.

Balsiger, J.W. 1972. Standardization of BS red king crab fishery CPUE. INPFC Doc. No. 1514.

Barbeaux S., J. Ianelli, and E. Brown. 2004. Stock assessment of AI region pollock. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI regions. Prepared by the BSAI Plan Team, North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510. North Pacific Fisheries Management Council, Anchorage, AK.

Barnhart, J. 2003. Personal communication, Alaska Department of Fish and Game, May 2003.

Bergman, M.J.N. and J.W. van Santbrink. 2000. Mortality in megafaunal benthic populations caused by trawl fisheries on the Dutch continental shelf in the North Sea in 1994 ICES Journal of Marine Science 57:1,321-1,331.

Berkeley, S.A., M.A. Hixon, R.J. Larson, and M.S. Love. Aug. 2004. Fisheries sustainability via protection of age structure and spatial distribution of fish populations. Fisheries 29:23-32.

Blood, D.M., A.C. Matarese, and M.S. Busby. In prep. Spawning, egg development, and early life history dynamics of arrowtooth flounder (*Atheresthes stomias*) in the GOA (based on research conducted 2001-2003).

Brodeur, R.D. 2001. Habitat-specific distribution of Pacific ocean perch (Sebastes alutus) in Priblof Canyon, Berring Sea. Continental Shelf Research. 21(3):207-224.

Brodeur, R.D., 1998. *In situ* observations of the association between juvenile fishes and *scyphomedusae* in the BS. Mar. Ecol. Prog. Ser. 163:11-20.

Brodeur, R.D., H. Sugisaki, and G.L. Hunt Jr. 2002. Increases in jellyfish biomass in the BS: implications for the ecosystem. Mar. Ecol. Prog. Ser. 233:89-103.

Brown, E. 2003. Effects of commercial otter trawling on EFH of the southeastern BS shelf. Master's Thesis, University of Washington.

Brylinsky, M., J. Gibson, and D.C. Gordon, Jr. 1994. Impacts of flounder trawls on the intertidal habitat and community of the Minas Basin, Bay of Fundy. Canadian Journal of Fisheries and Aquatic Sciences. 51(3):650-661.

Carlson, H.R. 1994. Consistent yearly appearance of age-0 walleye pollock *Theragra chalcogramma* at a coastal site in southeastern Alaska, 1973-1994. Fish. Bull. 93:386-390.

Carlson, H.R. and Haight, R.E. 1976. Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fjords of southeastern Alaska: Their environment, growth, food habits, and schooling behavior. Trans. Am. Fish. Soc 105: 191-201.

Carlson, H.R. and R.R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp., in rocky coastal areas of southeastern Alaska. Marine Fisheries Review 43(7):13-19.

Chikuni, S. 1975. Biological study on the population of the Pacific ocean perch in the North Pacific. Bull. Far Seas Fish. Res. Lab 12: 1-119.

Clark, M.R. and R. O'Driscoll. 2003. Deepwater fisheries and their impact on seamount habitat in New Zealand. Journal of Northwest Atlantic Fishery Science 31: 441-458.

Clausen, D.M. and J. Heifetz. 2003. The northern rockfish, *Sebastes polyspinis*, in Alaska: commercial fishery, distribution, and biology. Unpubl. manuscr. (submitted for publication to Mar. Fish. Rev. Available from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau Alaska 99801).

Clausen, D.M. and J. Heifetz. 2002. The northern rockfish, *Sebastes polyspinus*, in Alaska: Commercial fishery, distribution, and biology. Mar. Fish. Rev 64(4):1-28.

Clausen, D.M., C.R. Lunsford, and J.T. Fujioka. 2002. Pelagic shelf rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 383-417. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Clausen, D.M., J.T. Fujioka, and J. Heifetz. 2003. Shortraker/rougheye and other slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 531-572. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage AK 99501.

Collie, J.S., S.J. Hall, M.J. Kaiser, and I.R. Poiners. 2000. A quantitative analysis of fishing impacts on shelf-sea benthos. Journal of Animal Ecology 69:785-798.

Connors, M. E., A.B. Hollowed, and E. Brown. 2004. Retrospective analysis of BS bottom trawl surveys: regime shift and ecosystem reorganization. Progress in Oceanography - in press.

Cote, D., S. Moulton, A. Scruton, and R.S. McKinley. 2001. Microhabitat use of juvenile Atlantic cod in a coastal area of Bonavista Bay, Newfoundland. Transactions of the American Fisheries Society. 130(6). Pp. 1217-1223.

Council. 2004. Stock Assessment and Fishery Evaluation report for the king and Tanner crab fisheries of the BSAI Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage AK, 99501. 238 p.

Council. 2003. Stock assessment and fishery evaluation report for the king and Tanner crab fisheries of the BSAI Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage AK, 99501.

Council. 2000a. Environmental assessment for Amendment 11 to the Fishery Management Plan BSAI King and Tanner crabs. Rebuilding Plan for the Tanner Crab (*Chionoecetes bairdi*) Stock, North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage AK, 99501.

Council. 2000b. Environmental assessment for Amendment 14 to the Fishery Management Plan BSAI King and Tanner crabs. Rebuilding Plan for the Snow Crab (*Chionoecetes opilio*) Stock, North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage AK, 99501.

Council. 1999. Environmental assessment for Amendment 11 to the Fishery Management Plan BSAI King and Tanner crabs. Rebuilding Plan for the BS Tanner crab ©. *bairdi*) Stock, North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage AK, 99501.

Council. 1995. Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility analysis for red king crab bycatch in the BS trawl fisheries and alternatives for closure areas. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage AK, 99501.

Courtney, D.L., D.M. Clausen, J. Heifetz, J.T. Fujioka, and J.N. Ianelli. 2003. GOA northern rockfish, p. 481-529. In Stock assessment and fishery evaluation report for the groundfish resources of the GOA. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Dew, C.B. 1990. Behavioral ecology of podding red king crab, *Paralithodes camtschatica*. Canadian Journal of Fisheries and Aquatic Science, 47(9), pp. 1994-1958.

Dew, C.B. and R.A. McConnaughey. in press. Did bottom trawling in Bristol Bay's red king crab broodstock refuge contribute to the collapse of Alaska's most valuable fishery? J. of Appl. Ecol.

Dew C.B. and R.A. McConnaughey. 2003. Did bottom trawling in Bristol Bay's red king crab broodstock refuge contribute to the collapse of Alaska's most valuable fishery? Proceedings of the symposium on effects of fishing activities on benthic habitats: linking, geology, biology, socioeconomics, and management, Tampa, FL, November 2002.

Dorn, M.W. 2004. Extending separable age-structured assessment models to evaluate trends in juvenile mortality of walleye pollock in the GOA. ICES CM 2004/FF:31.

Dorn, M.W., S. Barbeaux, S. Gaichas, M. Guttormsen, B. Megrey, K. Spalinger, and M. Wilkins. 2004. Assessment of the walleye pollock stock in the GOA. In Stock Assessment and Fishery Evaluation Report for Groundfish Resources of the GOA. Prepared by the GOA Groundfish Plan Team, North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510. North Pacific Fisheries Management Council, Anchorage, AK.

Drinkwater, K. 2004. Summary Report: Review on evaluation of fishing activities that may adversely affect EFH in Alaska. Center for Independent Experts, Miami Florida.

Duffy-Anderson, J.T., L. Ciannelli, T. Honkalehto, K.M. Bailey, S.M. Sogard, A.M. Springer, and T. Buckley. 2003. Distribution of age-1 and age-2 walleye pollock in the GOA and EBS: sources of variation and implications for higher trophic levels. The Fish Big Bang. Proceedings of the 26th annual larval fish conference. Eds. H.I. Browman and A.B. Skiftesvik. Institute of Marine Research. Bergen, Norway.

Eno, N., D.S. Macdonald, J.A. Kinnear, S. Amos, C.J. Chapman, R.A. Clark, F.S. Bunker, and C. Munro. 2001. Effects of crustacean traps on benthic fauna. ICES Journal of Marine Science. 58(1):11-20.

Feder, H., and S. Jewett. 1981. Feeding interactions in the EBS with emphasis on the benthos. The Eastern Bering Sea Shelf: Oceanography and Resources, D.W. Hood and J.A. Calder, eds. OMPA/NOAA, University of Washington Press, Seattle, p. 69.

Fossa, J.H., P.B. Mortensen, and D.M. Furevik. 2002. The deep-water coral *Lophelia pertusa* in Norwegian waters distribution and fishery impacts. Hydrobiologia 471: 1-12.

Francis, R.C., S.R Hare, A.B. Hollowed, and W.S. Wooster. 1998. Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific. Fish. Oceanogr. **7**: 1-21.

Fredin, R. 1987. History of regulation of Alaska groundfish fisheries. NWAFC Processed Report 87-07.

Freese, J.L. 2001. Trawl induced damage to sponges observed from a research submersible. Marine Fisheries Review 63(3) 7-13.

Freese, L., P.J.Auster, J. Heifetz, and B.L. Wing. 1999. Effects of trawling on seafloor habitat and associated invertebrate taxa in the GOA. Marine Ecology Progress Series 182:119-126.

Freese, J.L. and B.L. Wing. 2004. Juvenile red rockfish, Sebastes sp., associations with sponges in the GOA. Mar. Fish. Rev. 65:38-42 (in press).

Fritz, L.W., A. Greig, and R.F. Reuter. 1998. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the BS, AI, and GOA regions based on groundfish fishery observer data. NOAA Tech. Memo. NMFS-AFSC-88. 179 p.

Fujioka, J. 2002. Presentation to the EFH Committee of the North Pacific Fisheries Management Council, Sitka Alaska.

Gharrett, A.J., Z. Li, C.M. Kondzela, and A.W. Kendall. 2002. Final report: species of rockfish (*Sebastes* spp.) collected during ABL-OCC cruises in the GOA in 1998-2002. (Unpubl. manuscr. available from the NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau AK 99801).

Gilkinson, K., M. Paulin, S. Hurley, and P. Schwinghamer. 1998. Impacts of trawl door scouring on infaunal bivalves: results of a physical trawl door model/dense sand interaction Journal of Experimental Marine Biology and Ecology 224(2):291-312.

Gittings, S.R., T. J. Bright, A. Choi, and R.R. Barnett. 1988. The recovery process in a mechanically damaged coral reef community: Recruitment and growth. Proceedings of the Sixth International Coral Reef Symposium 2:225-230.

Grant, J. 2000. Modelling approaches to dredging impacts and their role in scallop population dynamics. Pages 27-36 in ADF&G, 2000. A workshop examining potential fishing effects on population dynamics and benthic community structure of scallops with emphasis on the weathervane scallop *Patinopecten caurinus* in Alaska waters. ADF&G Special Publication 14.

Gunderson, D.R. 1997. Spatial patterns in the dynamics of slope rockfish stocks and their implications for management. Fish. Bull. 95: 219-230.

Gunderson, D.R. 1977. Population biology of Pacific Ocean perch, Sebastes alutus, stocks in the Washington-Queen Charlotte Sound region, and their response to fishing. Fish. Bull. 75: 369-403.

Gunderson, D.R., S.J. Westrheim, R.L. Demory, and M.E. Fraidenburg. 1976. The status of Pacific ocean perch (*Sebastes alutus*) stocks off British Columbia, Washington, and Oregon in 1974. Tech. Rep. Fish. Mar. Serv. Res. Dev. No. 690.

Gunderson, D.R. 1971. Evidence that Pacific ocean perch (*Sebastes alutus*) in Queen Charlotte Sound form aggregations that have different biological characteristics. J. Fish. Res Bd. Can. 29:1061-1070.

Gregory, R.S. and J.T. Anderson. 1997. Substrate selection and use of protective cover by juvenile Atlantic cod *Gadus morhua* in inshore waters of Newfoundland. Marine Ecology Progress Series. 146(1-3). pp 9-20.

Hanselman, D.H., Heifetz, J., Fujioka, J., and Ianelli, J. 2003. GOA Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA. North Pacific Fisheries Management Council. p. 429-479.

Hanselman, D.H., T.J. Quinn II, J. Heifetz, D. Clausen, and C. Lunsford. 2001. Spatial inferences from adaptive cluster sampling of GOA rockfish. *In* Spatial Processes and Management of Marine Populations. University of Alaska Sea Grant, PO Box 755040 203 O'Neill Bldg. Fairbanks AK 99775-5040, [URL http //www.uaf.alaska.edu/seagrant/].

Hart, J.L. 1973. Pacific Fishes of Canada. Bulletin 180, Fisheries Research Board of Canada. 740 p.

Heifetz, J. 2002. Coral in Alaska: distribution, abundance, and species associations. Hydrobiologia 471: 19-28.

Hennick, D.P. 1973. Sea scallop, *Patinopecten caurinus*, investigations in Alaska. Alaska Department of Fish & Game, Division of Commercial Fisheries, Completion Report 5-23-R, Juneau, Alaska.

Hobson, E.S., J.R.Chess, and D.F. Howard. 2001. Interannual variation in predation on first-year Sebastes spp. by three northern California predators. Fish. Bull. 99: 292-302.

Hollowed, A., J. N. Ianelli, and P. Livingston. 2000. Including predation mortality in stock assessments: A case study for GOA pollock. ICES J. Mar. Sci 57(2):279-293.

Hunt, Jr., G.L., P. Stabeno, G. Walters, E. Sinclair, R.D. Brodeur, J.M. Napp, and N.A. Bond. 2002. Climate change and control of the southeastern BS pelagic ecosystem. Deep-Sea Res. Pt. II, 49(26), 5821–5853.

Ianelli, J.N., S. Barbeaux, T. Honkalehto, N. Williamson and G. Walters. 2004a. EBS Walleye Pollock Stock Assessment. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI regions. Prepared by the BSAI Plan Team, North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510. North Pacific Fisheries Management Council, Anchorage, AK.

Ianelli, J. N., T. K. Wilderbuer, and T. M. Sample. 2004b. Greenland turbot. *In* Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the BSAI Region as Projected for 2005. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

International North Pacific Fisheries Commission (INPFC; now the North Pacific Anadromous Fish Commission). 1968. INPFC document number 1148.

INPFC 1964. Condition of the king crab resource in the EBS. By K. Niwa and H. Fujita. Fisheries Agency of Japan. INPFC document number 765.

INPFC 1959. Progress report on king crab investigations - 1959. INPFC document number 316.

Ito, D.H. 1999. Assessing shortraker and rougheye rockfishes in the GOA: addressing a problem of habitat specificity and sampling capability. Ph.D. Dissertation, Univ. Washington, Seattle. 205 p.

Johnson, K.A. 2002. A review of national and international literature on the effects of fishing on benthic habitats. NOAA Technical Memorandum NMFS-FSPO-57. 72 pp.

Kenchington, E.L.R., J. Prena, K.D. Gilkinson, D.C. Gordon, K. MacIsaac, C. Bourbonnais, P.J. Schwinghamer, T.W. Rowell, D.L McKeown, and W.P. Vass. 2001. Effects of experimental otter trawling on the macrofauna of a sandy bottom ecosystem on the Grand Banks of Newfoundland. Canadian Journal of Fisheries and Aquatic Sciences. 58(6):1043-1057.

Kendall, A.W. and W.H. Lenarz. 1986. Status of early life history studies of northeast Pacific rockfishes. *Proceedings of the International Rockfish Symposium*, Anchorage, Alaska, pp. 99-117. *In* National Marine Fisheries Service 2001(a).

Kendall, A.W., Jr. 2000. An historical review of Sebastes taxonomy and systematics. Mar. Fish. Rev. 62: 1-16.

Kimura D.K. and L.L. Ronholt. 1988. In R.G. Bakkala (editor), Condition of groundfish resources of the EBS and AI region in 1987, p. 143-171. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-139.

Krieger, K. 2001. Coral impacted by fishing gear in the GOA. Proceedings of the First International Symposium on Deepwater Corals. (Ecology Action Centre and Nova Scotia Museum, Halifax, Nova Scotia 106-117).

Krieger, K. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fishery Bulletin 91(1):87-96.

Krieger, K. 1992. Shortraker rockfish, *Sebastes borealis*, observed from a manned submersible. Marine Fisheries Review. 54(4):34-37.

Krieger, K. J. 1997. Sablefish, *Anoplopoma fimbria*, observed from a manned submersible. *In* M. Saunders and M. Wilkens (eds.). Proceedings of the International Symposium on the Biology and Management of Sablefish. pp 115-121. NOAA Tech. Rep. 130.

Krieger, K.J. and B.L. Wing. 2002. Megafauna associations with deepwater corals (*Primnoa* spp.) in the GOA. Hydrobiologia 471: 83-90.

Krieger, K.J. and D.H. Ito. 1999. Distribution and abundance of shortraker rockfish, Sebastes borealis, and rougheye rockfish, S. aleutianus, determined from a manned submersible. Fish. Bull. 97: 264-272.

Laidig, T.E., P.B. Adams, and W.M. Samiere. 1997. Feeding habits of sablefish, *Anoplopoma fimbria*, off the coast of Oregon and California. *In* M. Saunders and M. Wilkens (eds.). Proceedings of the International Symposium on the Biology and Management of Sablefish. pp 65-80. NOAA Tech. Rep. 130.

Lang, G.M, C.W. Derrah, and P.A. Livingston. 2003. Groundfish food habits and predation on commercially important prey species in the EBS from 1993 through 1996. AFSC processed report 2003-04. NMFS, NOAA, Dept. Commer., U. S., p. 351.

Laurel, B.J., Gregory, R.S. and J.A. Brown. 2003. Settlement and distribution of Age-0 juvenile cod, *Gadus morhua* and *G. ogac*, following a large-scale habitat manipulation. Marine Ecology Progress Series. 262. pp. 241-252.

Li, Z. 2004. Phylogenetic relationships and identification of juveniles of the genus Sebastes. University of Alaska-Fairbanks, School of Fisheries and Ocean Sciences. M.S. Thesis.

Leys, S.P. and N.R.J. Lauzon. 1998. Hexactinellid sponge ecology: growth rates and seasonality in deep water sponges. J. Exper. Mar. Biol. and Ecol. 230(1): 111-129.

Loher, T. 2001. Recruitment variability in southeast BS red king crab (*Paralithodes camtschaticus*): the roles of early juvenile habitat requirements, spatial population structure, and physical forcing mechanisms. Ph.D. Dissertation, Univ. Washington, Seattle.

Loher, T. and D.A. Armstrong. 2000. Effects of habitat complexity and relative larval supply on the establishment of early benthic phase red king crab (*Paralithodes camtschaticus* Tilesius, 1815) populations in Auke Bay, Alaska. J. of Exp. Mar. Bio. And Ecol. 245(2000) 83-109.

Love, M.S., M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. University of California Press, Berkeley, CA. 414 p.

Lowe, S. A. and R. Lauth. 2003. Assessment of GOA Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the GOA. North Pacific Fisheries Management Council, P.O. Box 103136, Anchorage, AK.

Lowe, S., J. Ianelli, H. Zenger, K. Aydin, and R. Lauth. 2004. Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions. North Pacific Fisheries Management Council, P.O. Box 103136, Anchorage, AK.

Lowe, S.A., D.M. Van Doornik, and G.A. Winans. 1998. Geographic variation in genetic and growth patterns of Atka mackerel, *Pleurogrammus monopterygius* (Hexagrammidae), in the Aleutian archipelago. Fish. Bull. U.S. 96:502-515.

Lyubimova, T.G. 1965. The main stages of the life cycle of Pacific ocean perch (*Sebastes alutus* Gilbert) in the GOA. *In* Soviet fisheries investigations in the northeast Pacific, Part 4: 85-111. (Transl. from Russian by Clearinghouse Fed. Sci. Tech. Inform., Springfield, VA, TT67-51206).

Lunsford, C.R. 1999. Distribution patterns and reproductive aspects of Pacific ocean perch (*Sebastes alutus*) in the GOA. Master's Thesis. University of Alaska Fairbanks, Juneau, Alaska. p. 154.

Lunsford, C.R., D.H. Hanselman, S.K. Shotwell, and D.M. Clausen. 2004. Pelagic shelf rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 465-498. North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

Lunsford, C.R., L. Haldorson, J.T. Fujioka, and T. J. Quinn II. 2001. Distribution patterns and survey design considerations of Pacific ocean perch (*Sebastes alutus*) in the GOA. Spatial Processes and Management of Marine Populations, Alaska Sea Grant College Program. Lowell Wakefield Fisheries Symposium. Anchorage, Alaska., AK-SG-01- 02.

MacDonald, B.A. 2000. Potential impacts of increased particle concentrations on scallop feeding and energetics. Pages 20-26 in ADF&G, 2000. A workshop examining potential fishing effects on population dynamics and benthic community structure of scallops with emphasis on the weathervane scallop *Patinopecten caurinus* in Alaska waters. ADF&G Special Publication 14.

Mackas, D.L., and A. Tsuda. 1999. Mesozooplankton in the eastern and western subarctic Pacific: community structure, seasonal life histories, and interannual variability. Prog. Oceanogr. 43: 335-363.

Major, R.L. and H.H. Shippen. 1970. Synopsis of biological data on Pacific ocean perch, *Sebastodes alutus*. FAO Fisheries Synopsis No. 79, NOAA Circular 347, p. 38.

Matarese, A.C., D.M. Blood, S.J. Picquelle, and J.L. Benson. 2003. Abundance and distribution patterns of ichthyoplankton from the northeast Pacific Ocean and BS ecosystems based on research conducted by the AFSC (1972-1996). NOAA Professional Papers 1:1 -281.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. NOAA Tech. Rep. NMFS 80, 652 p.

Matthews, K.R., J.R. Candy, L.J. Richards, and C.M. Hand. 1989. Experimental gillnet fishing on trawlable and untrawlable areas off northwestern Vancouver Island, from the MV Caledonian, August 15-28, 1989. *Can. Manuscr. Rep. Fish. Aquat. Sci. 2046*. p. 78.

McConnaughey, R.A. 2003. AFSC, personal communication.

McConnaughey, R.A., K.L. Mier, and C.B. Dew. 2000. An examination of chronic trawling effects on soft-bottom benthos of the EBS. ICES Journal of Marine Sciences. 57(5):1377-1388.

McConnaughey, R.A. and K.R. Smith. 2000. Association between flatfish abundance and surficial sediments in the EBS. Canadian journal of fisheries and aquatic sciences. 57(12):2410-2419.

McDermott, S.F. 1994. Reproductive biology of rougheye and shortraker rockfish, *Sebastes aleutianus* and *Sebastes borealis*. M.S. Thesis, Univ. Washington, Seattle. 76 p.

McDermott, S.F. and S.A. Lowe. 1997. The reproductive cycle of Atka mackerel, *Pleurogrammus monopterygius*, in Alaska waters. Fish. Bull. U.S. 95:231-333.

McFarlane, G.A. and W.D. Nagata. 1988. Overview of sablefish mariculture and its potential for industry. Alaska Sea Grant Report 88-4. PP. 105-120. University of Alaska Fairbanks, Fairbanks, Alaska 99775. Mecklenburg, C.W., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda Maryland. 1037 p.

Mecklenburg, C.W., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesa, Maryland. 1037 p.

Moiseev, P.A. and I.A. Paraketsov. 1961. Information on the ecology of rockfishes (family *Scorpaenidae*) of the northern part of the Pacific Ocean. Transl. from Russian by Fish. Res. Bd. Can., Pac. Biol. Sta., Nanaimo B.C., FRB Transl. Ser. 358).

Moles, A. and B.L. Norcross. 1995. Sediment preference in juvenile Pacific flatfishes. Neth. J. Sea Res. 34(1-3): 177-182 (1995).

Moore, P.G. 1999. Fisheries exploitation and marine habitat conservation: a strategy for rational coexistence. Aquatic Conserv: Mar. Freshw. Ecosyst. 9: 585-591.

Moran, M.J. and P.C. Stephenson. 2000. Effects of otter trawling on macrobenthos and management of demersal scalefish fisheries on the continental shelf of north-western Australia. 2000. ICES Journal of Marine Science. 57(3):510-516.

Nasby-Lucas, N.M., Embley, B.W., Hixon, M.A., Merle, S.G., Tissot, B.N., and Wright, D.J. 2002. Integration of submersible transect data and high-resolution multibeam sonar imagery for a habitat-based groundfish assessment of Heceta Bank, Oregon. Fishery Bulletin 100: 739-751.

National Marine Fisheries Service (NMFS). 2004. Website: Resources Assessment and Conservation Engineering Field Videos—Underwater Habitat Footage, AFSC. http://www.afsc.noaa.gob/race/media/videos/vids_habitat.htm.

NMFS. 2004. Final Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement. DOC, NOAA, National Marine Fisheries Service, Alaska Region, P. O. Box 21668, Juneau, Alaska 99802-1668. Volumes I-VII.

NMFS. 2003. Annual Report to Congress on the Status of U.S. Fisheries, 2002. U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Silver Spring, MD. 156 p.

NMFS. 2002. Report to industry on the 2002 eastern BS crab survey. AFSC Processed Report, 2002-05, U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115-0070.

NRC (National Research Council). 2002. Effects of trawling and dredging on seafloor habitat. National Academy Press, Washington D.C. 126 pp.

Nichol, D.G. and E.I. Acuna. 2000. Annual and batch fecundities of yellowfin sole, *Limanda aspera*, in the EBS. Fish. Bull 99(1):108-122.

Nichol, D.G. and D.A. Somerton. 2002. Diurnal vertical migration of the Atka mackerel *Pleurogrammus monopterygius* as shown by archival tags. Mar Ecol Prog Ser 239: 193-207.

Orensanz, J., B. Ernst, D. Armstrong, P. Stabeno, and P. Livingston. 2005. Contraction of the geographic range of distribution of snow crab (Chionoecetes opilio) in the Eastern Bering Sea-An Environmental Ratchet? (CALCOFI SCIENTIFIC REPORTS, accepted, 2005).

Orr, J.W. and J.E. Blackburn. 2004. The dusky rockfishes (Teleostei: Scorpaeniformes) of the north Pacific Ocean: resurrection of *Sebastes variabilis* (Pallas, 1814) and a redescription of *Sebastes ciliatus* (Tilesius, 1813). Fish. Bull., U.S. 102:328-348. Online. (.pdf, 569KB).

Pearcy, W.G., D.L. Stein, M.A. Hixon, E.K. Pikitch, W.H. Barss, and R.M. Starr. 1989. Submersible observations of deep-reef fishes of Heceta Bank, Oregon. *Fishery Bulletin*, 87:955-965. *In* National Marine Fisheries Service 2001(a).

Prena, J., P. Schwinghamer, T.W. Rowell, D.C. Jr Gordon, K.D. Gilkinson, W.P. Vass, and D.L McKeown. 1999. Experimental otter trawling on a sandy bottom ecosystem of the Grand Banks of Newfoundland: Analysis of trawl bycatch and effects on epifauna. Marine Ecology Progress Series. 181:107-124.

Reuter, R.F. 1999. Describing dusky rockfish (*Sebastes ciliatus*) habitat in the GOA using historical data. M.S. Thesis, California State University, Hayward CA. 83 p.

Reuter, R.F., and P.D. Spencer. 2004. 2004 BSAI other rockfish *In* Appendix A stock assessment and fishery evaluation report for the groundfish resources of the BS and AI region, North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Richards, L.J., and N. Olsen. 1996. Slope rockfish assessment for the west coast of Canada in 1996 and recommended yeilds for 1997. Can. Tech. Rep. Fish. Aquat. Sci.: 91 p.

Rijnsdorp, A.D. and P.I. van Leeuwen. 1996. Changes in growth of North Sea plaice since 1950 in relation to density, eutrophication, beam-trawl effort and temperature. ICES J. Marine Science, 53: 1199-1213.

Rijnsdorp, A.D., A.M. Buys, F. Storbeck, and E.G. Visser. 1998. Micro-scale distribution of beam trawl effort in the southern North Sea between 1993 and 1996 in relation to the trawling frequency of the seabed and the impact on benthic organisms. ICES Journal of Marine Science 55:403-419. (B-5)

Rooper, C. and Boldt, J. 2004. Distribution of juvenile Pacific ocean perch (*Sebastes alutus*) in the AI. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI region as projected for 2005. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501.

Rose, C.S. 2002. An analysis of the effects of fishing on fish habitats of the waers off of Alaska. White paper prepared for the EFH Committee of the North Pacific Management Council. (B-3).

Rutecki, T.L. and E.R. Varosi. 1997. Distribution, age, and growth of juvenile sablefish, *Anoplopoma fimbria*, in Southeast Alaska. *In* M. Saunders and M. Wilkens (eds.). Proceedings of the International Symposium on the Biology and Management of Sablefish. pp 45-54. NOAA Tech. Rep. 130.

Ryer, C.H., A.W. Stoner, and R.H. Titgen. 2004. Behavioral mechanisms underlying the refuge value of benthic habitat structure for two flatfishes with differing anti-predator strategies. Marine Ecology Progress Series, Vol. 268:231-243.

Sasaki, T. 1985. Studies on the sablefish resources in the North Pacific Ocean. Bulletin 22, (1-108), Far Seas Fishery Laboratory. Shimizu, 424, Japan.

Schnute, J.T., R. Haigh, B.A. Krishka, and P. Starr. 2001. Pacific Ocean Perch Assessment for the West Coast of Canada in 2001. DFO Research Document 2001: 96 pp.Scott, B. 1995. Oceanographic features that define the habitat of Pacific Ocean perch, Sebastes alutus. Fish. Oceanogr. 4: 147-157.

Schwinghamer, P., D.C. Gordon, Jr., T.W. Rowell, J.P. Prena, D.L McKeown, G. Sonnichsen, and J.Y. Guignes. 1998. Effects of experimental otter trawling on surficial sediment properties of a sandy-bottom ecosystem on the Grand Banks of Newfoundland. Conservation Biology 12: 1215-1222.

Scott, B. 1995. Oceanographic features that define the habitat of Pacific ocean perch, *Sebastes alutus*. Fish. Oceanogr. 4:147-157.

Shima, M., A.B. Hollowed, and G.R. VanBlaricom. 2002. Changes over time in the spatial distribution of walleye pollock (*Theraga chalcogramma*) in the GOA, 1984-1996. Fish. Bull. 100:307-323.

Seeb, L. W. and A.W. Kendall Jr. 1991. Allozyme polymorphisms permit the identification of larva and juvenile rockfishes of the genus *Sebastes*. Environ. Biol. Fish. 30:191–201.

Shester, G. 2004. Letter dated April 13, 2004 to Dr. James Balsiger, Alaska Regional Administrator, National Marine Fisheries Service re: Comments on Alaska Region EFH Draft Environmental Impact Statement. 24 p.

Siegel, V. 2000. Krill (Euphausiacea) demography and variability in abundance and distribution. Can. J. Fish. Aquat. Sci. 57 (Sup. 3): 151-167.

Sigler, M.F., C.L. Lunsford, J.T. Fujioka, and S.A. Lowe. 2004. Sablefish *in* November 2004 Stock Assessment and Fishery Evaluation Report. NPFMC.

Sigler, M.F., C.R. Lunsford, J.T. Fujioka and S.A. Lowe. 2002. Alaska sablefish assessment for 2003. In Stock assessment and fishery evaluation report for the groundfish resources of the GOA as projected for 2003. Available from North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252.

Sigler, M. F., T. L. Rutecki, D.L. Courtney, J.F. Karinen, and M.S.Yang. 2001. Young-of-the-year sablefish abundance, growth, and diet. Alaska Fisheries Research Bulletin 8(1): 57-70.

Sigler, M. 2003. Personal observation. AFSC, Auke Bay Laboratory.

Smith, C.J., K.N. Papadopoulou, S. Diliberto. 2000. Impact of otter trawling on eastern Mediterranean commercial trawl fishing ground. ICES Journal of Marine Science 55:1340-1351. (B-16).

Smith, K.R. and R.A. McConnaughey. 1999. Surficial sediments of the EBS Continental Shelf: EBSSED Database Documentation.

Sogard, S.M. and B.L. Olla. 1993. The influence of predator pressure on utilization of artificial seagrass habitats by juvenile walleye pollock, *Theragra chalcogramma*. Env. Biol. Fish. 37:57-65.

Sparks-McConkey, P.J. and L. Watling. 2001. Effects on the ecological integrity of a soft-bottom habitat from a trawling disturbance. Hydrobiologia. 456(1-3):73-85.

Spencer, P.D. and J.N. Ianelli. 2004. Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI region as projected for 2005, pp. 675-746. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501.

Spencer, P.D. and J.N. Ianelli. 2003. Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI region as projected for 2004, pp. 563-610. North Pacific Fishery Management Council, Anchorage, AK.

Spencer, P.D. and J.N. Ianelli. 2002. Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI region, pp. 515-558. North Pacific Fishery Management Council, Anchorage, AK.

Spencer, P.D., G.E. Walters, and T.K. Wilderbuer. 2002. Flathead sole. *In* Appendix A Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Region. P 361-408. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Spencer, P., T.K. Wilderbuer, and T.M. Sample. 2004a. Flathead sole. *In* Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the BSAI Region as Projected for 2005. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

Spencer, P., T.K. Wilderbuer, and T.M. Sample. 2004b. Alaska plaice. *In* Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the BSAI Region as Projected for 2005. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

Stevens, B.G., and J. Kittaka. 1998. Postlarval settling behavior, substrate preference, and time to metaorphosis for red king crab *Paralithodes camtschaticus*. Marine Ecology Progress Series, 167, pp. 197-205.

Stokesbury, K.D.E. 2000. Physical and Biological Variables Influencing the Spatial Distribution of the Giant Scallop, Placopecten magellanicus. *In* A Workshop Examining Potential Fishing Effects on Population Dynamics and Benthic Community Structure of Scallops with Emphasis on the Westhervane Scallop, *Patinopecten caurinus*, in Alaskan Waters. Alaska Department of Fish and Game Special Publication 14.

Stone, R. and B. Wing. 2001. Growth and recruitment of an Alaskan shallow-water gorgonian. In Proceedings of the First International Symposium on Deep-Sea Corals. Willis on et al. Eds. p 88-94.

Stone, R. 2004. Depth distribution, fisheries interactions, and habitat of deep-sea corals in the AI off of Alaska-Preliminary research data presented at American Association for the Advancement of Science. Seattle Washington. NOAA Fisheries. AFSC. Auke Bay Laboratory.

Stoner, A.W. and A.A. Abookire. 2002. Sediment preference and size-specific distribution of young-of-the-year Pacific halibut in an Alaska nursery. J. Fish Biology (2002) 61, 540-559.

Stoner, A.W. and M.L. Ottmar. 2002. Relationships between size-specific sediment preferences and burial capabilities in juveniles of two Alaska flatfishes. J. Experimental Marine Biology and Ecology 282 (2002) 85-101.

Stoner, A.W. and R.H. Titgen. 2003. Biological structures and bottom type influence habitat choices made by Alaska flatfishes. J. Experimental Marine Biology and Ecology 292(2003) 43-59.

Straty, R.R. 1987. Habitat and behavior of juvenile Pacific rockfish (*Sebastes* spp. and *Sebastolobus alascanus*) off southeastern Alaska. NOAA Symp. Ser. Undersea Res. 2(2):109-123.

Tanasichuk, R.W. 1997. Diet of sablefish, *Anoplopoma fimbria*, from the southwest coast of Vancouver Island. *In* M. Saunders and M. Wilkens (eds.). Proceedings of the International Symposium on the Biology and Management of Sablefish. pp 93-98. NOAA Tech. Rep. 130.

Thompson, G.G. and M.W. Dorn. 2004. Assessment of the Pacific cod stock in the EBS and AI Area. *In* Plan Team for Groundfish Fisheries of the BSAI (compiler), Stock assessment and fishery evaluation report for the groundfish resources of the BSAI regions, p. 185-302. North Pacific Fishery Management Council, 605 W. 4th Avenue Suite 306, Anchorage, AK 99501.

Thompson, G.G., H.H. Zenger, and M.W. Dorn. 2004. Assessment of the Pacific cod stock in the GOA. *In* Plan Team for Groundfish Fisheries of the GOA (editor), Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 131-232. North Pacific Fishery Management Council, 605 W. 4th Avenue Suite 306, Anchorage, AK 99501.

Thrush S.F. and P.K. Dayton. 2002. Disturbance to marine benthic habitats by trawling and dredging: Implications for marine biodiversity. A nnu. Rev. Ecol. Syst. 33:449-473.

Turk, T. 2000. Distribution, Abundance, and Spatial Management of the Weathervane Scallop Fishery in Alaska. Masters Thesis, University of Washington. 231p.

Turnock, B.J. 2004. BS snow crab. *In* 2004 Stock Assessment and Fishery Evaluation report for the king and Tanner crab fisheries of the BSAI Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage AK, 99501.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2004. GOA arrowtooth flounder. In stock assessment and fishery evaluation report for the groundfish resources of the GOA. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2003a. Arrowtooth flounder. In Stock Assessment and Fishery Evaluation Report for the 1997 GOA Groundfish Fishery. GOA Groundfish Plan Team, North Pacific Fishery Management Council, P. O. Box 103136, Anchorage, AK 99510.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2003b. GOA flatfish. In Stock Assessment and Fishery Evaluation Report for the 2004 GOA Groundfish Fishery. GOA Groundfish Plan Team, North Pacific Fishery Management Council, P. O. Box 103136, Anchorage, AK 99510.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2002. Arrowtooth flounder. *In* Appendix B Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the GOA Region. P 199-228. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Turnock, B.J. and Z.T. A'mar. 2004a. GOA Dover Sole. In Stock Assessment and Fishery Evaluation Report for the 2004 GOA Groundfish Fishery. GOA Groundfish Plan Team, North Pacific Fishery Management Council, P. O. Box 103136, Anchorage, AK 99510.

Turnock, B.J. and Z.T. A'mar. 2004b. GOA Rex Sole. In Stock Assessment and Fishery Evaluation Report for the 2004 GOA Groundfish Fishery. GOA Groundfish Plan Team, North Pacific Fishery Management Council, P. O. Box 103136, Anchorage, AK 99510.

Umeda, Y., T. Sample, and R.G. Bakkala. 1983. Recruitment processes of sablefish in the EBS. In Proceedings of the International Sablefish Symposium March 1983, Anchorage, Alaska. Alaska Sea Grant Report 83-8.

Van Dolah, R.F., P.H. Wendt, and N. Nicholson. 1987. Effects of a research trawl on a hard-bottom assemblage of sponges and corals. Fisheries Research 5: 39-54.

Wahl, M. 1985. *Metridium senile*: distribution and small scale colonization by the combined strategy of locomotion and asexual reproduction (laceration). Mar. Ecol. Prog. Ser. 26:271-277.

Walters, C.J. and D. Ludwig. 1981. Effects of measurement errors on the assessment of stock-recruitment relationships. Can. J. Fish. Aquat. Sci. 38:704-710.

Walters, G.E. and T.K. Wilderbuer. 2000. Decreasing length at age in a rapidly expanding population of northern rock sole in the EBS and its effect on management advice. J. Sea Ressearch 44(2000) 17-26.

Westrheim, S.J. 1970. Survey of rockfishes, especially Pacific ocean perch, in the northeast Pacific Ocean, 1963-66. *J. Fish. Res. Bd. Can.*, 27:1,781-1,809.

Westrheim, S.J. and W.R. Harling. 1975. Age-length ralationships for 26 scorpaenids in the Northeast Pacific Ocean. Tech. Rep. Environ. Can. Fish. Mar. Serv. no. 565.

Wilderbuer, T.K, A.B. Hollowed, W.J. Ingraham Jr., P.D. Spencer, M.E. Conners, N.A. Bond, and G.E. Walters. 2002. Flatfish recruitment response to decadal climatic variability and ocean conditions in the EBS. Prog. Oceanog. 55 (2002) 235-247.

Wilderbuer, T.K. and D. Nichol. 2004a. Yellowfin sole. *In* Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the BSAI Region as Projected for 2005. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

Wilderbuer, T.K. and T.M. Sample. 2004b. Arrowtooth flounder. *In* Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the BSAI Region as Projected for 2005. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

Wilderbuer, T.K. and G.E. Walters. 2004c. Northern rock sole. *In* Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the BSAI Region as Projected for 2005. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

Wing, B.L. 1997. Distribution of sablefish, *Anoplopoma fimbria*, larvae in the Eastern GOA. *In* M. Saunders and M. Wilkens (eds.). Proceedings of the International Symposium on the Biology and Management of Sablefish. pp 13-26. NOAA Tech. Rep. 130.

Witherell, D. 2002. A preliminary evaluation of fishery effects on EFH off Alaska. North Pacific Fishery Management Council, Anchorage, AK. Unpublished draft manuscript.

Witherell, D. 1997. A brief history of bycatch management measures for EBS groundfish fisheries. Marine Fisheries Review

Witherell, D, D. Ackley, and C. Coon. 2002. An overview of salmon bycatch in Alaska groundfish fisheries. Alaska Fishery Research Bulletin (9)1:53-64.

Witherell, D. and C. Pautzke. 1997. A brief history of bycatch management measures for EBS groundfish fisheries. Marine Fisheries Review, 59(4), pp. 15-22.

Withler, R.E., T.D. Beacham, A.D. Schultze, L.J. Richards, and K.M. Miller. 2001. Co-existing populations of Pacific ocean perch, Sebastes alutus, in Queen Charlotte Sound, British Columbia. Mar. Biol. 139:1-12.

Yang, M.S. 2003. Food habits of the important groundfishes in the AI in 1994 and 1997. AFSC Proc. Rep 2003-07. 233 p. (Available from National Marine Fisheries Service, AFSC, 7600 Sand Point Way NE, Seattle WA 98115).

Yang, M.S. 1999. The trophic role of Atka mackerel, *Pleurogrammus monopterygius*, in the AI area. Fishery Bulletin, 97(4):1047-1057.

Yang, M.S. 1996. 1996. Diets of the important groundfishes in the AI in 1991. U.S. Dept. of Commer., NOAA Tech Memo. NMFS-AFSC-60, 105 p.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. of Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M.S. and M.W. Nelson. 2000. Food habits of the commercially important groundfishes in the GOA in 1990, 1993, and 1996. NOAA Tech. Memo. NMFS-AFSC-112. 174 p.

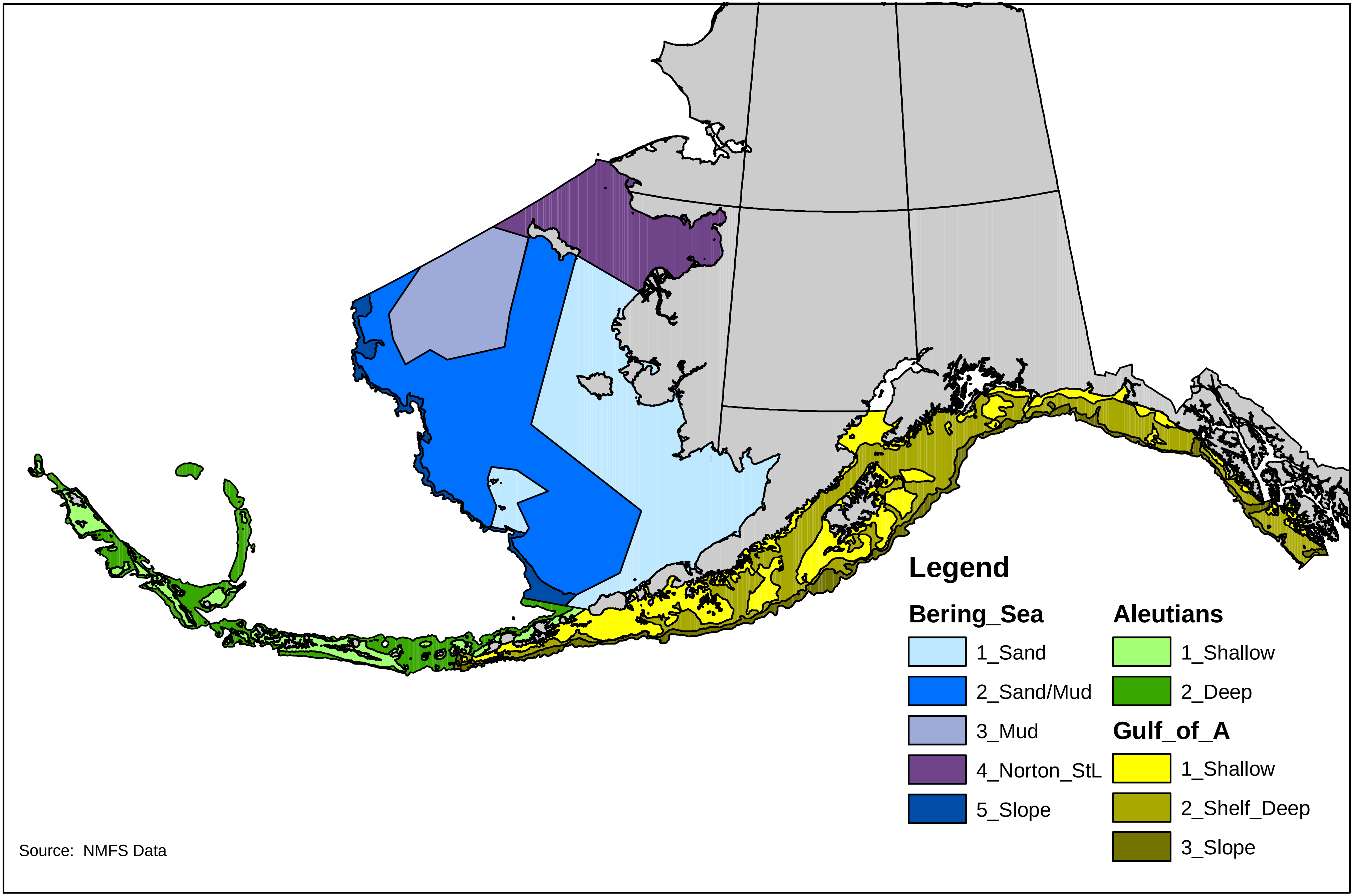
Yoklavich, M.M., H.G. Greene, G.M. Cailliet, D.E. Sullivan, R.N. Lea, and M.S. Love.. 2000. Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. Fishery Bulletin 98: 625-641.

Yoon, W.D., Cho, S.H., Lim, D., Choi, Y.K., and Lee, Y. 2000. Spatial distribution of *Euphausia pacifica* (Euphausiacea: Crustacea) in the Yellow Sea. J. Plankton Res. 22: 939-949.

Zenger, H.H., Jr. and M.F. Sigler. 1992. Relative abundance of GOA sablefish and other groundfish based on National Marine Fisheries Service longline surveys, 1988-90. U. S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-216, 103 p.

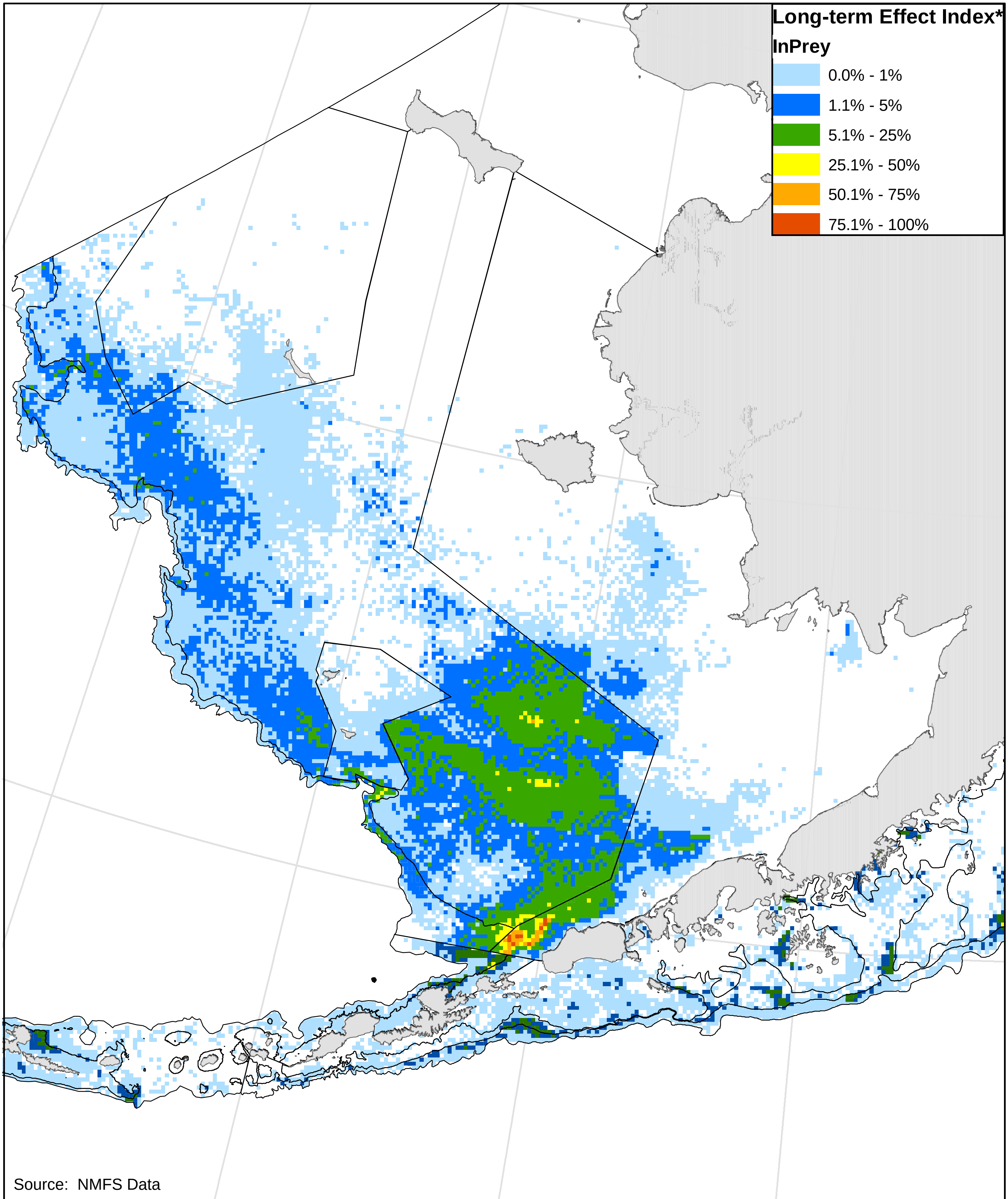
Zhang, C.I., T.K. Wilderbuer, and G.E. Walters. 1998. Biological characteristics and fishery assessment of Alaska plaice, *Pleuronectes quadrituberculatus*, in the EBS. Mar. Fish. Rev. 60(4): 16-27.

Figure B.2-1 Habitats Used for Evaluation of Fishing Activities



Source: NMFS Data

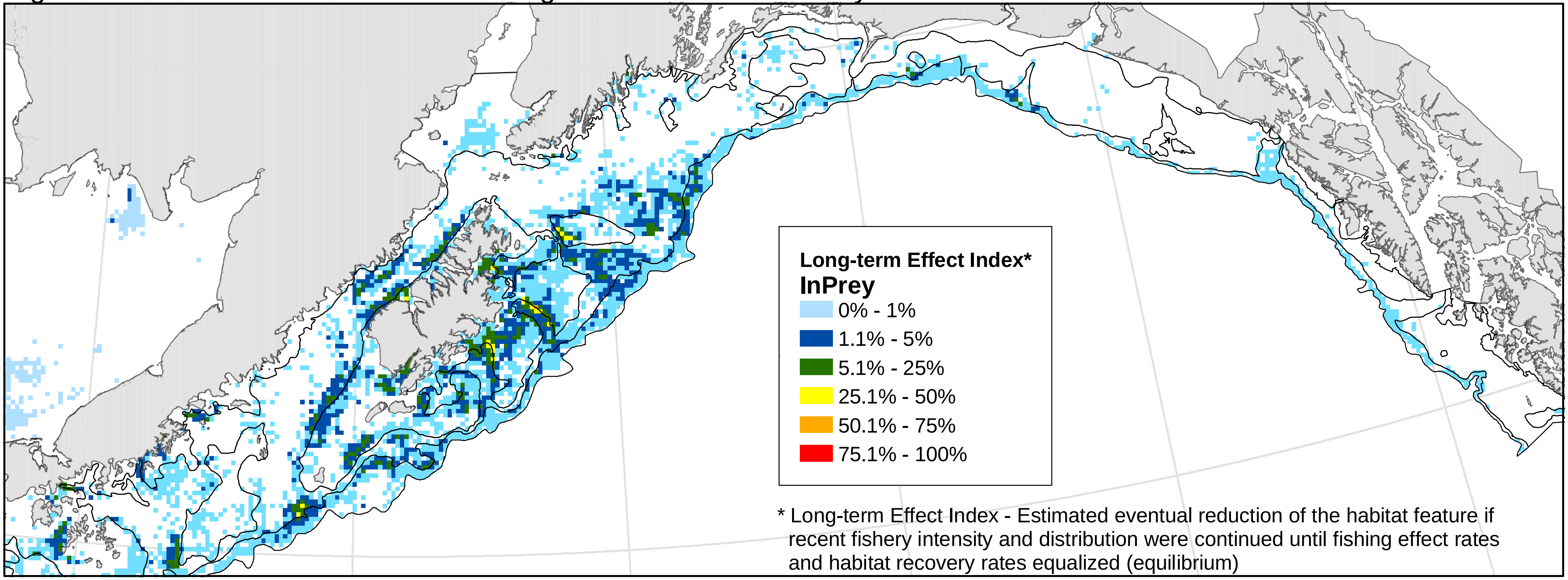
Figure B.2-2a. Distribution of Long-term Effect Index (LEI) of Fishing Effects on Infaunal Prey - Bering Sea



Source: NMFS Data

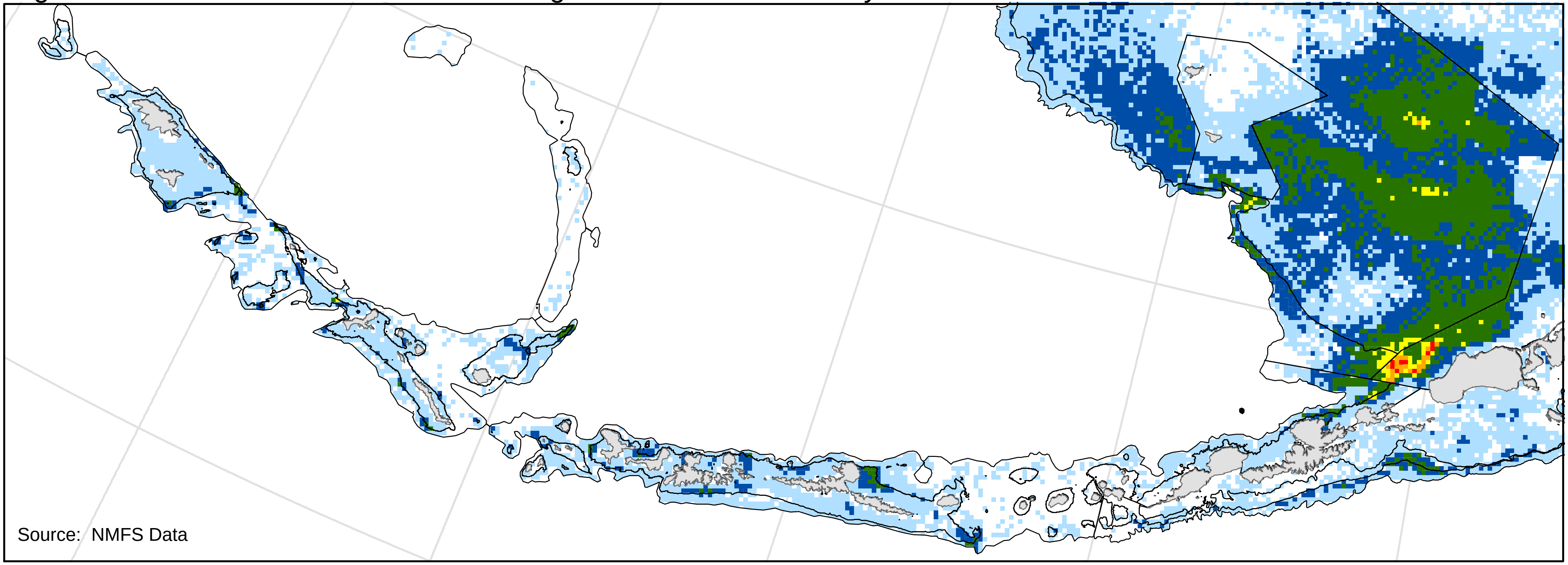
* LEI - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-2b. Distribution of LEI of Fishing Effects on Infaunal Prey - Gulf of Alaska



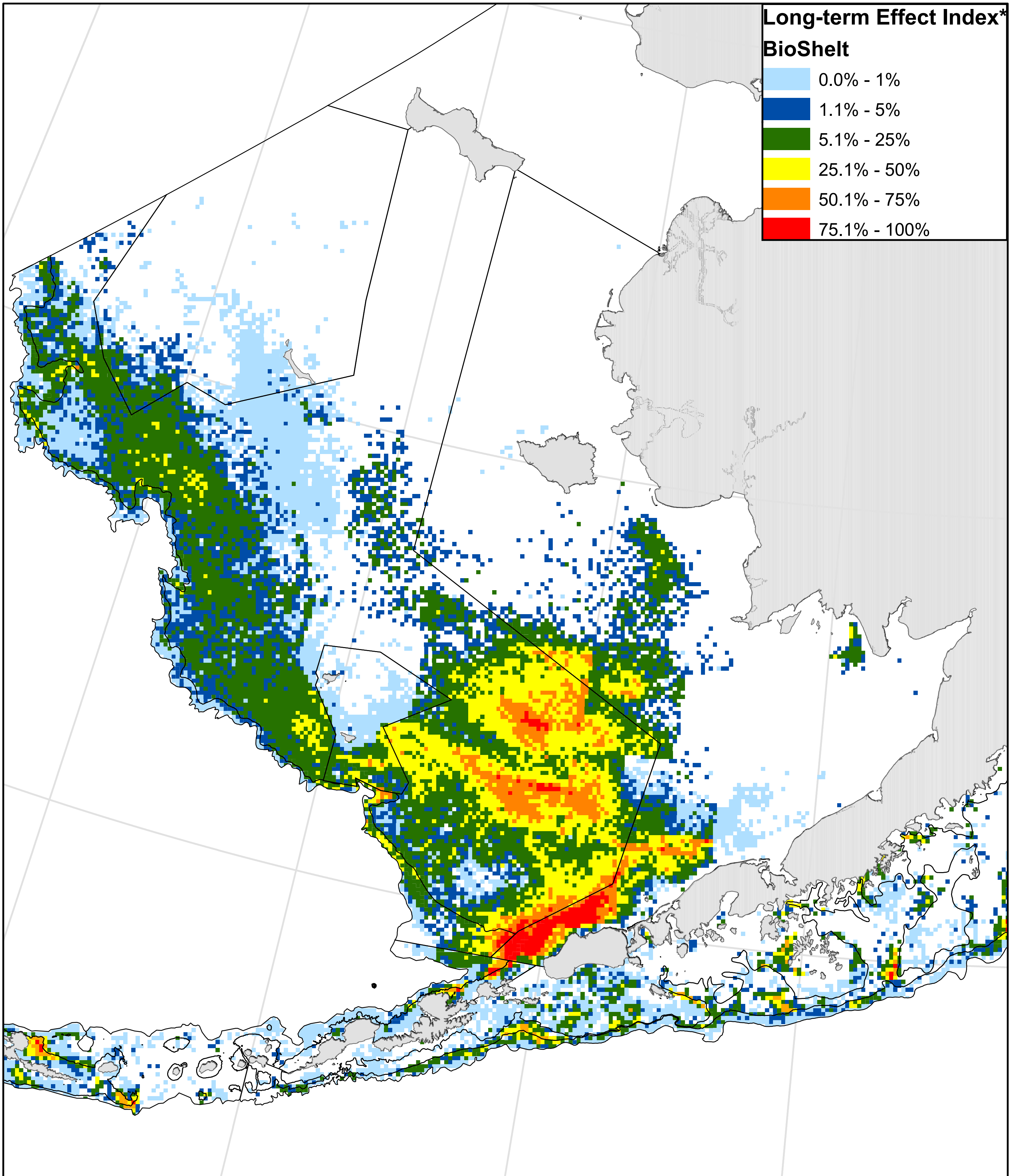
* Long-term Effect Index - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-2c. Distribution of LEI of Fishing Effects on Infaunal Prey - Aleutian Islands



Source: NMFS Data

Figure B.2-3a. Distribution of LEI of Fishing Effects on Living Structure - Bering Sea



Source: NMFS Data

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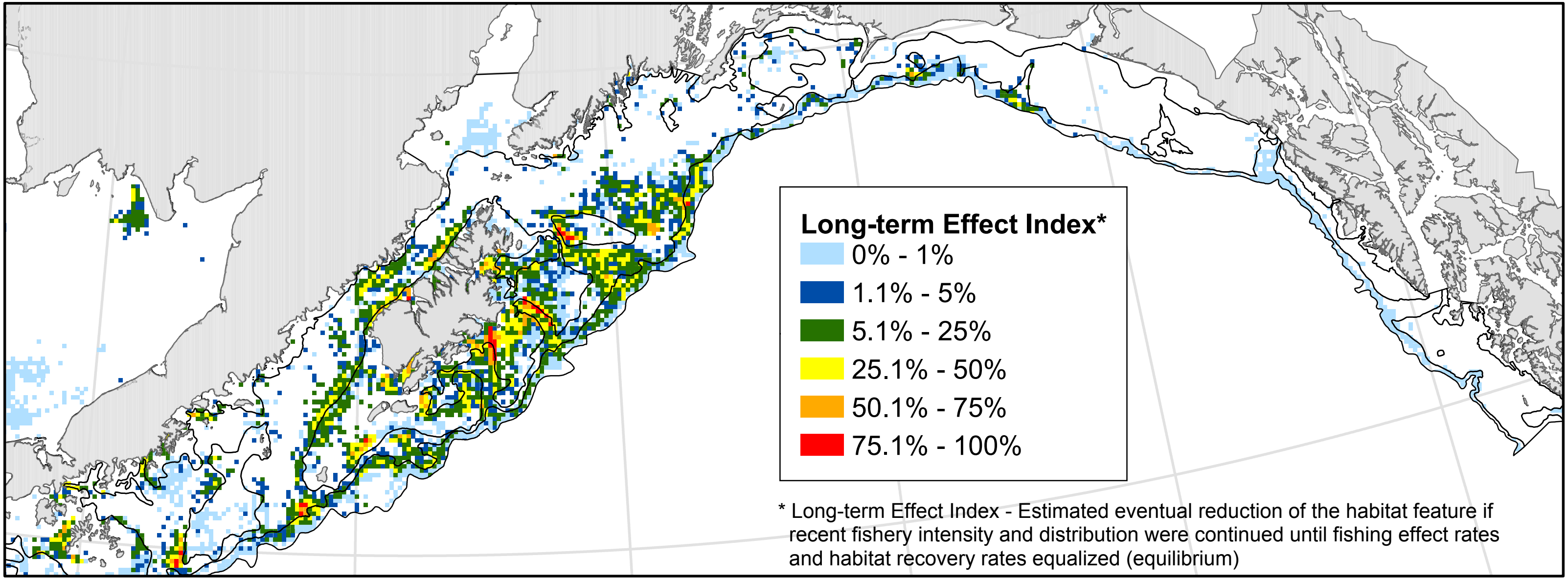
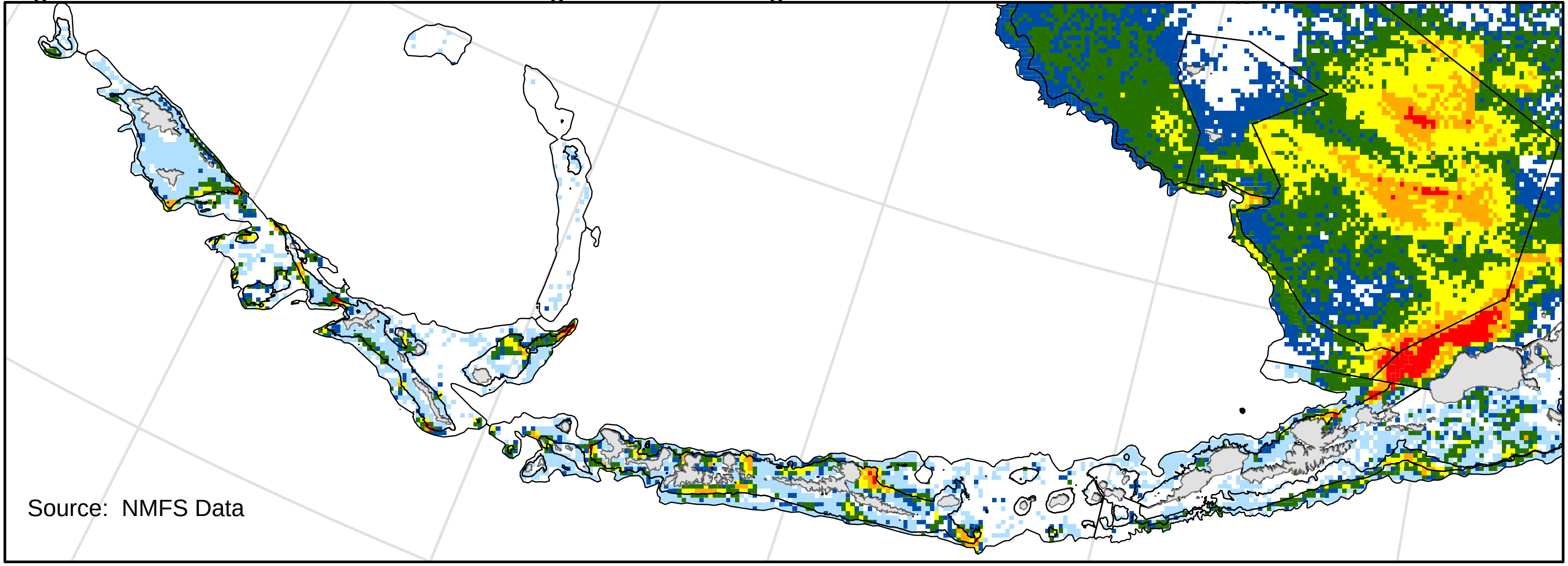
Figure B.2-3b. Distribution of LEI of Fishing Effects on Living Structure - Gulf of Alaska



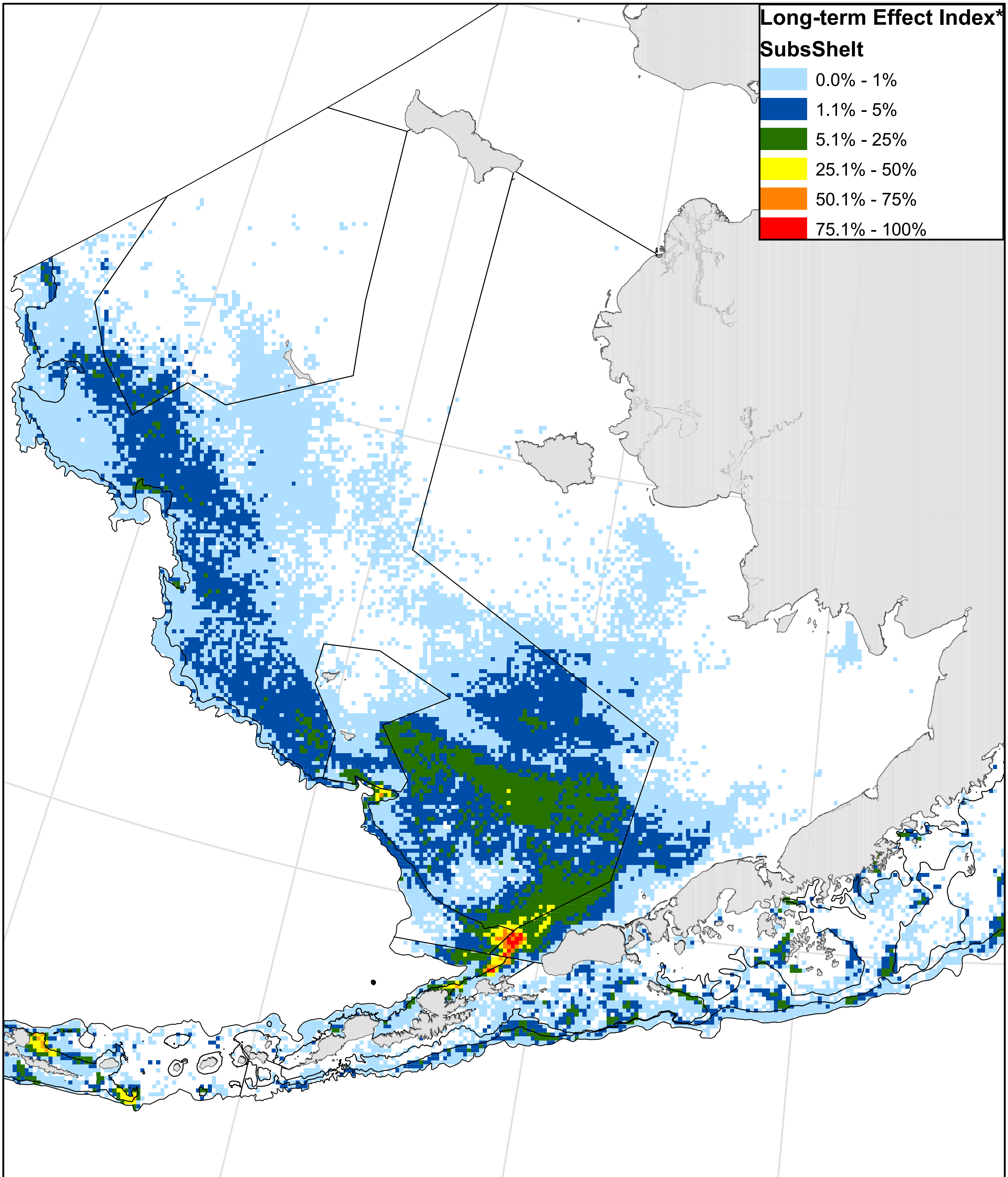
* Long-term Effect Index - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-3c. Distribution of LEI of Fishing Effects on Living Structure - Aleutian Islands



Source: NMFS Data

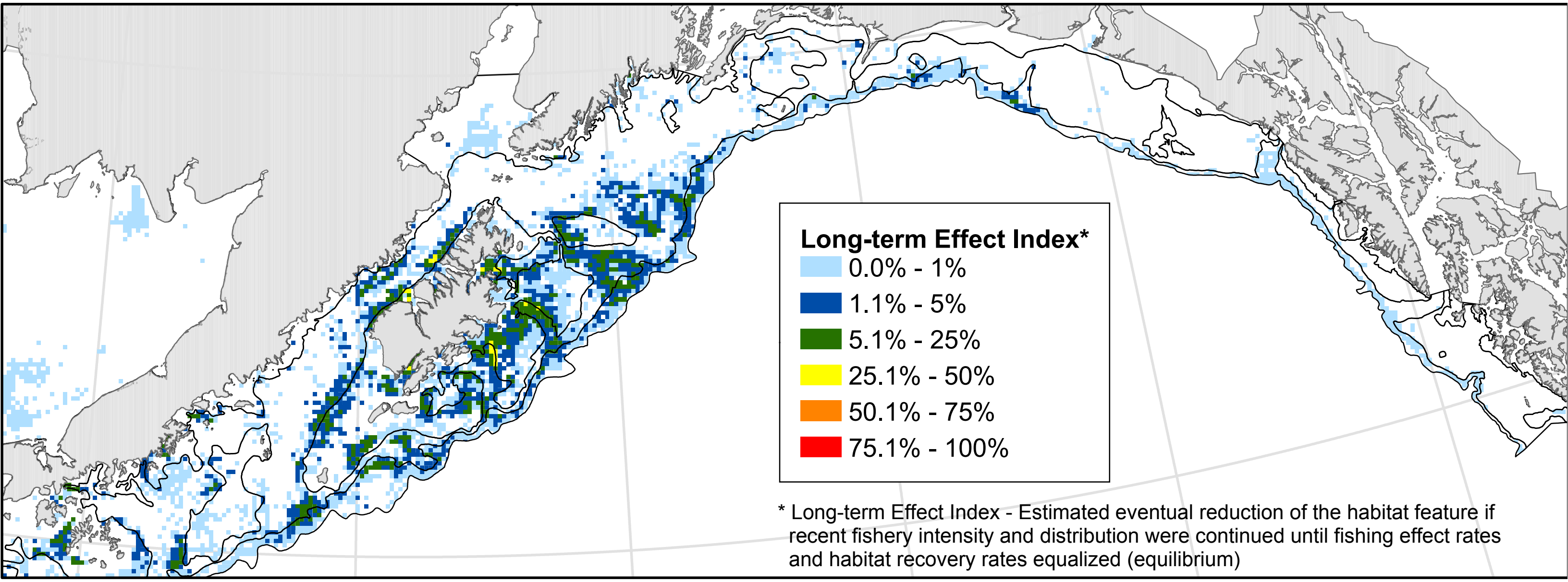
Figure B.2-4a. Distribution of LEI of Fishing Effects on Non-living Structure - Bering Sea



Source: NMFS Data

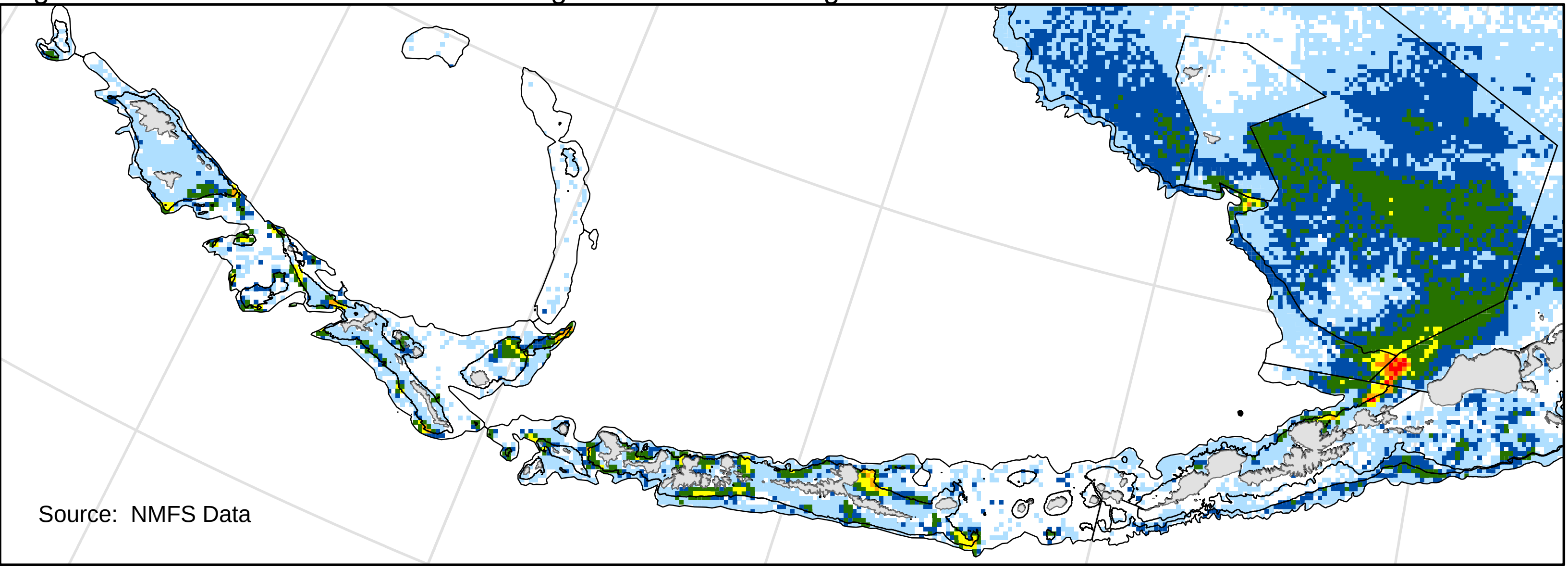
* LEI - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-4b. Distribution of LEI of Fishing Effects on Non-living Structure - Gulf of Alaska



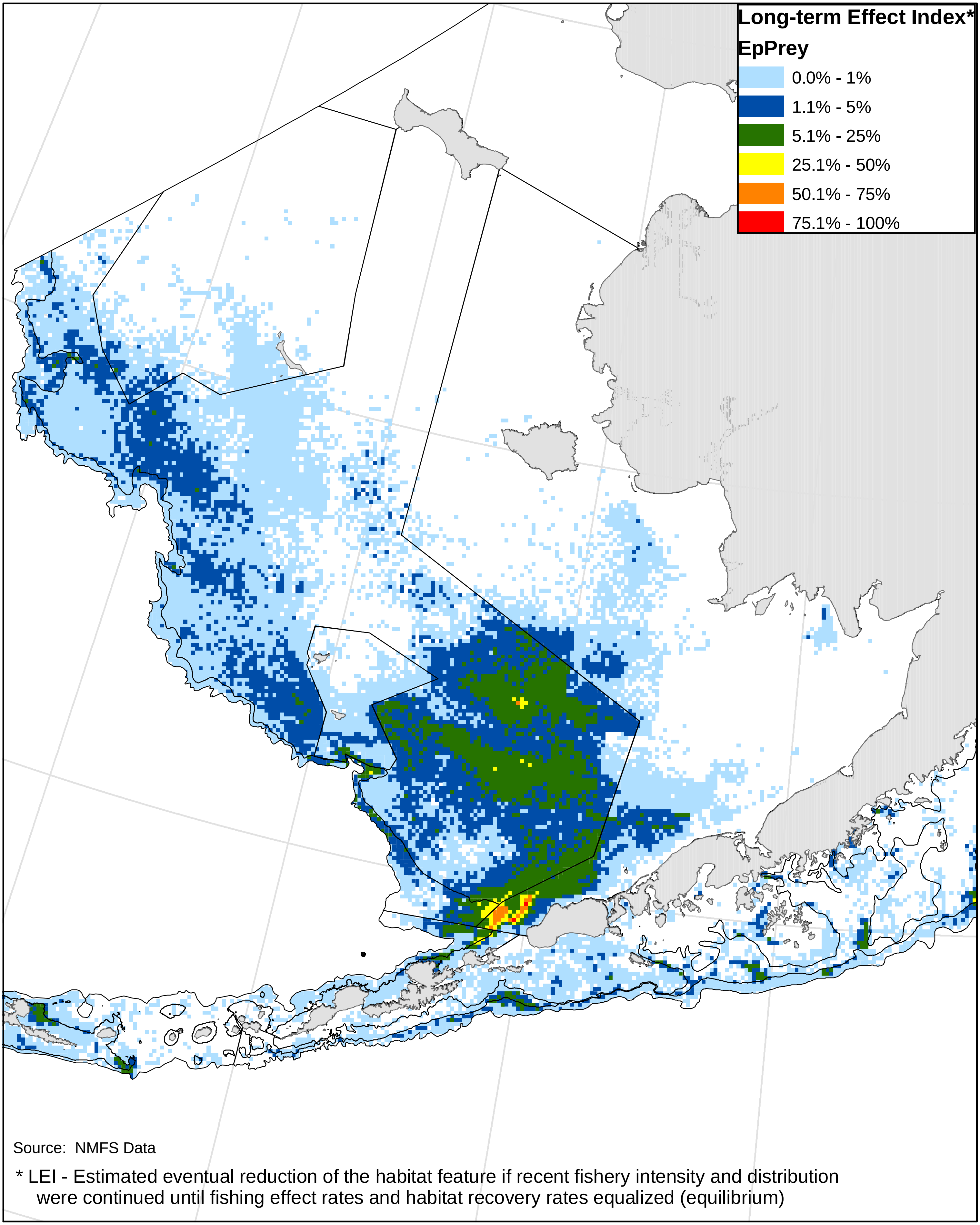
* Long-term Effect Index - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-4c. Distribution of LEI of Fishing Effects on Non-living Structure - Aleutian Islands



Source: NMFS Data

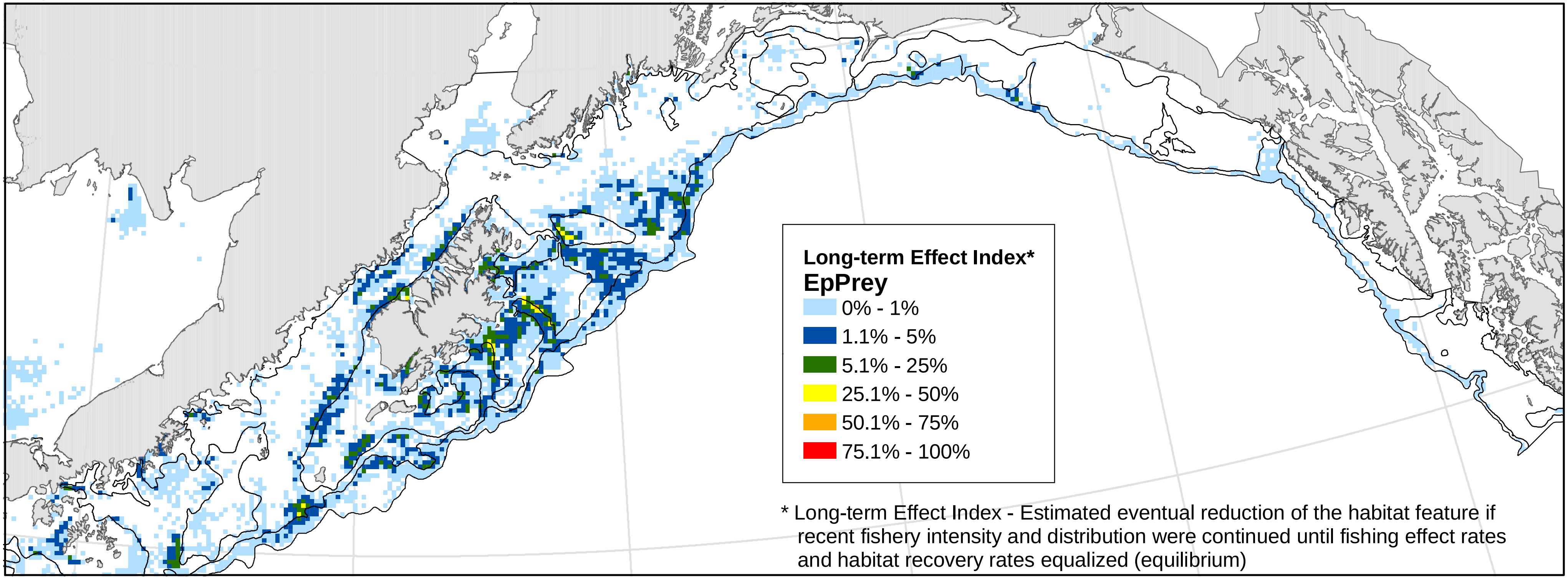
Figure B.2-5a Distribution of LEI of Fishing Effects on Epifauna Prey - Bering Sea



Source: NMFS Data

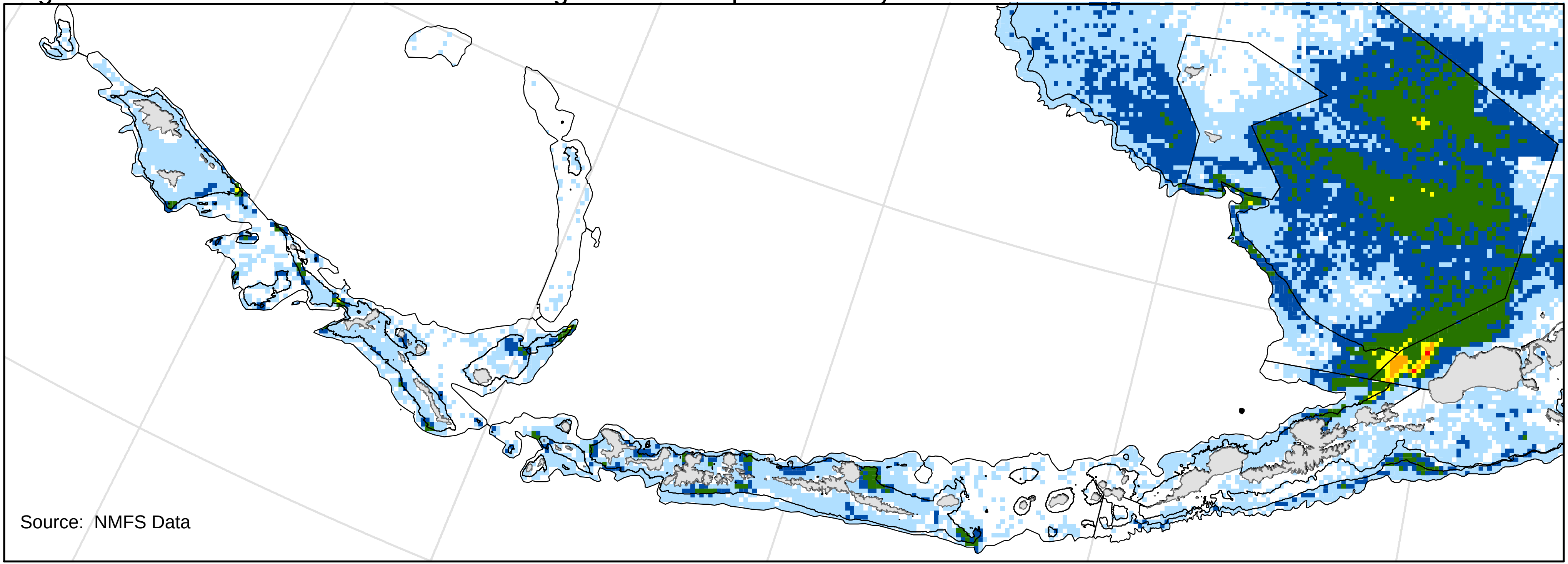
* LEI - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-5b. Distribution of LEI of Fishing Effects on Epifauna Prey - Gulf of Alaska



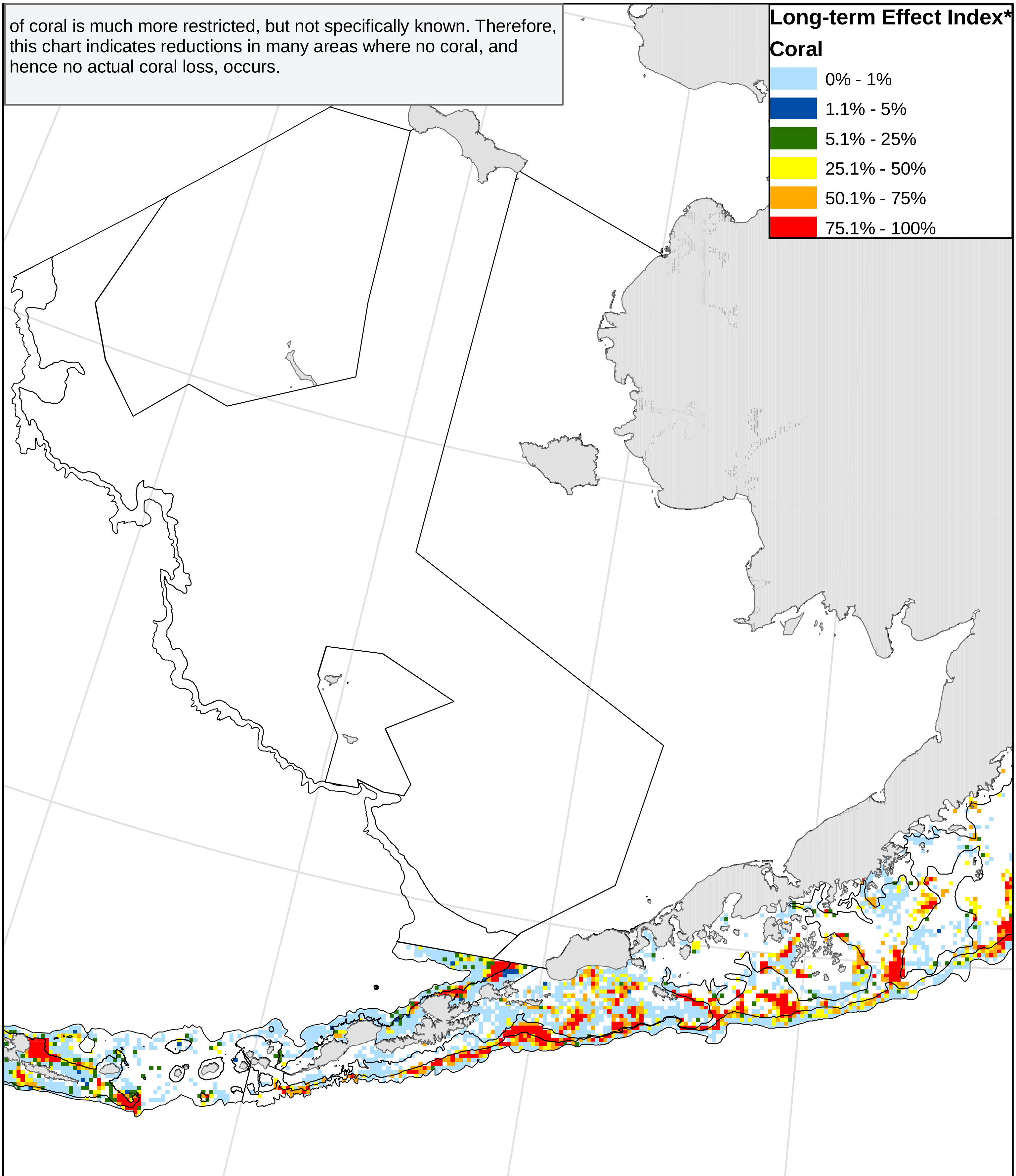
* Long-term Effect Index - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-5c. Distribution of LEI of Fishing Effects on Epifauna Prey - Aleutian Islands



Source: NMFS Data

Figure B.2-6a. Distribution of LEI of Fishing Effects on Coral - Bering Sea

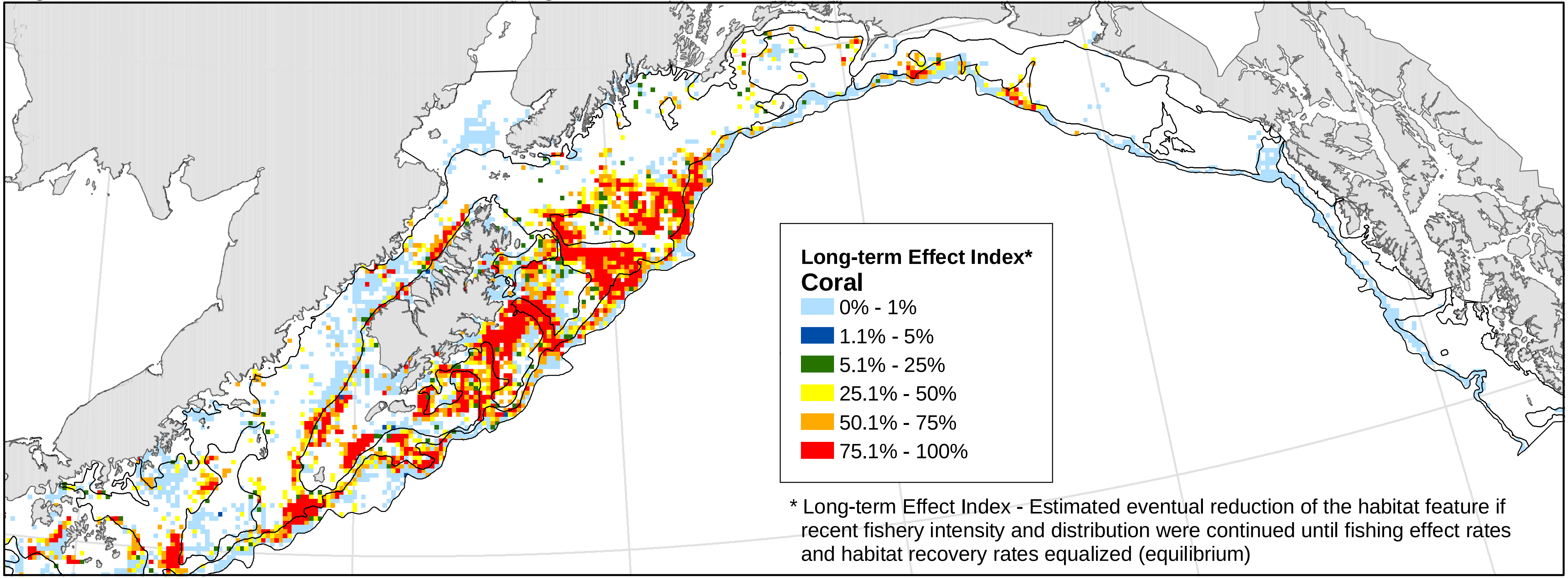


of coral is much more restricted, but not specifically known. Therefore, this chart indicates reductions in many areas where no coral, and hence no actual coral loss, occurs.

Source: NMFS Data

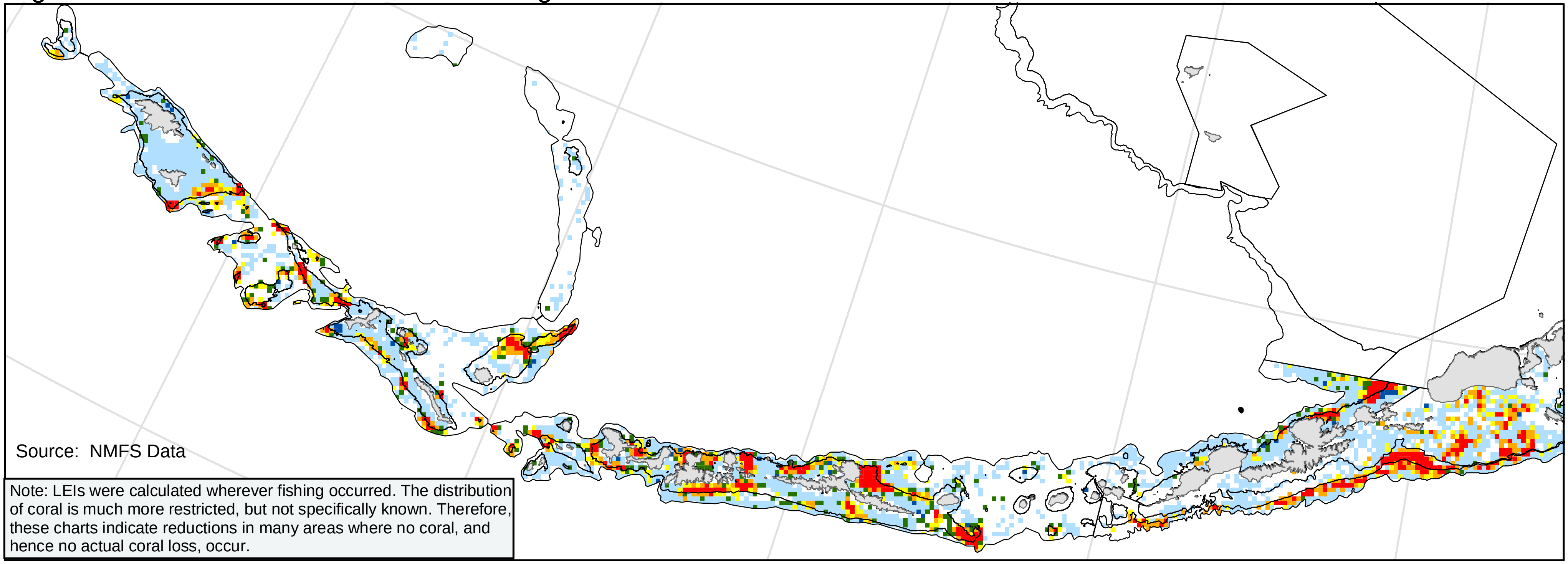
* LEI - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

Figure B.2-6b. Distribution of LEI of Fishing Effects on Coral - Gulf of Alaska



* Long-term Effect Index - Estimated eventual reduction of the habitat feature if recent fishery intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium)

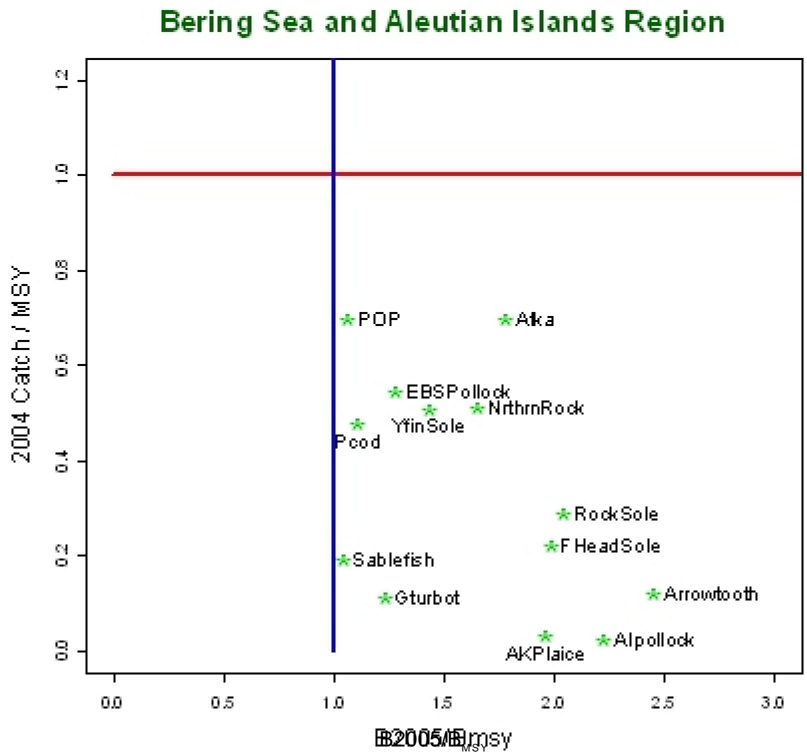
Figure B.2-6c. Distribution of LEI of Fishing Effects on Coral - Aleutian Islands

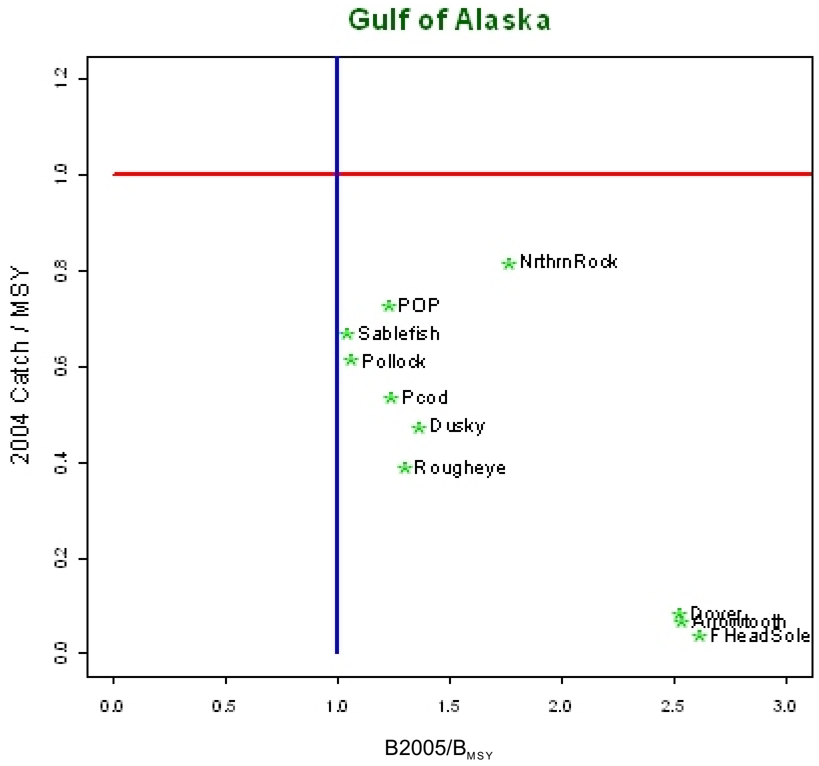


Source: NMFS Data

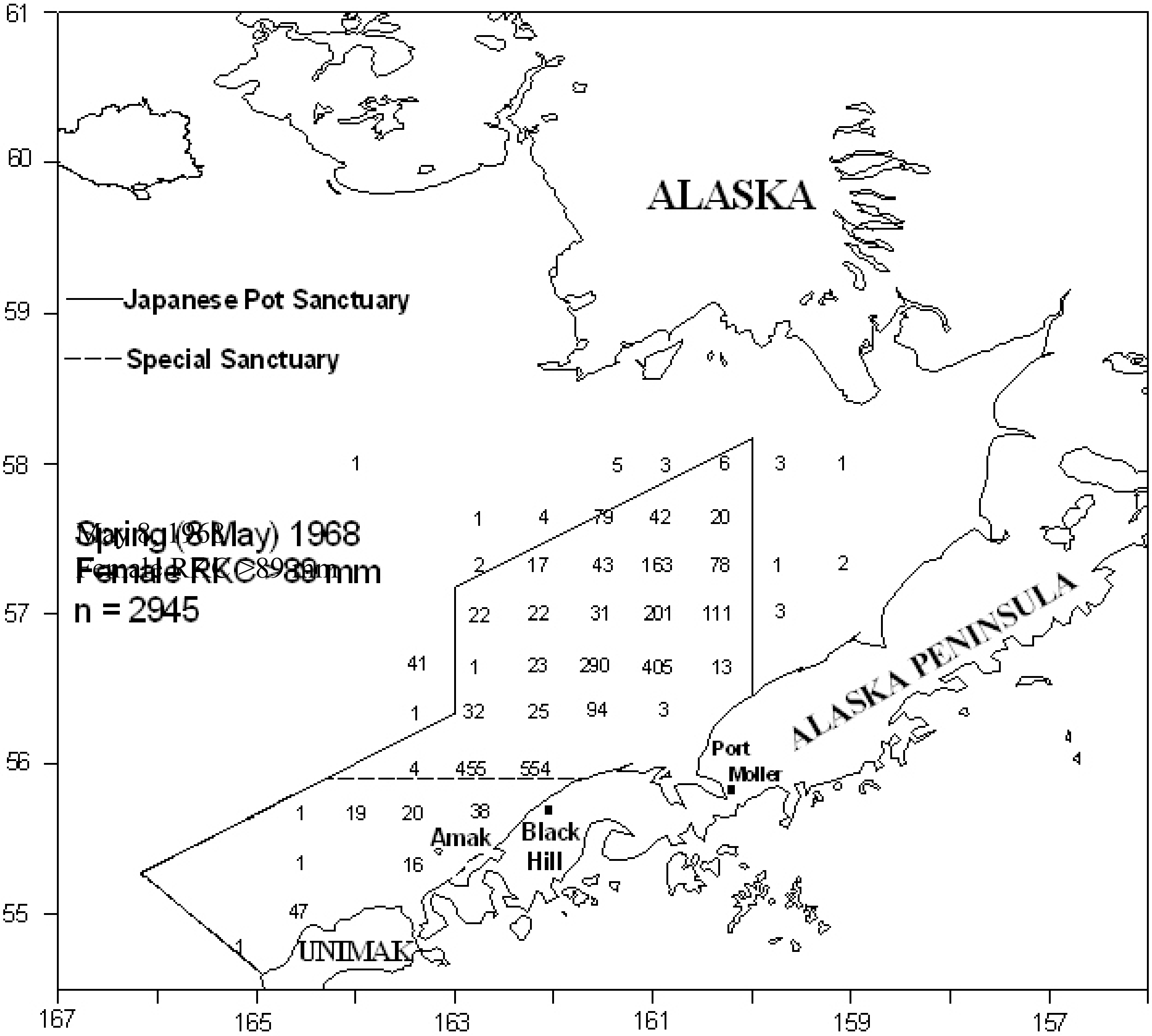
Note: LEIs were calculated wherever fishing occurred. The distribution of coral is much more restricted, but not specifically known. Therefore, these charts indicate reductions in many areas where no coral, and hence no actual coral loss, occur.

Figure B.3.1-1. Stock Status Relative to B_{MSY} and MSY for the Major Target Species in the BS and AI Region and the GOA Region



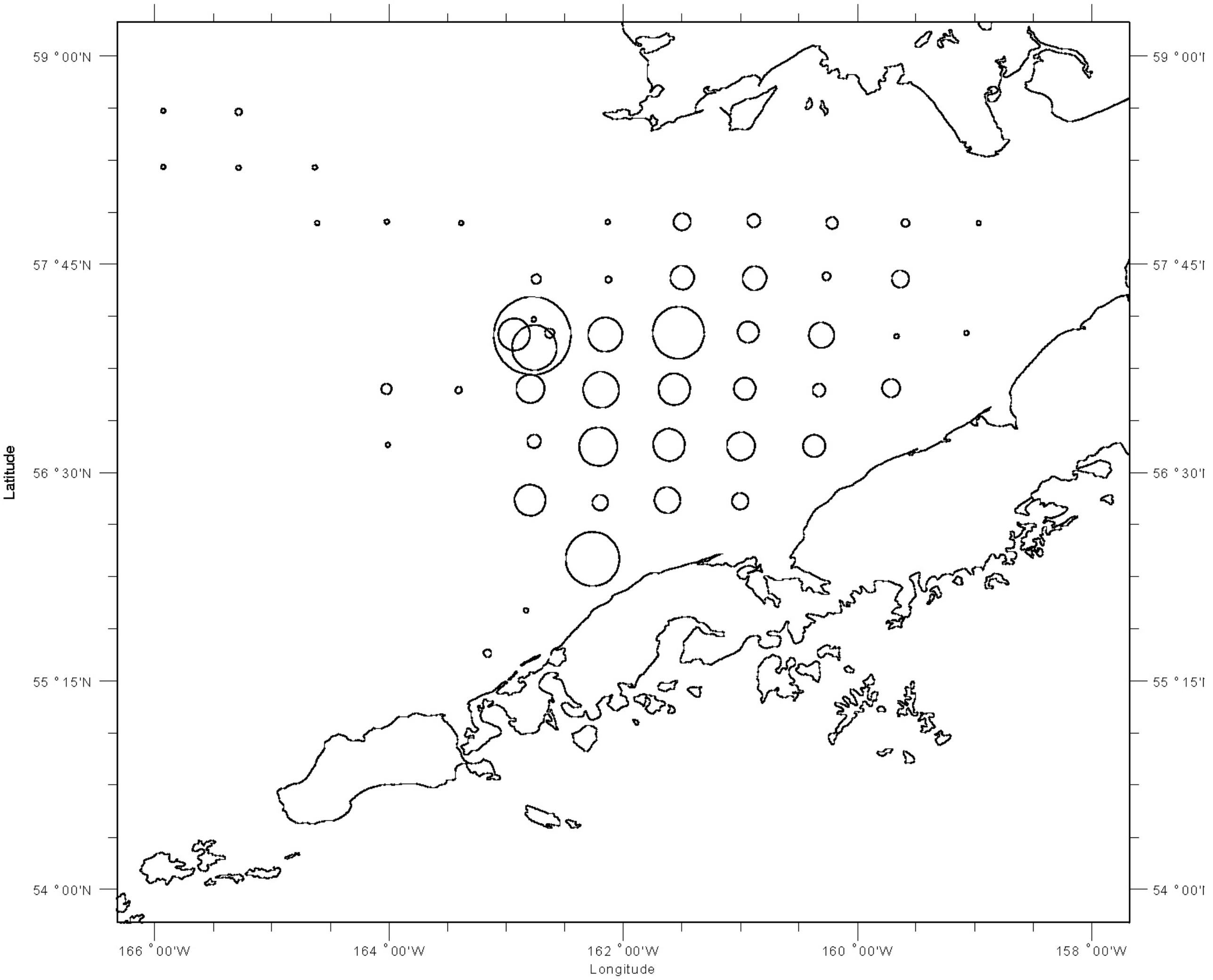


Notes: B_{MSY} = biomass maximum sustainable yield
Source: NMFS Data



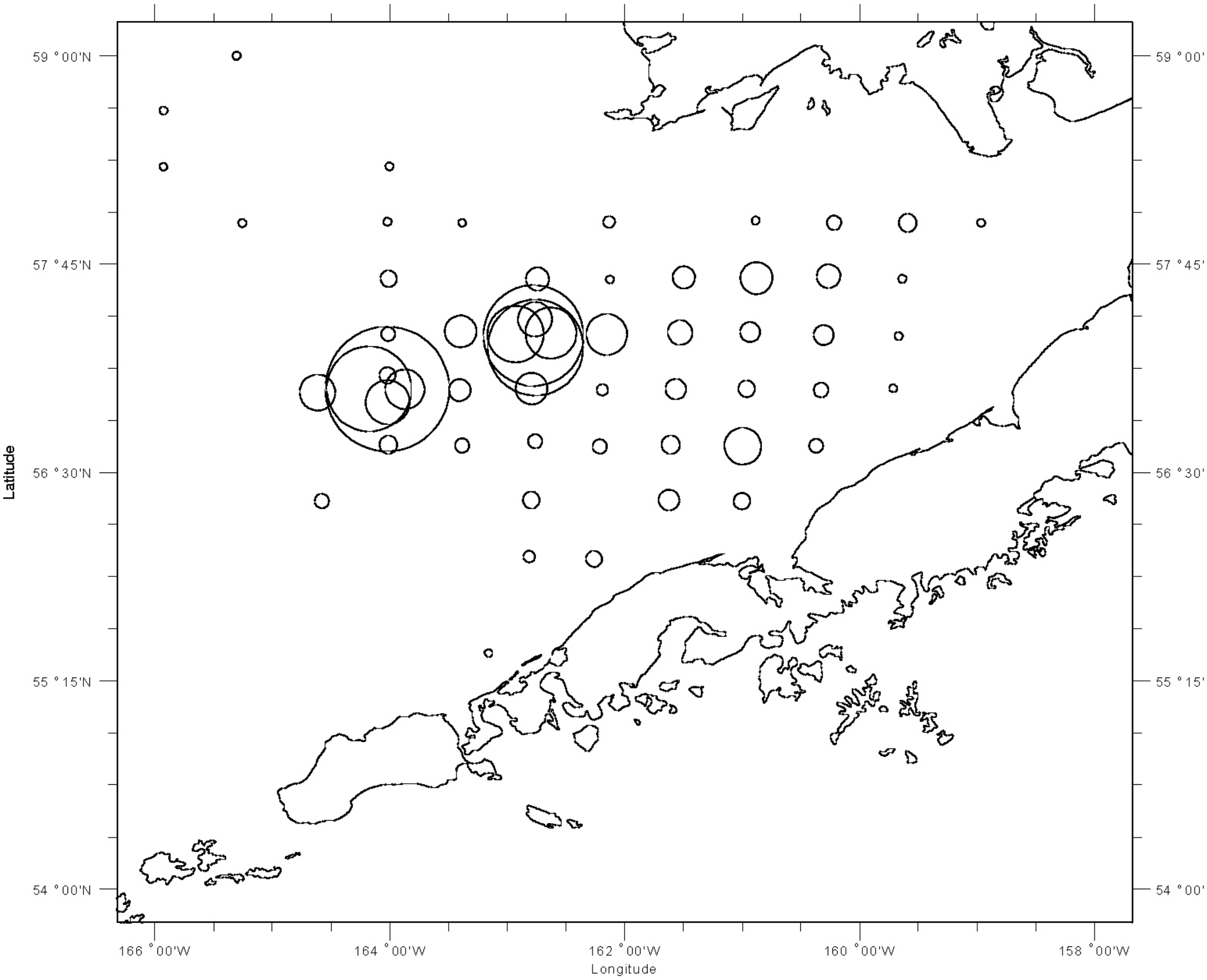
Source: Bureau of Commercial Fisheries, 1968

Figure B.3.2.3-2. Large Female Red King Crab (>=90 mm carapace length)



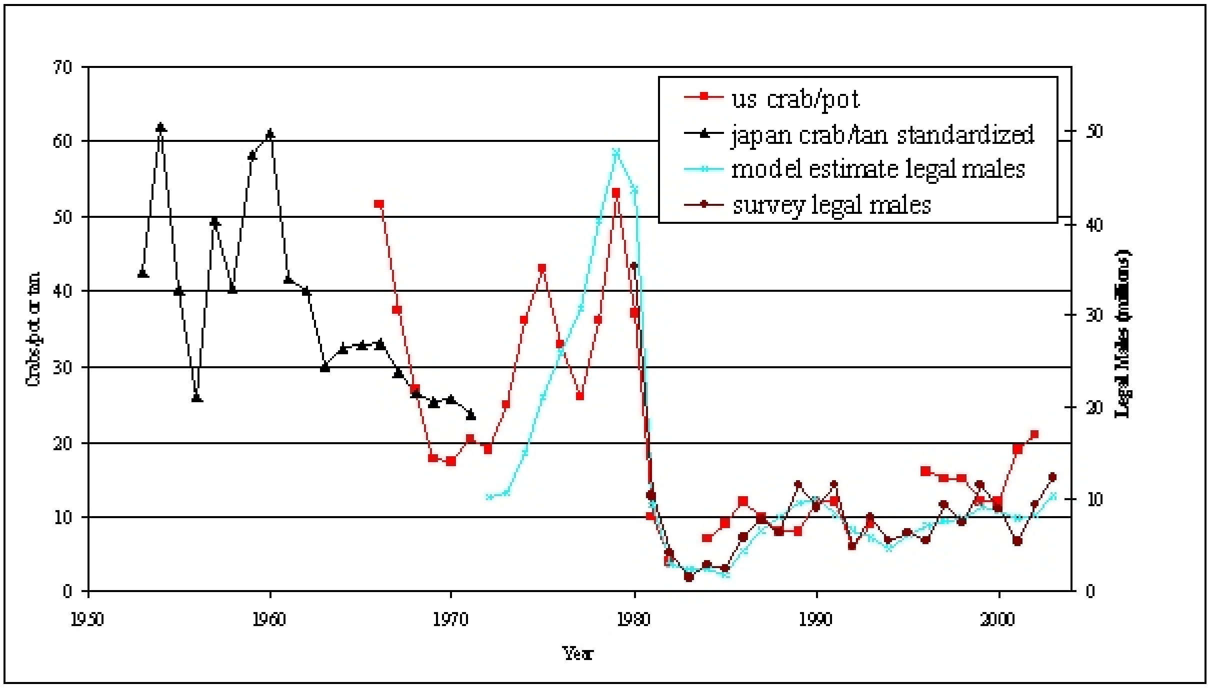
Note: The area of the circle is proportional to CPUE per tow.
Source: NMFS 2004 Survey

Figure B.3.2.3-3. Large Male (>=135 mm carapace length) CPUE



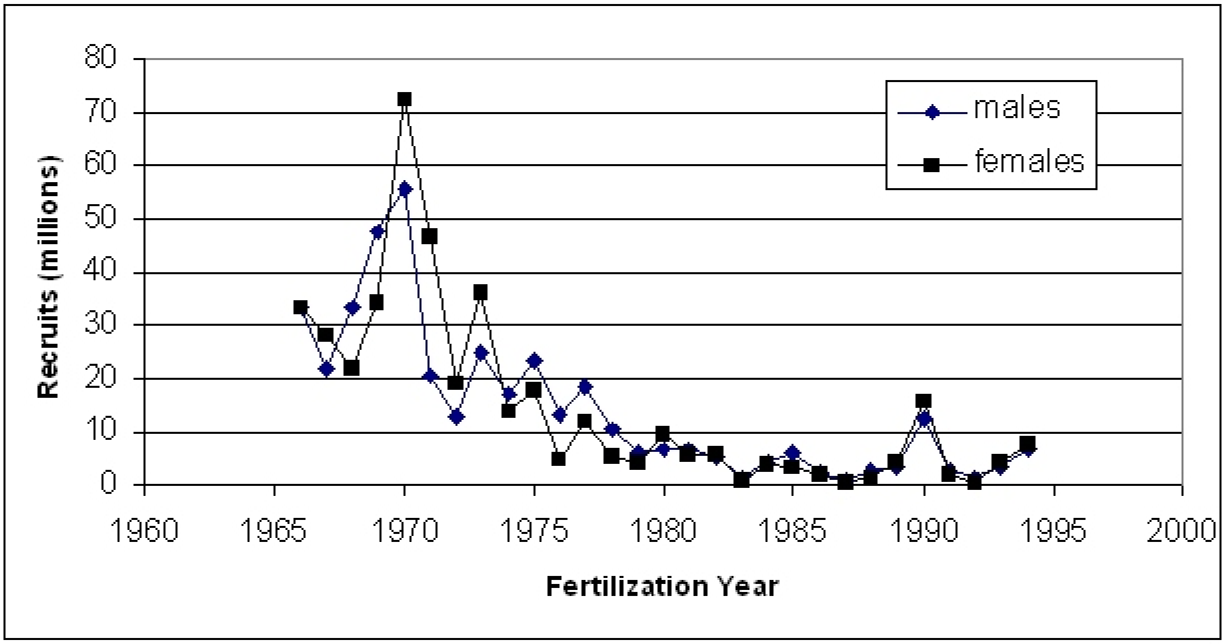
Note: The area of the circle is proportional to CPUE per tow.
Source: NMFS 2004 Survey

Figure B.3.2.3-4. CPUE Trends of Bristol Bay Legal Male Red King Crab from Calibrated Japanese Tangle Net Fishing and U.S. Directed Pot Fishing, as well as Abundance Estimates of Legal Males



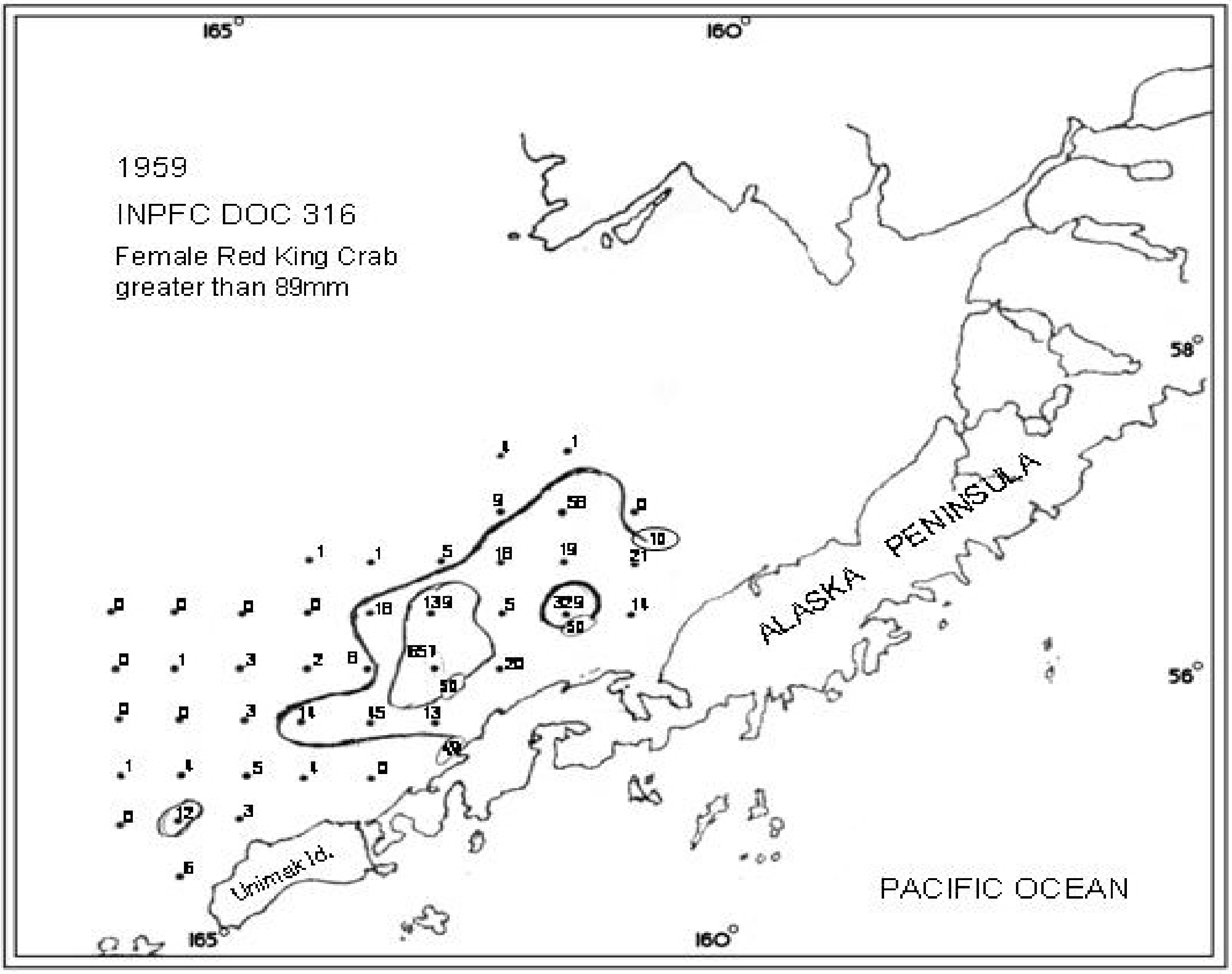
Source: NMFS surveys and stock assessment modeling.

Figure B.3.2.3-5. Recruitment from Red King Crab Stock Assessment Model for Male and Female Red King Crab by Fertilization Year



Source: NMFS surveys and stock assessment modeling.

Figure B.3.2.3-6. Numbers of Female Red King Crab Greater than 89 mm Caught Per Tow



Source: Bureau of Commercial Fisheries, 1959

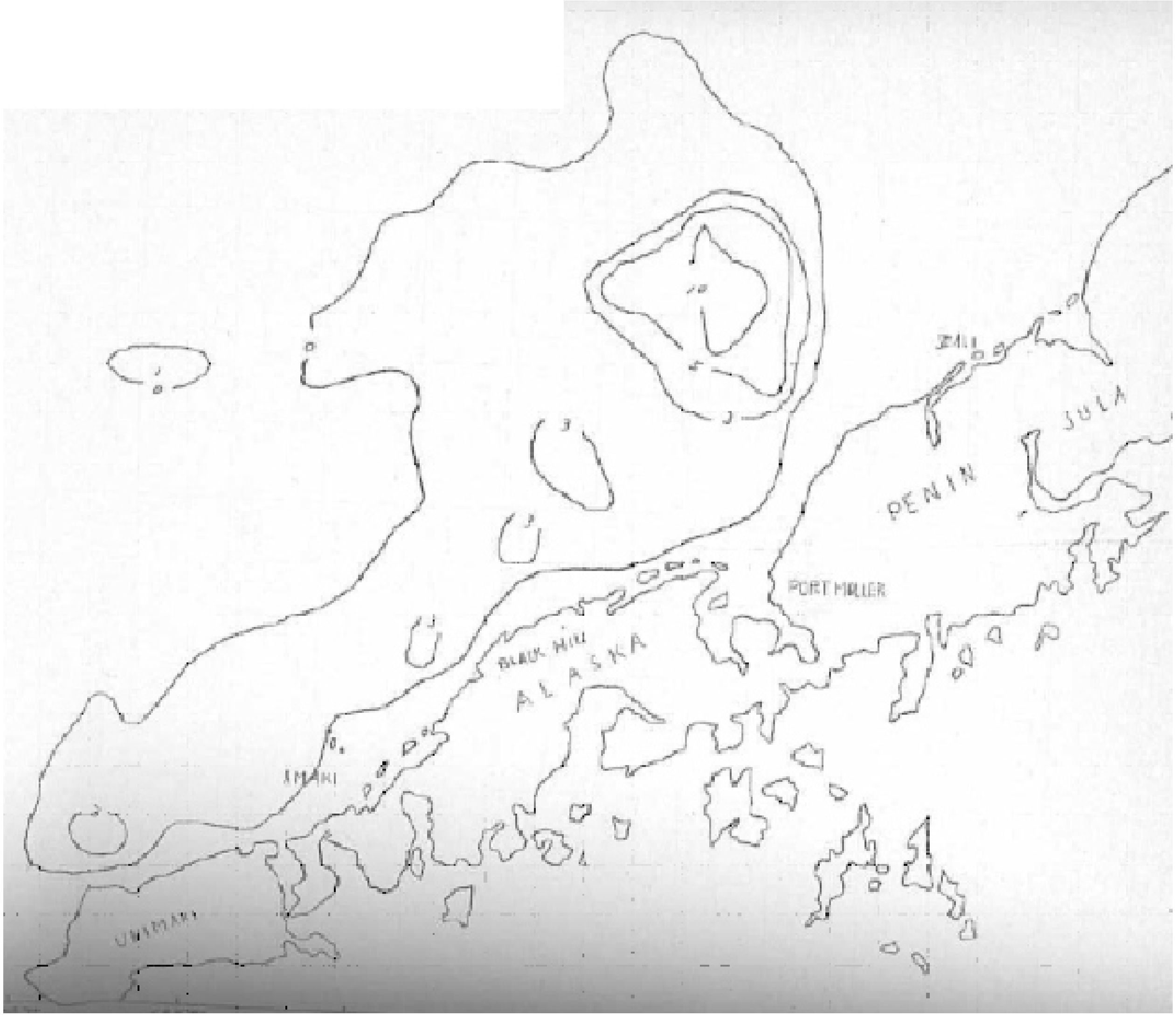
Figure B.3.2.3-7. Distribution of Commercial-size Male Red King Crab During the Spawning Season from Japanese Exploratory Fishing in 1964

Source: NMFS Data

Figure B.3.2.3-8. Distribution of Commercial-size Male Red King Crab During the Spawning Season from Japanese Exploratory Fishing in 1963

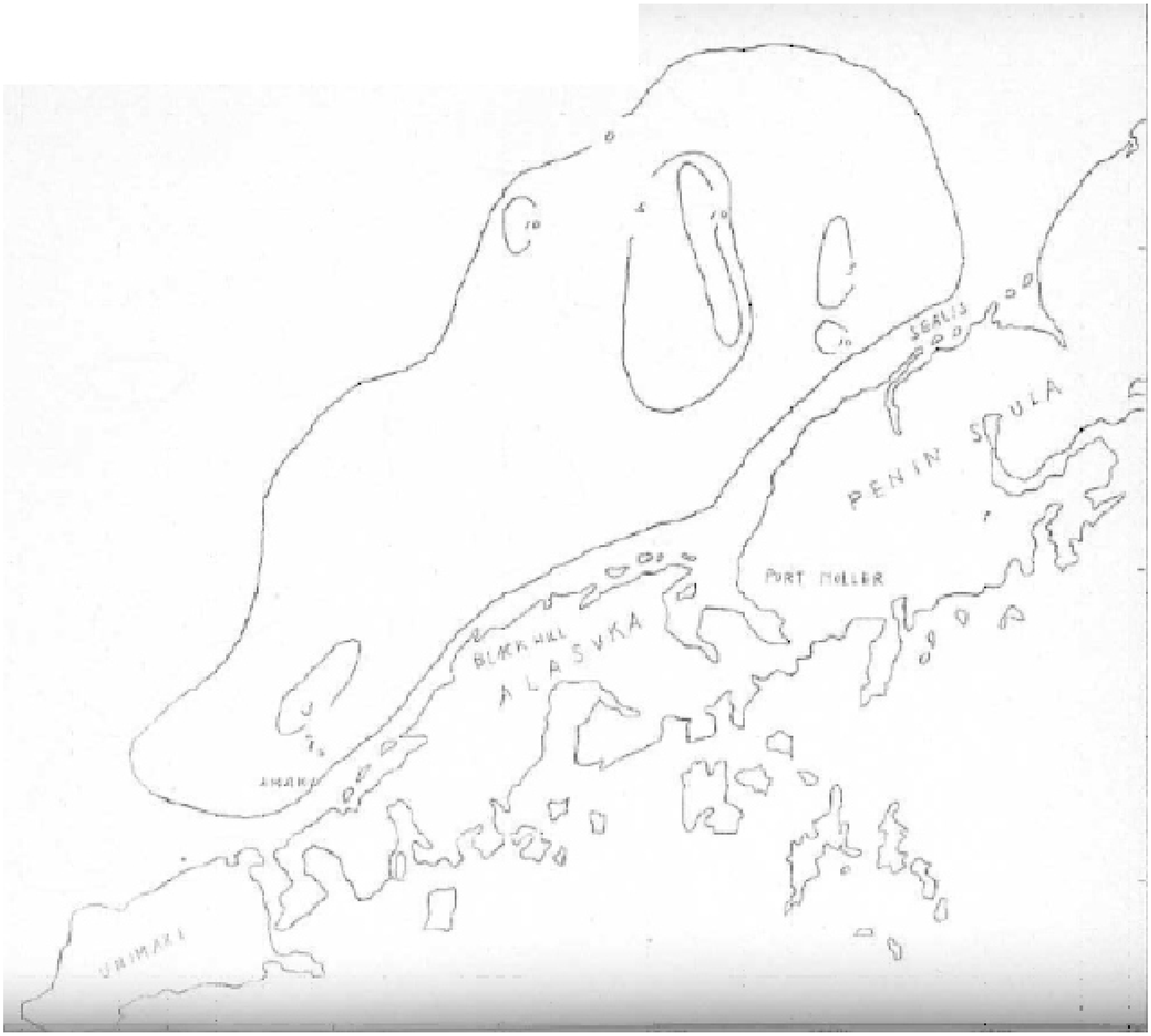
Source: NMFS Data

Figure B.3.2.3-9. Distribution of Female Red King Crab During the Spawning Season from Japanese Exploratory Fishing in 1964



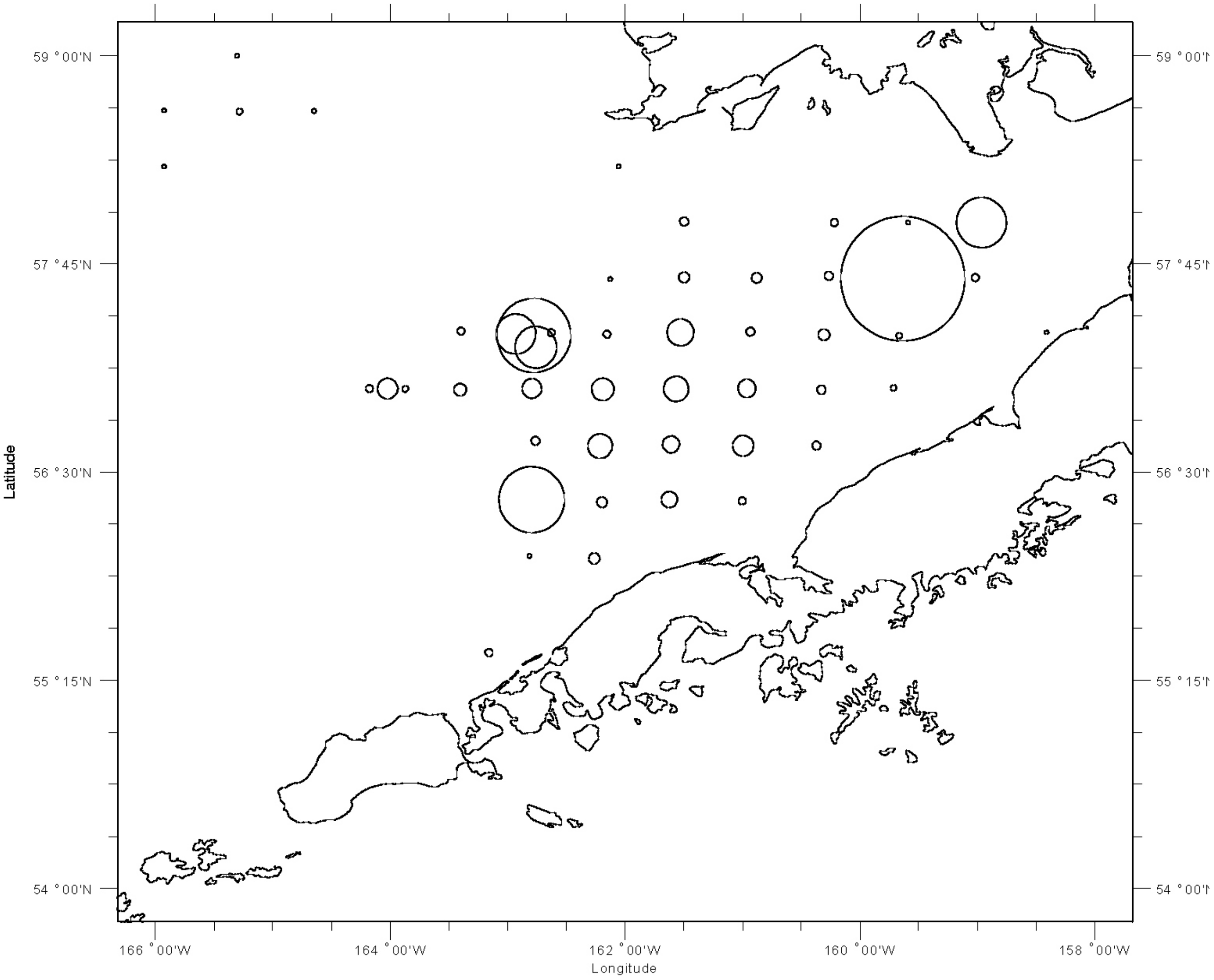
Source: NMFS Data

Figure B.3.2.3-10. Distribution of Female Red King Crab During the Spawning Season from Japanese Exploratory Fishing in 1963



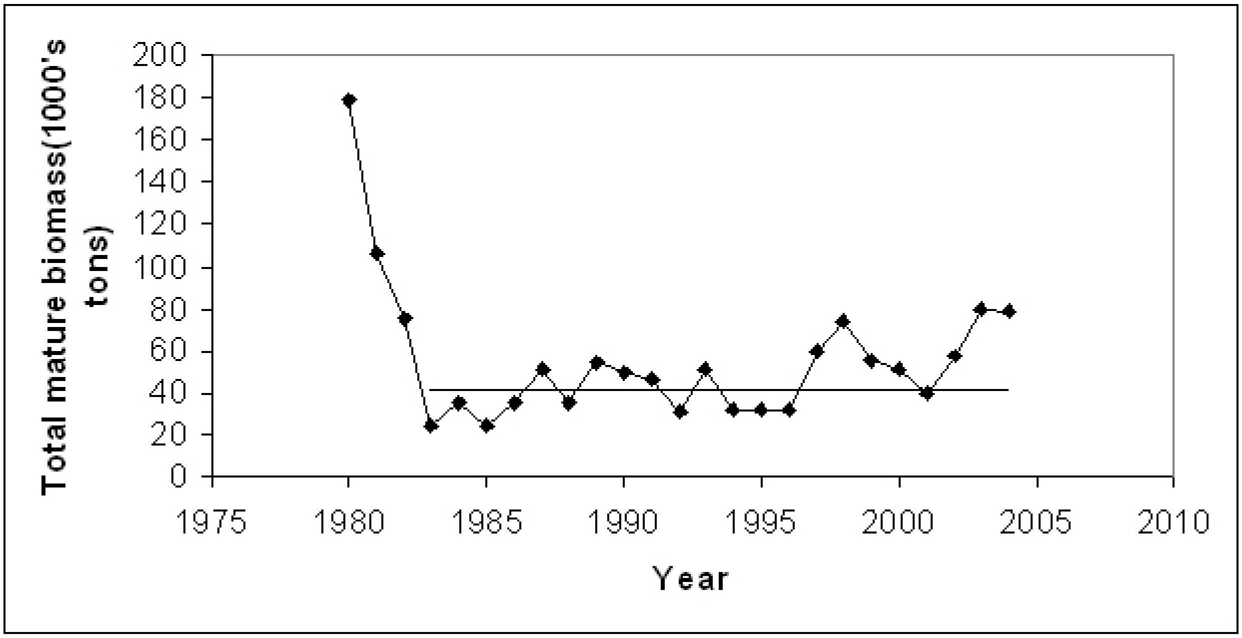
Source: NMFS Data

Figure B.3.2.3-11. Small Red King Crab (males <110 mm carapace length and females <90 mm carapace length)



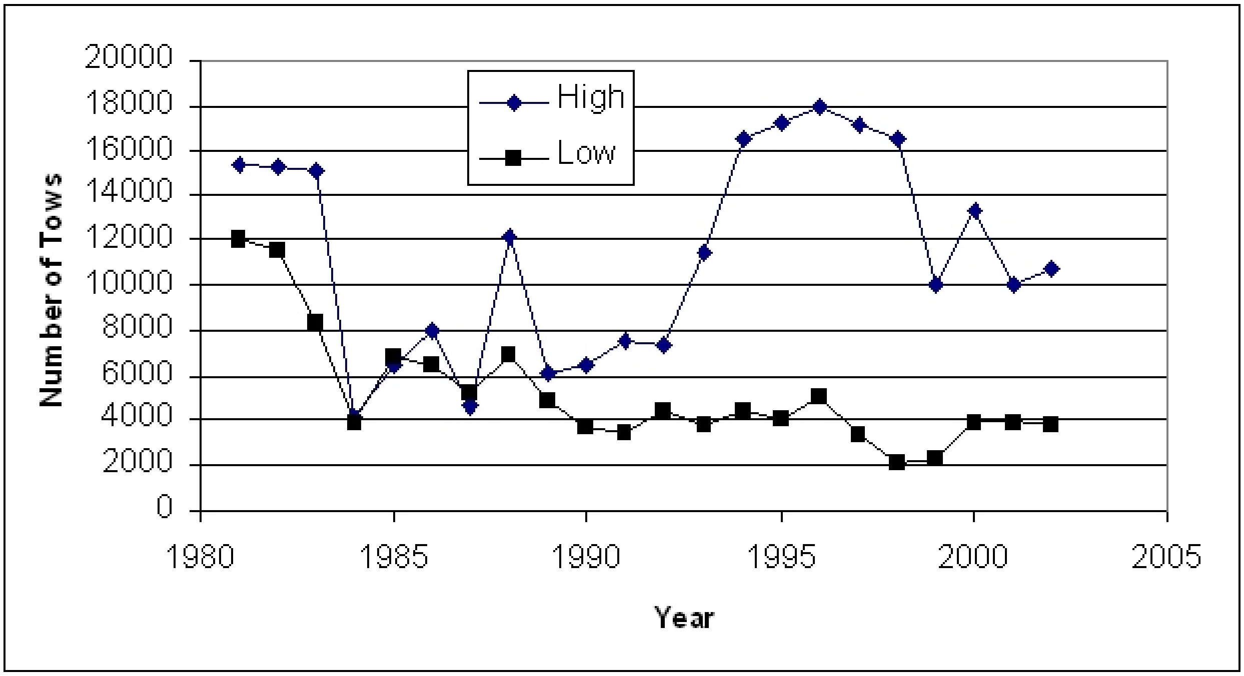
Note: The area of the circle is proportional to CPUE per tow.
Source: NMFS Survey, 2004

Figure B.3.2.3-12. Survey Total Mature Biomass (males and females) of Bristol Bay Red King Crab from 1980 to 2003



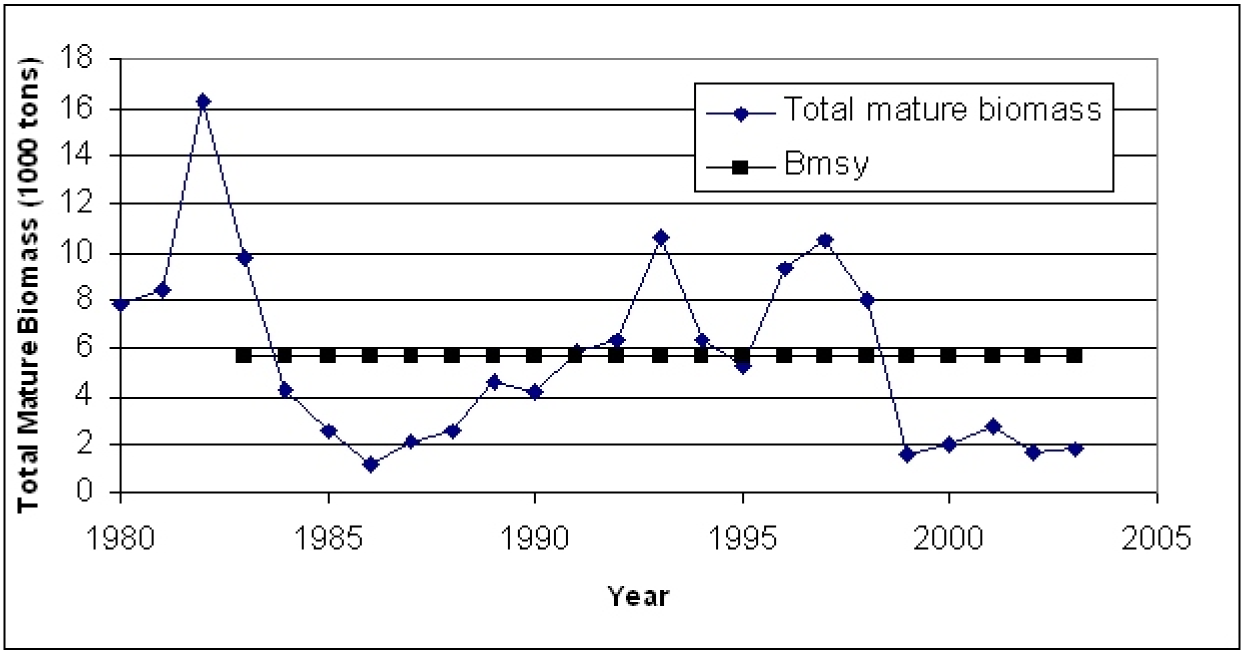
Note: The solid horizontal line is B_{MSY}
Source: NMFS Surveys

Figure B.3.2.3-13. Number of Tows in High and Low Effects Areas in the EBS from 1981 to 2002



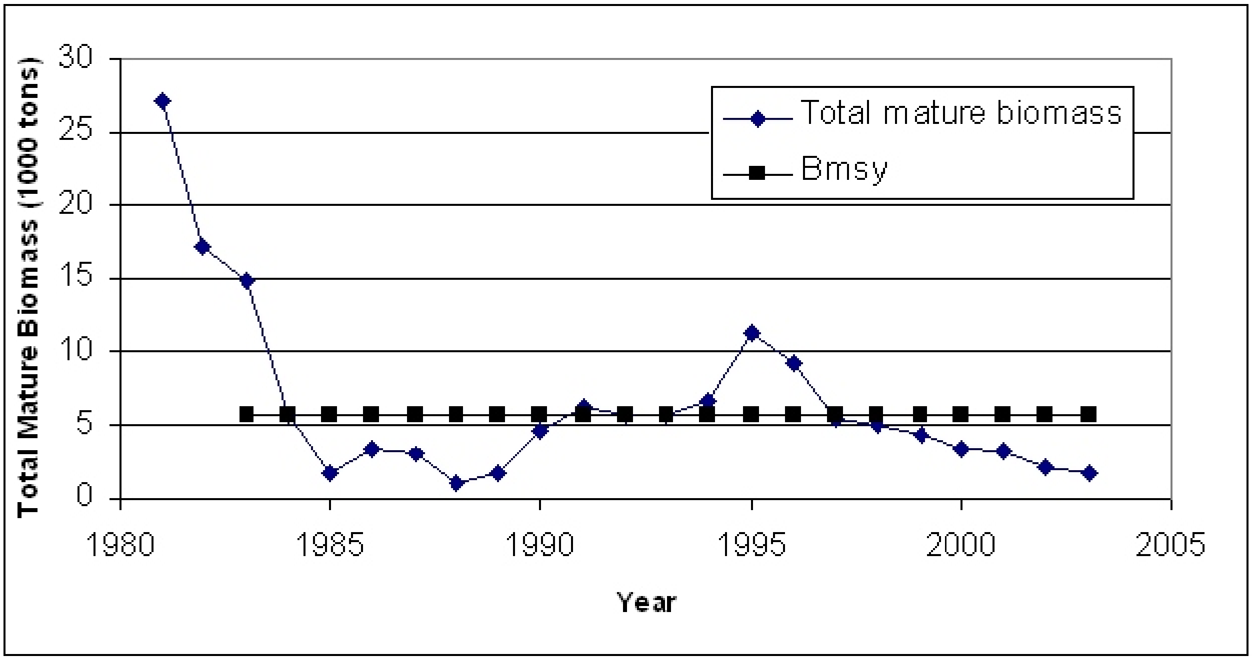
Source: NMFS Surveys

Figure B.3.2.4-1. Pribilof Islands Blue King Crab Survey Estimates of Total Mature Biomass (1,000 tons) from 1981 to 2003



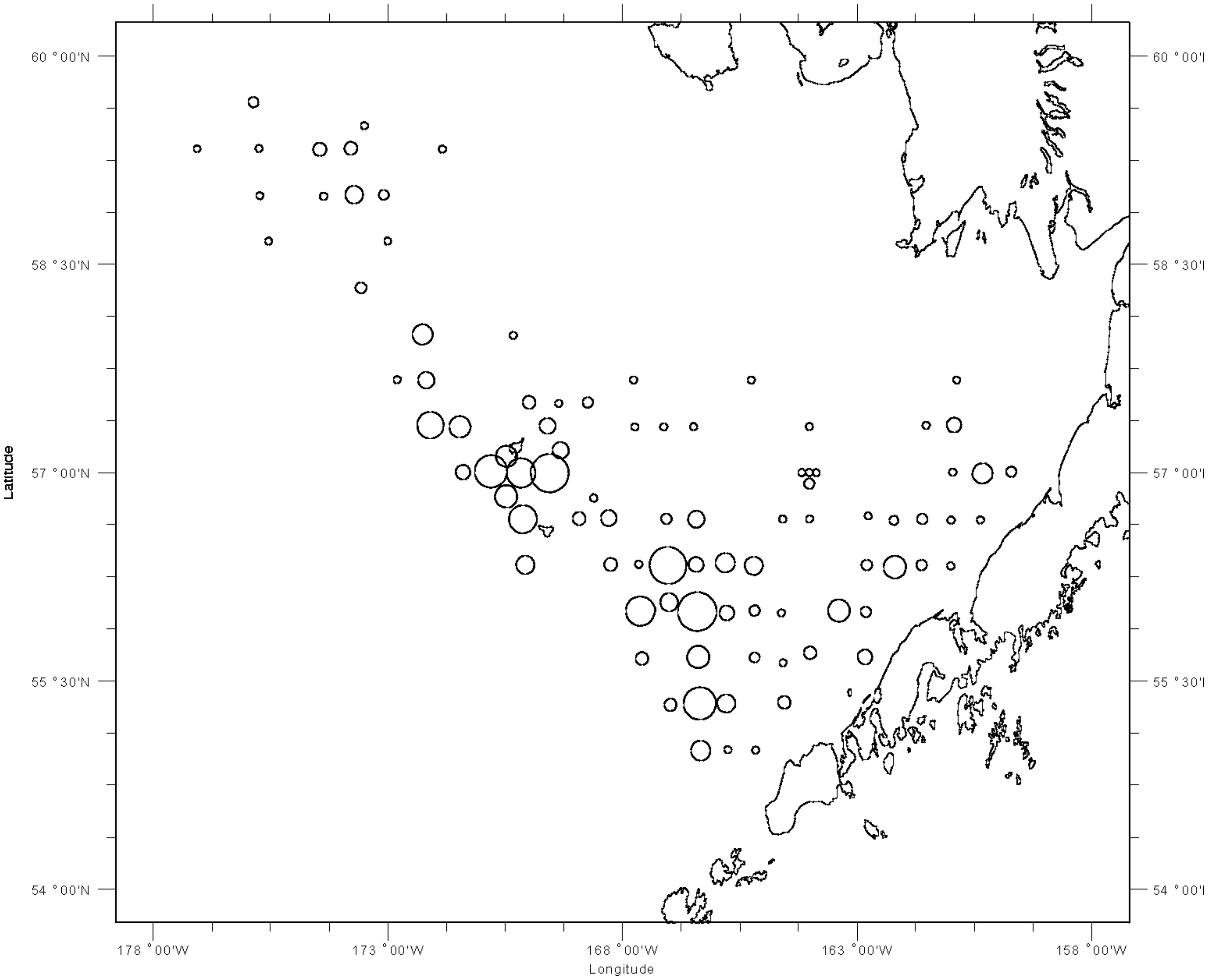
Source: NMFS Surveys

Figure B.3.2.4-2 St. Matthew Island Blue King Crab Survey Estimates of Total Mature Biomass (1,000 tons) from 1981 to 2003



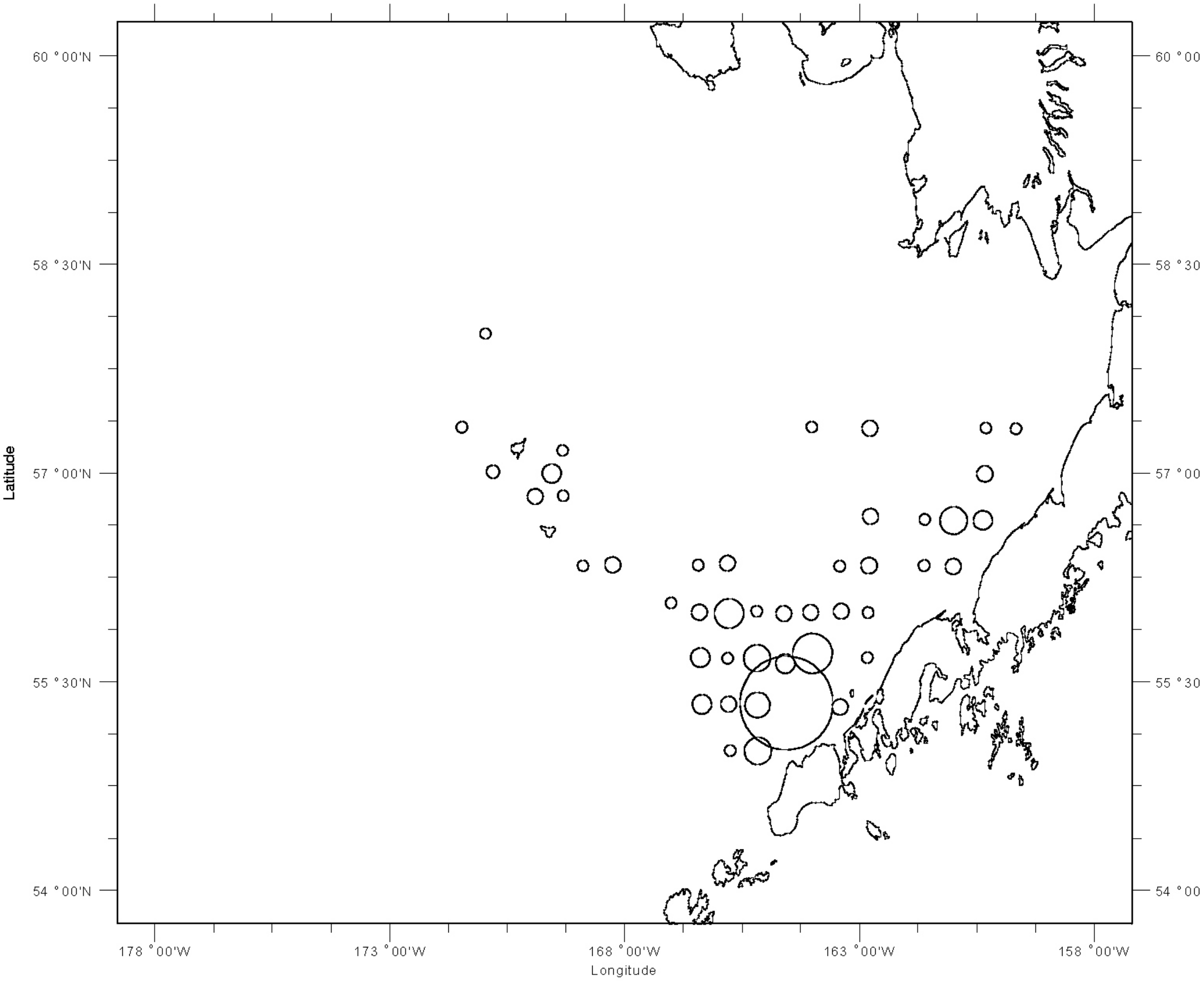
Source: NMFS Surveys

Figure B.3.2.7-1. Large Female Tanner Crab (>=85 mm carapace width) CPUE



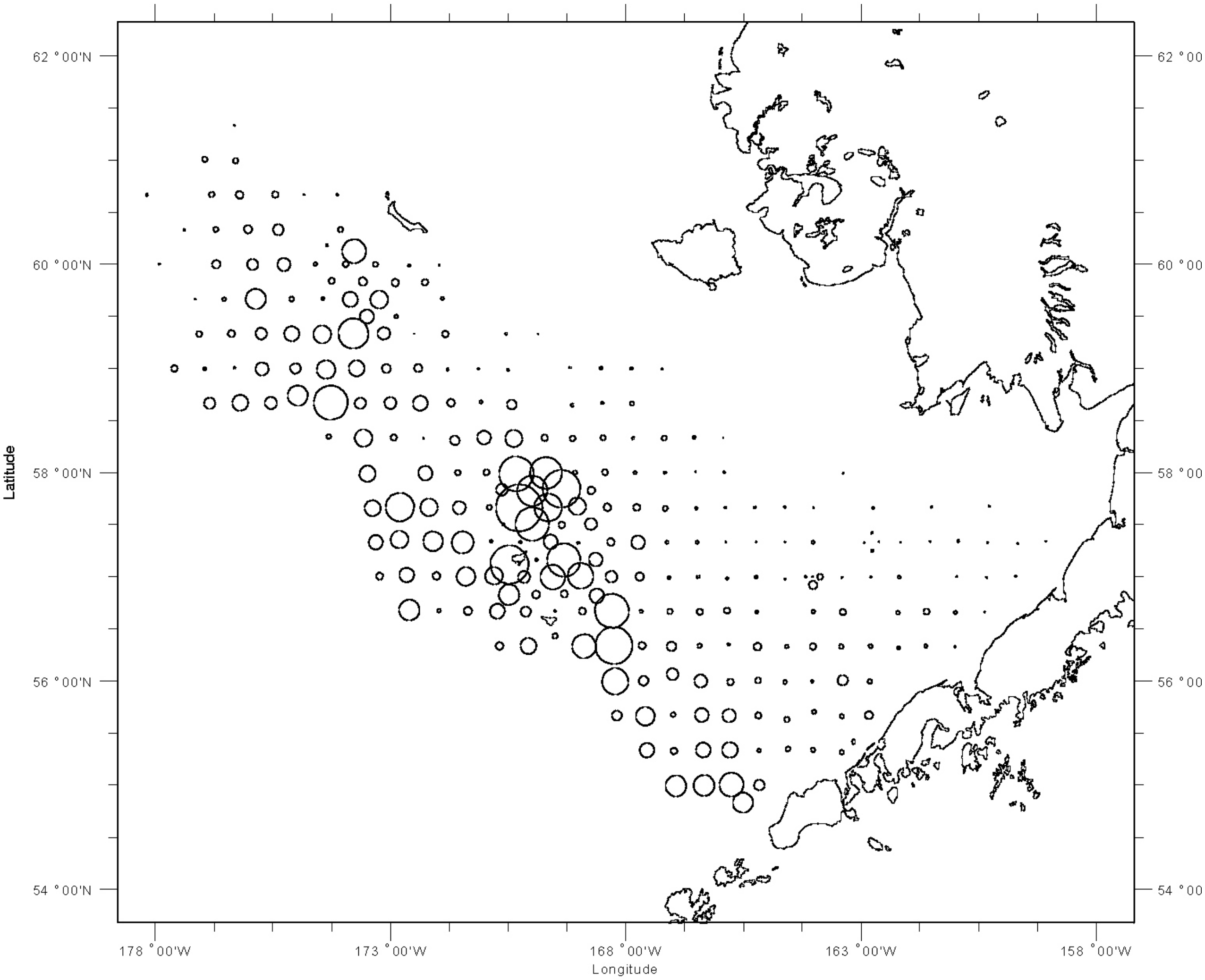
Source: NMFS 2004 Survey

Figure B.3.2.7-2. Large Male Tanner Crab (>=138 mm carapace width) CPUE



Source: NMFS 2004 Survey

Figure B.3.2.7-3. Combined Small Male (<110 mm carapace width) and Small Female (<85 mm carapace width) Tanner Crab CPUE



Source: NMFS 2004 Survey

Figure B.3.2.7-4. Number of Large Male Tanner Crab (>138 mm carapace width) Caught Per Mile Towed in the 1979 NMFS Trawl Survey

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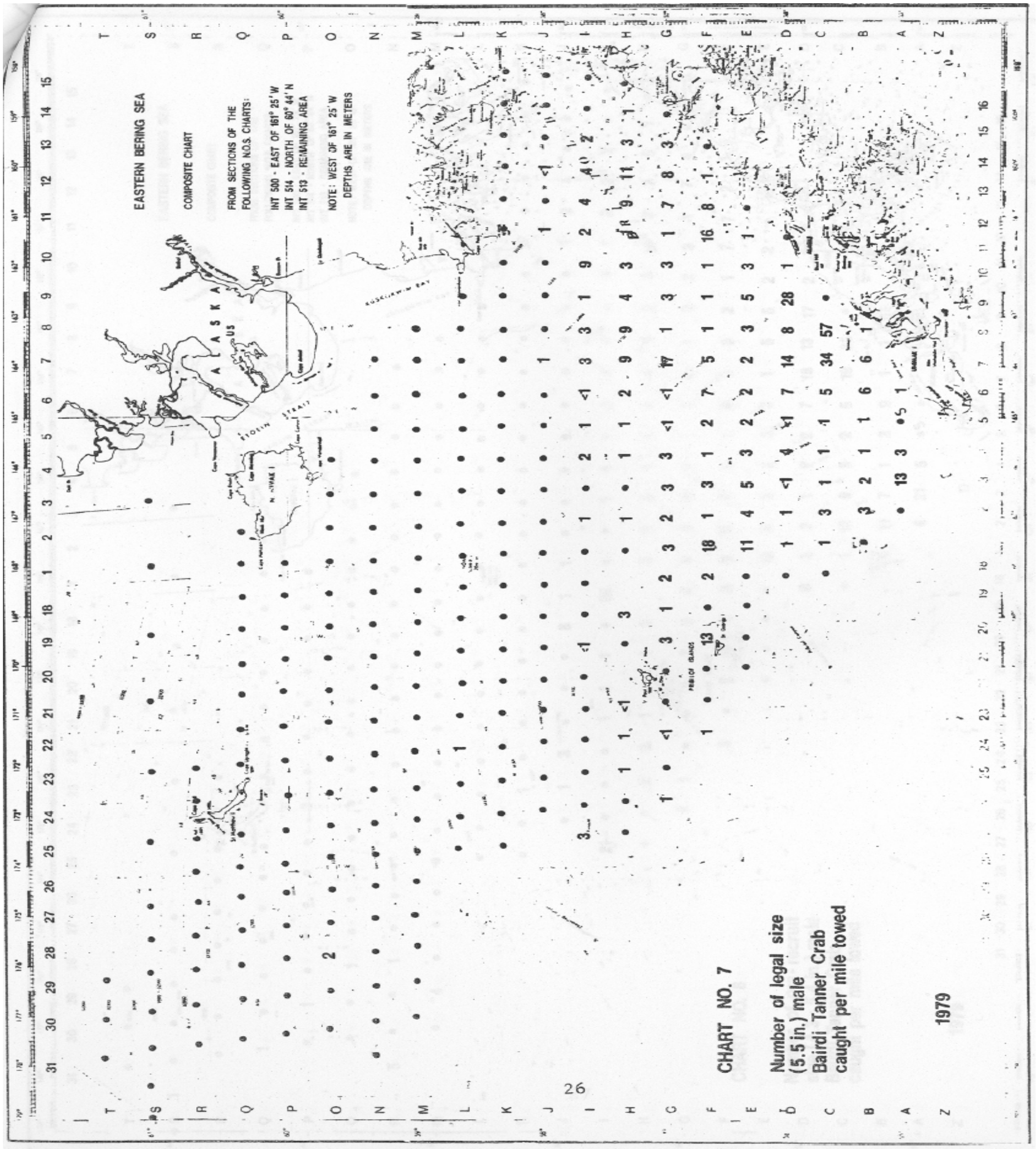
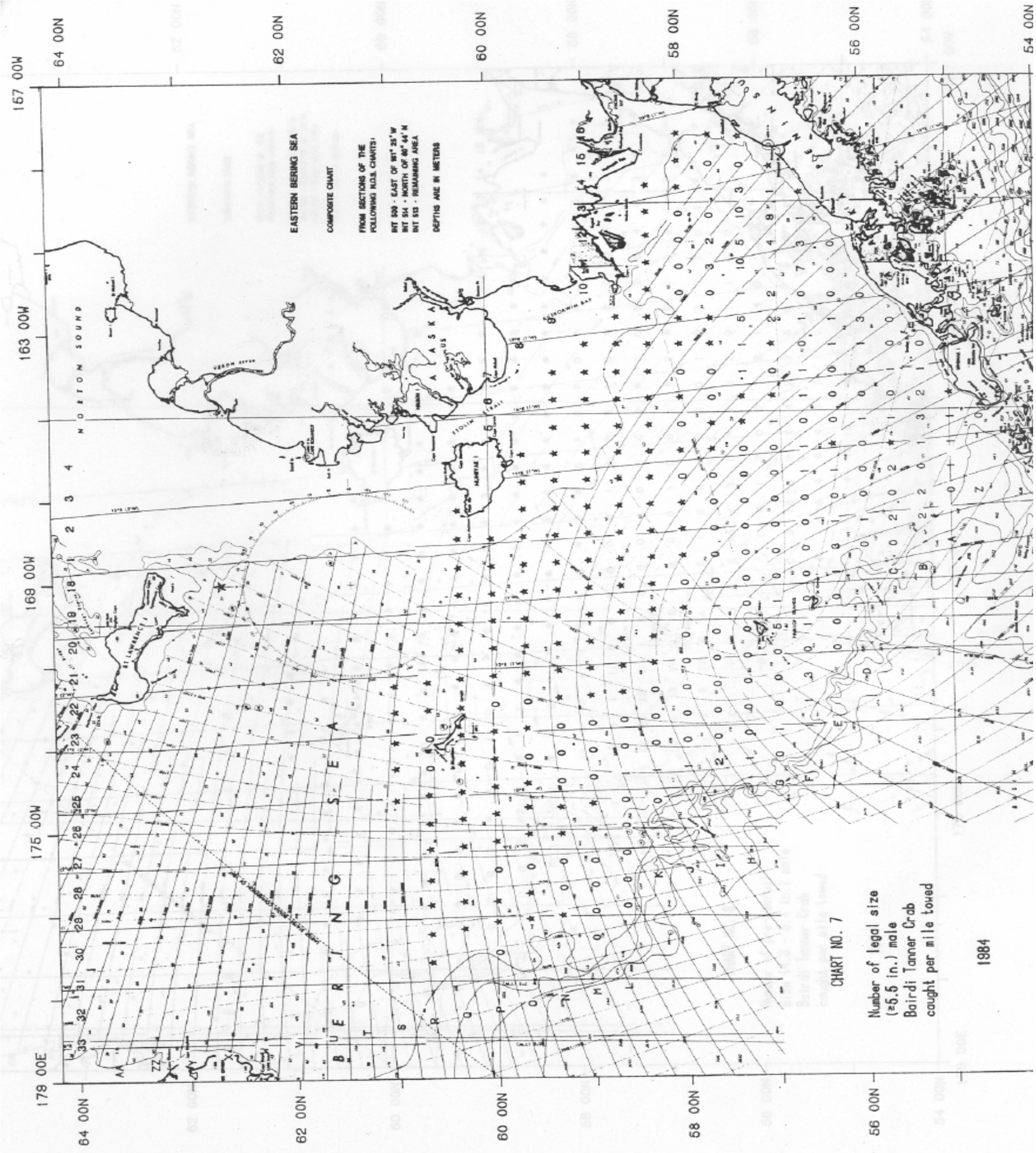


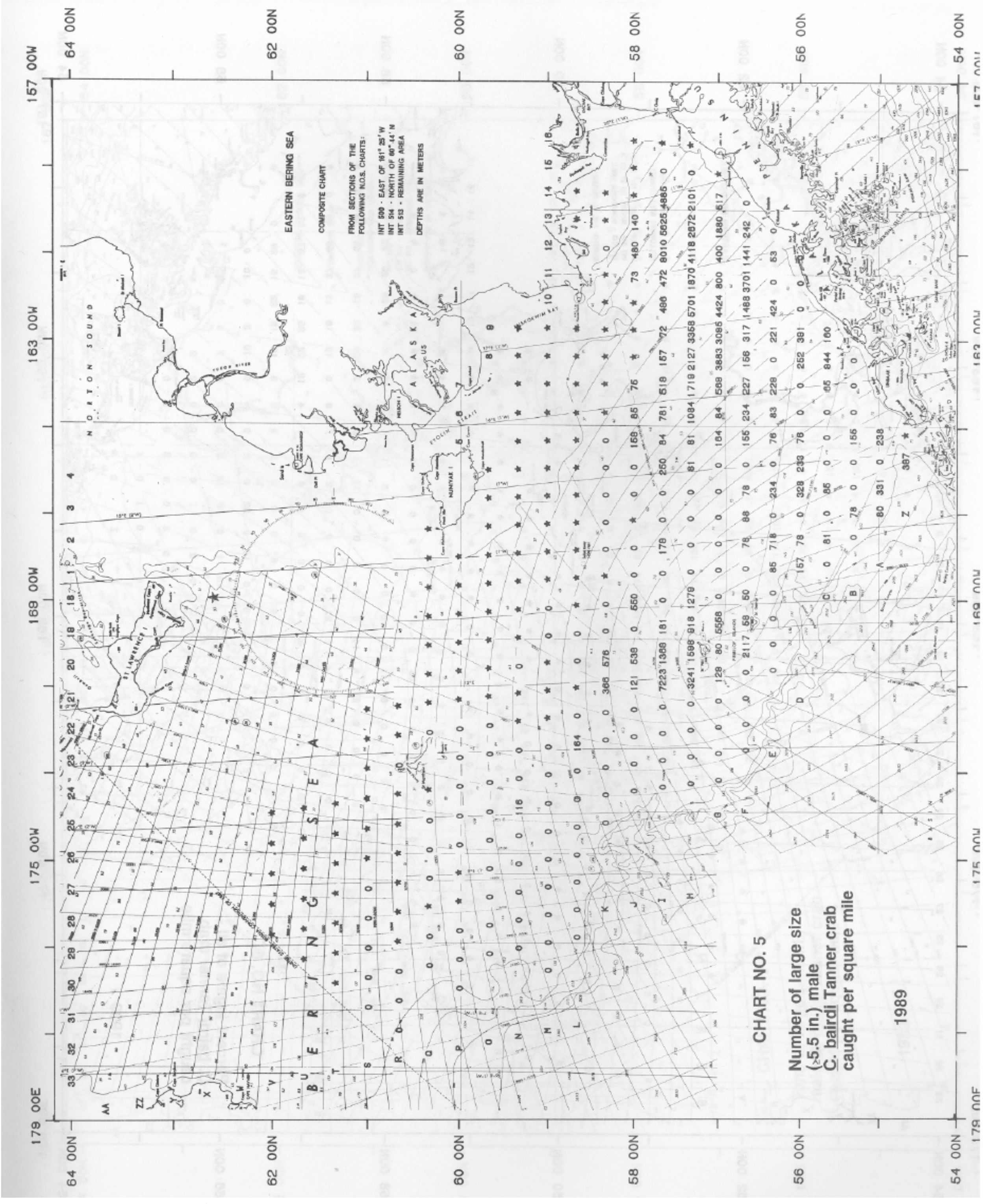
Source: NMFS Trawl Survey, 1979

Figure B.3.2.7-5. Number of Large Male Tanner Crab (>138 mm carapace width) Caught Per Mile Towed in the 1984 NMFS Trawl Survey



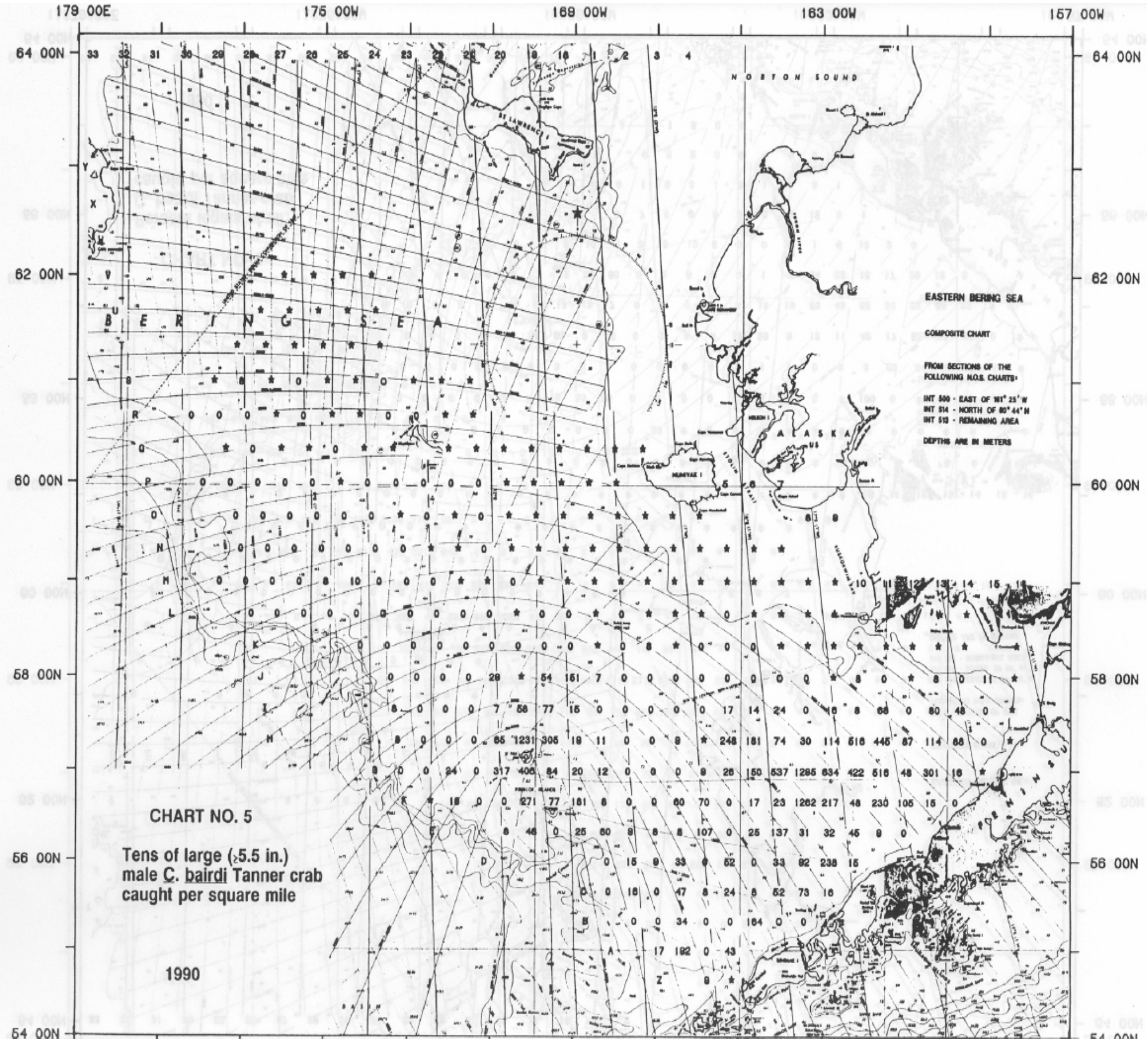
Source: NMFS Trawl Survey, 1984

Figure B.3.2.7-6. Number of Large Male Tanner Crab (>138 mm carapace width) Caught Per Square Mile in the 1989 NMFS Trawl Survey



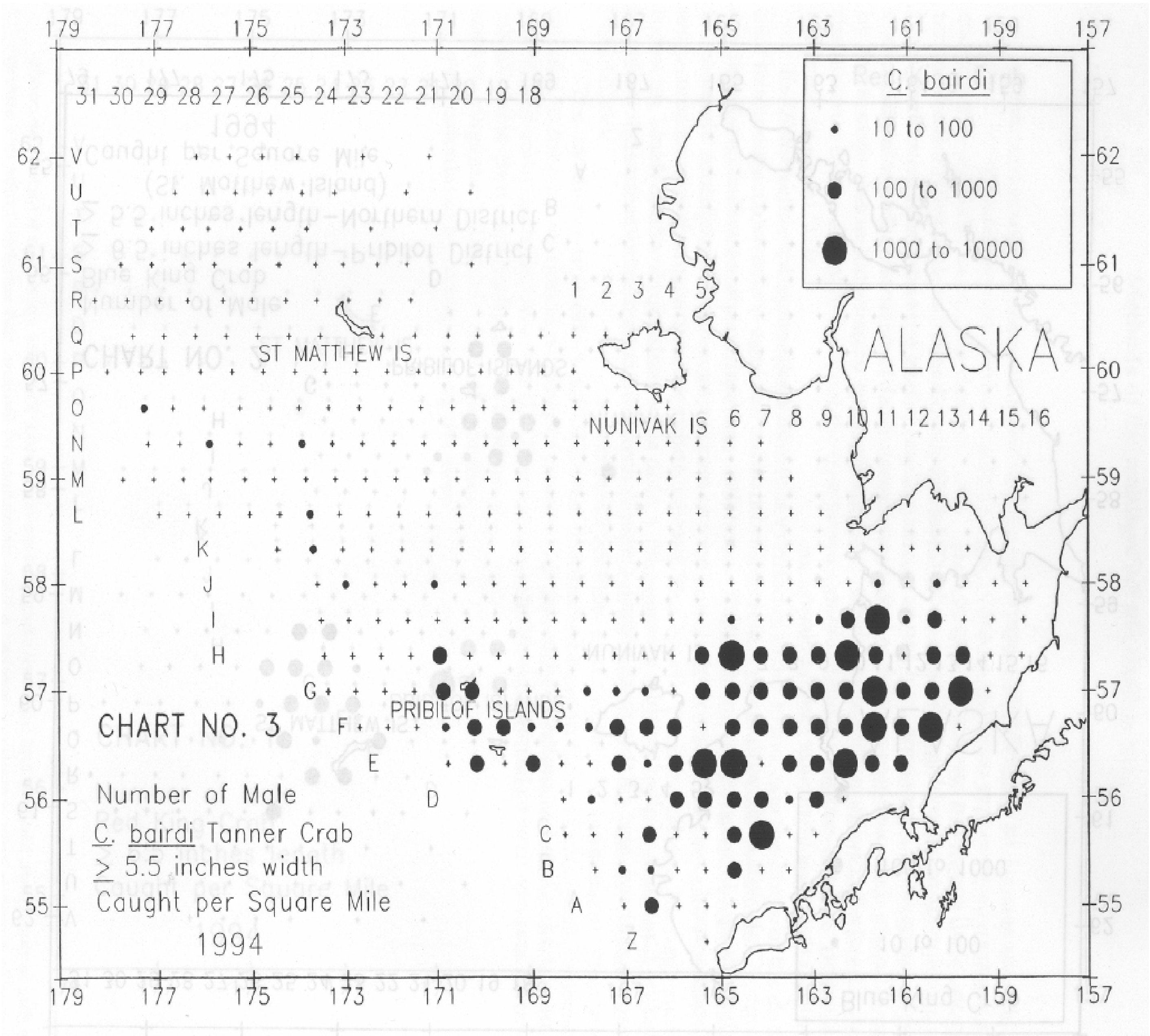
Source: NMFS Trawl Survey, 1989

Figure B.3.2.7-7. Number of Large Male Tanner Crab (>138 mm carapace width) Caught Per Square Mile in the 1990 NMFS Trawl Survey



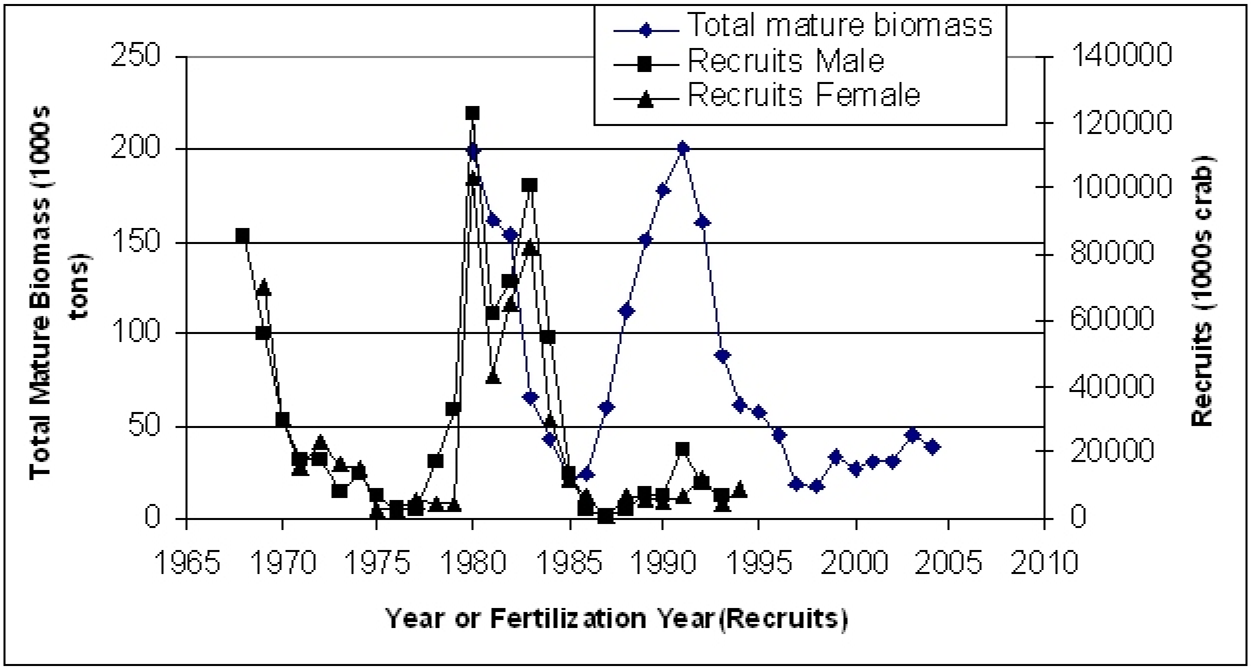
Source: NMFS Trawl Survey, 1990

Figure B.3.2.7-8. Number of Large Male Tanner Crab (>138 mm carapace width) Caught Per Square Mile in the 1994 NMFS Trawl Survey



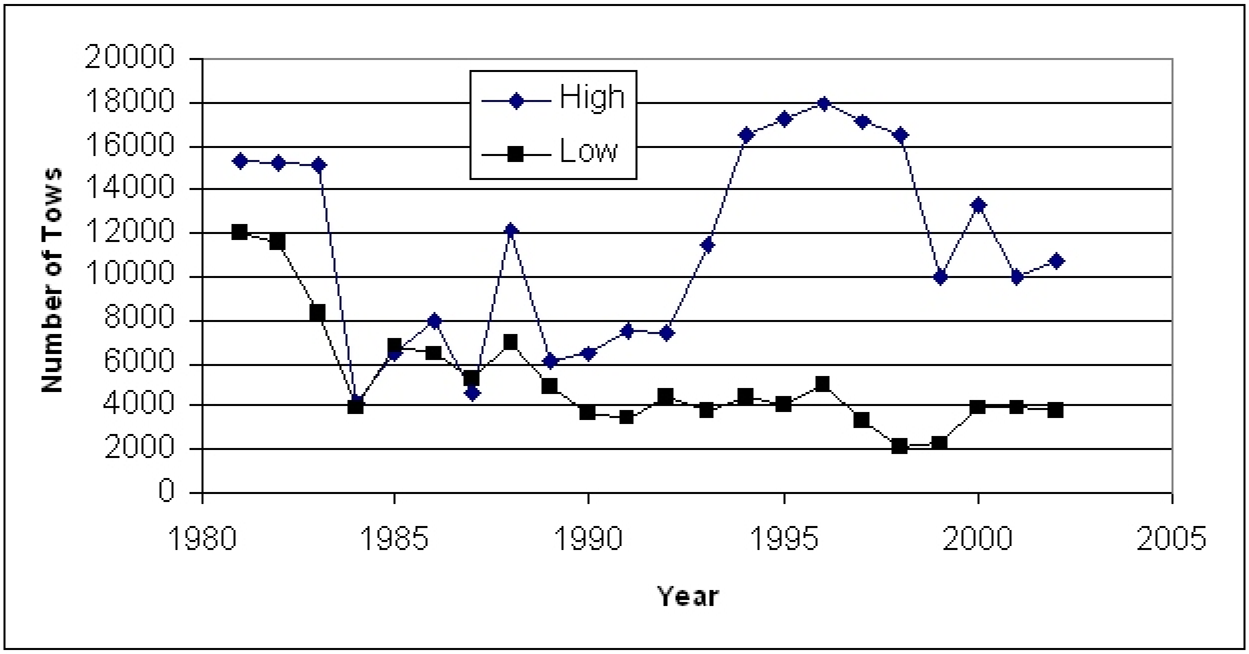
Source: NMFS Trawl Survey, 1994

Figure B.3.2.7-9. Survey Estimate of Total Mature Biomass of BS Tanner Crab (1,000 tons) from 1980 to 2004



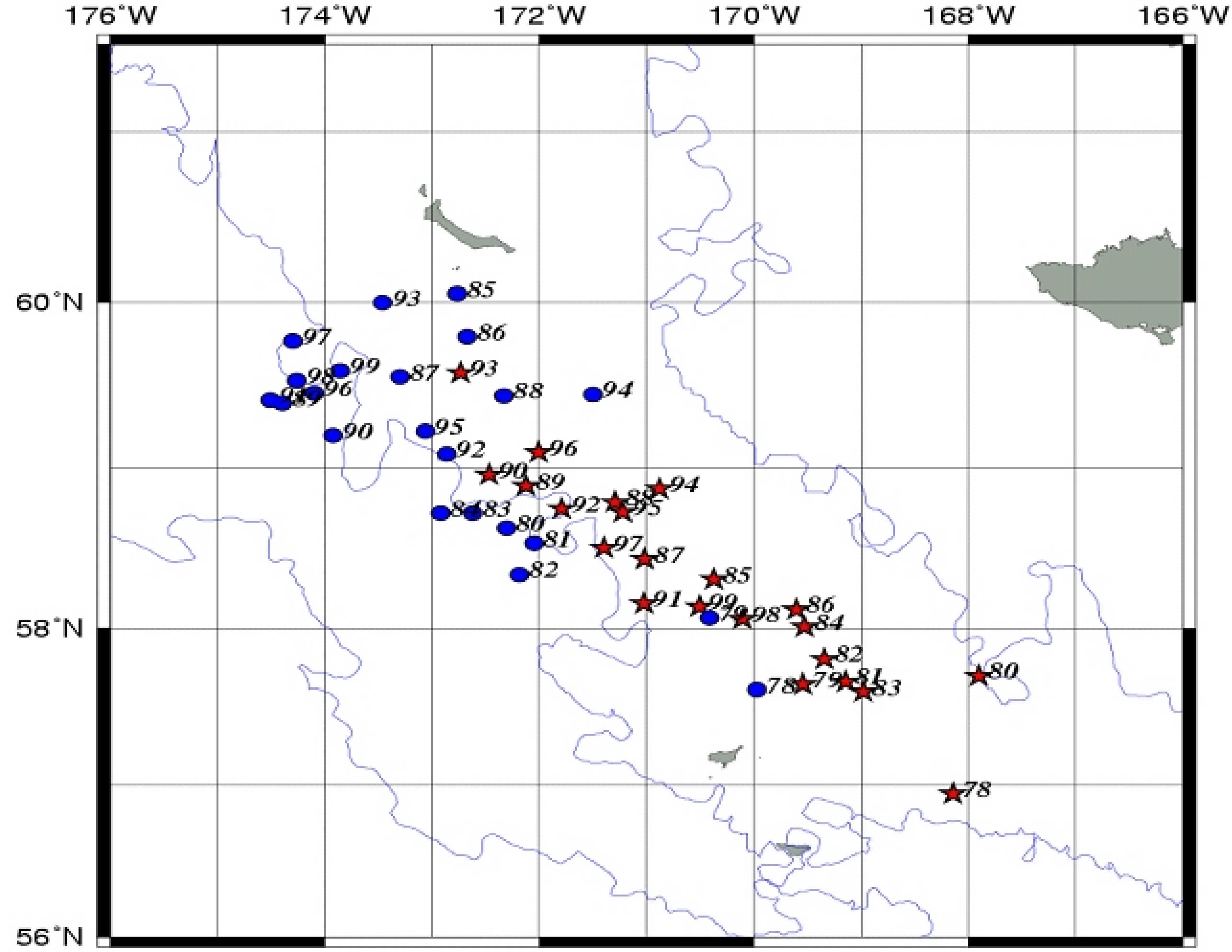
Note: Male and female recruits were estimated from a stock assessment model by fertilization year.
Source: BSAI Crab SAFE, 2003

Figure B.3.2.7-10. Number of Tows in High and Low Effects Areas in the EBS from 1981 to 2002

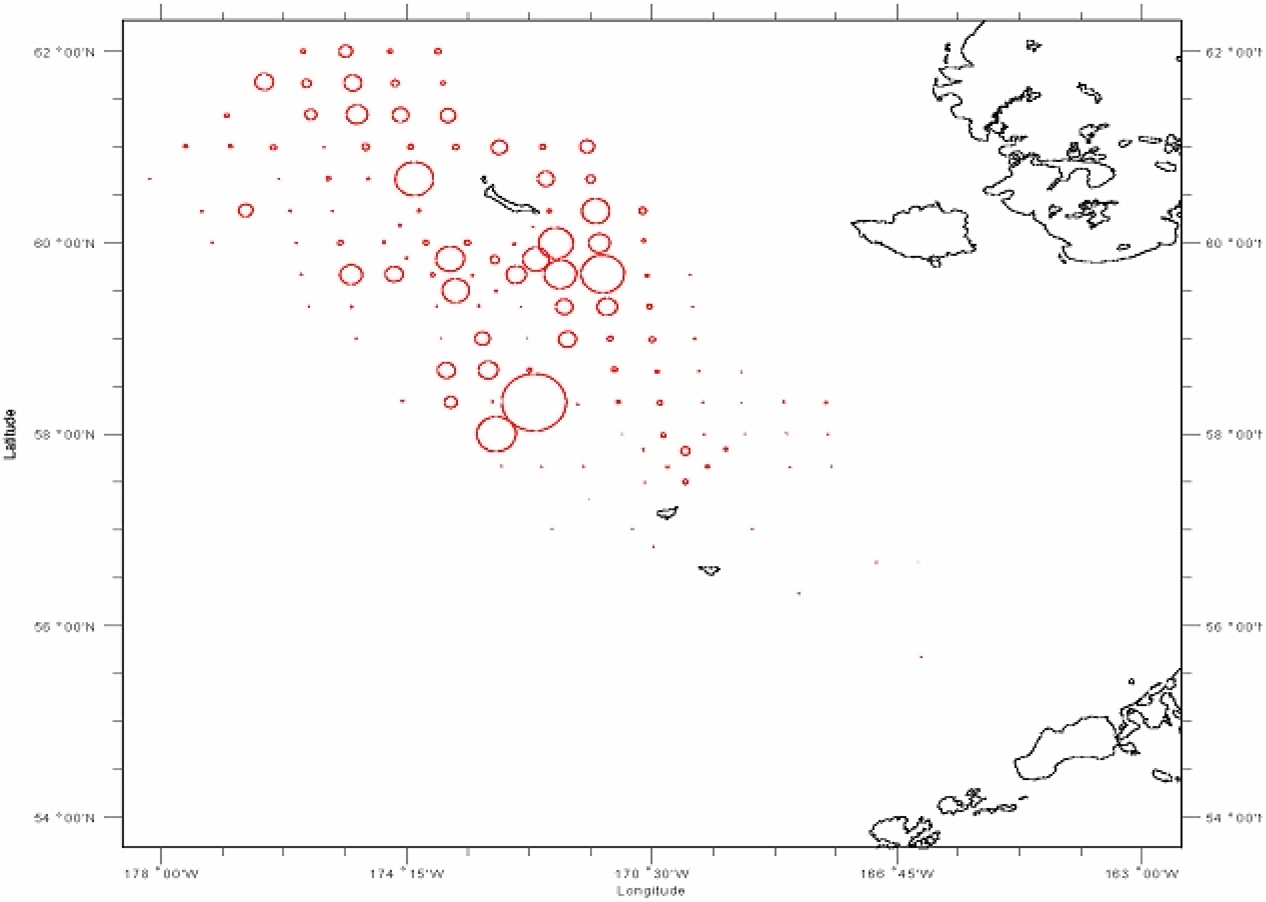


Source: NMFS Data

Figure B.3.2.8-1. Centroids of Abundance of Mature Female Snow Crabs (shell condition 2+) in

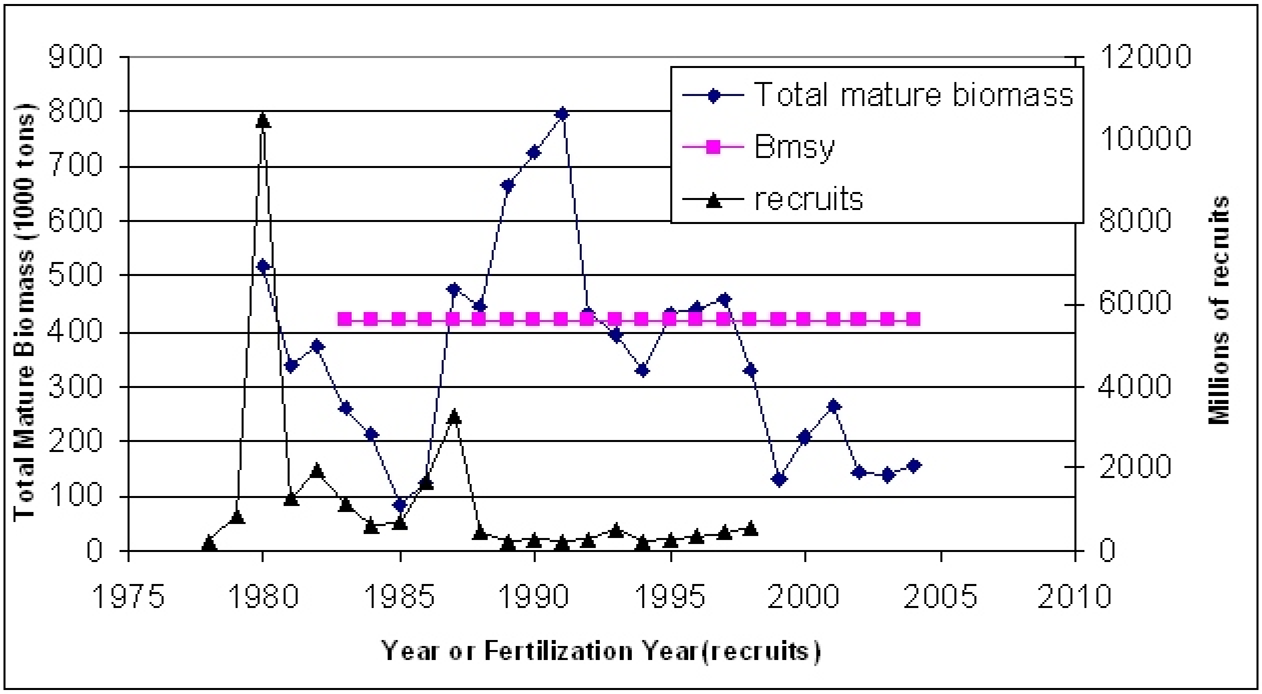


Source: Reprinted from Orensanz et al. 2005

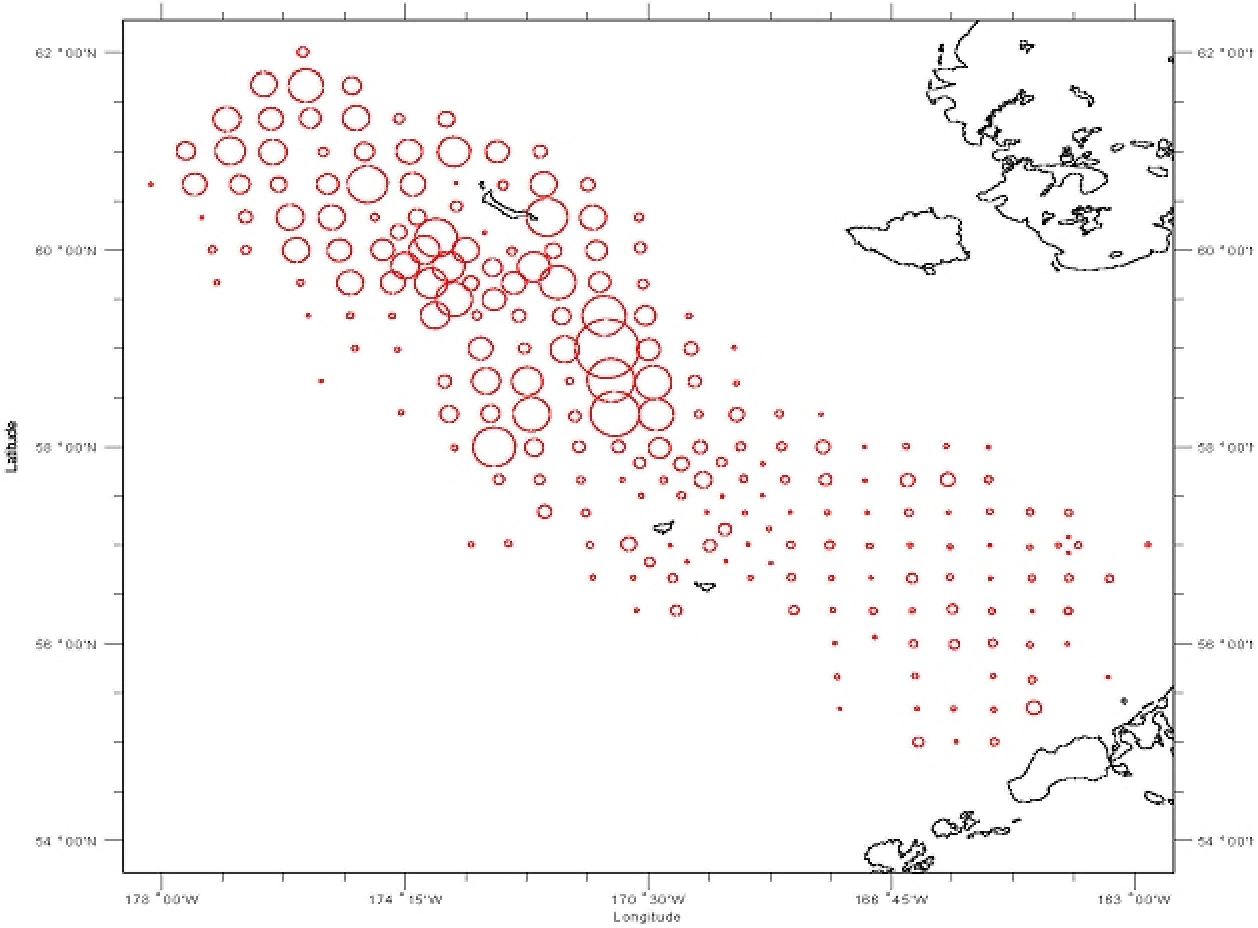


Note: Abundance is proportional to the area of the circle.
Source: NMFS Survey 2004

Figure B.3.2.8-3. Survey Estimates of Total Mature Biomass of BS Snow Crab (1,000 tons) from 1980 to 2004 and Recruitment by Fertilization Year from Stock Assessment Model

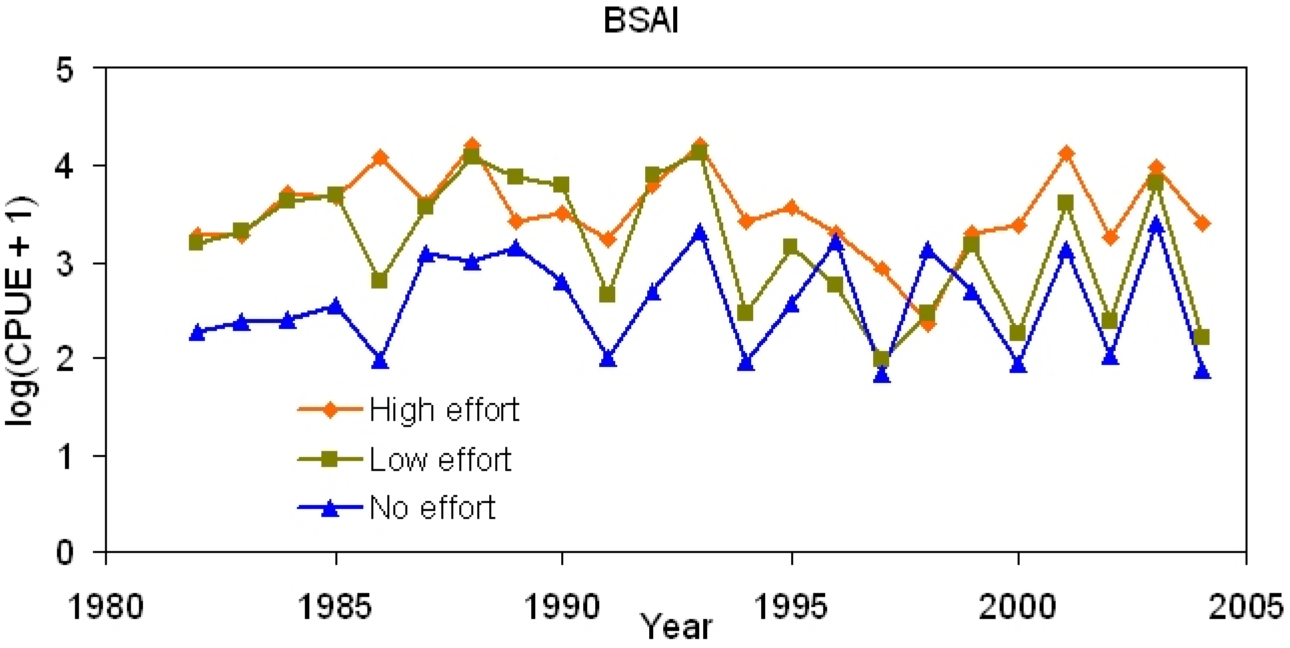


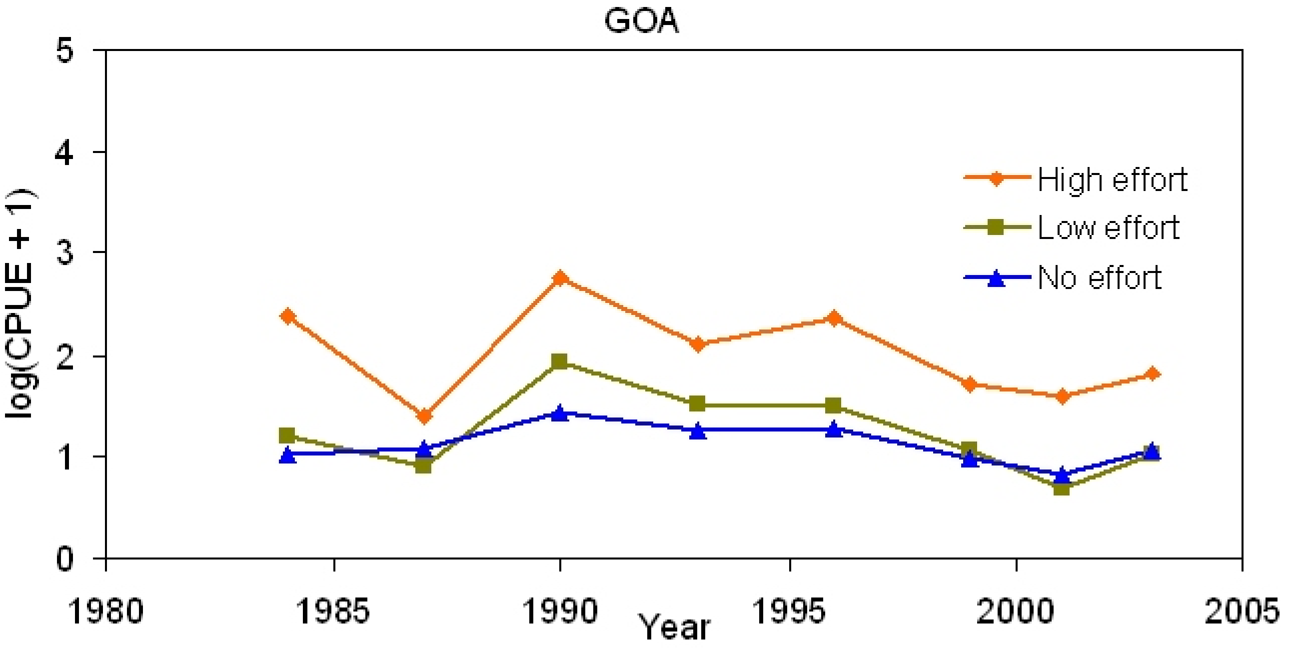
Source: Turnock 2004



Note: Abundance is proportional to the area of the circle.
Source: NMFS Survey 2004

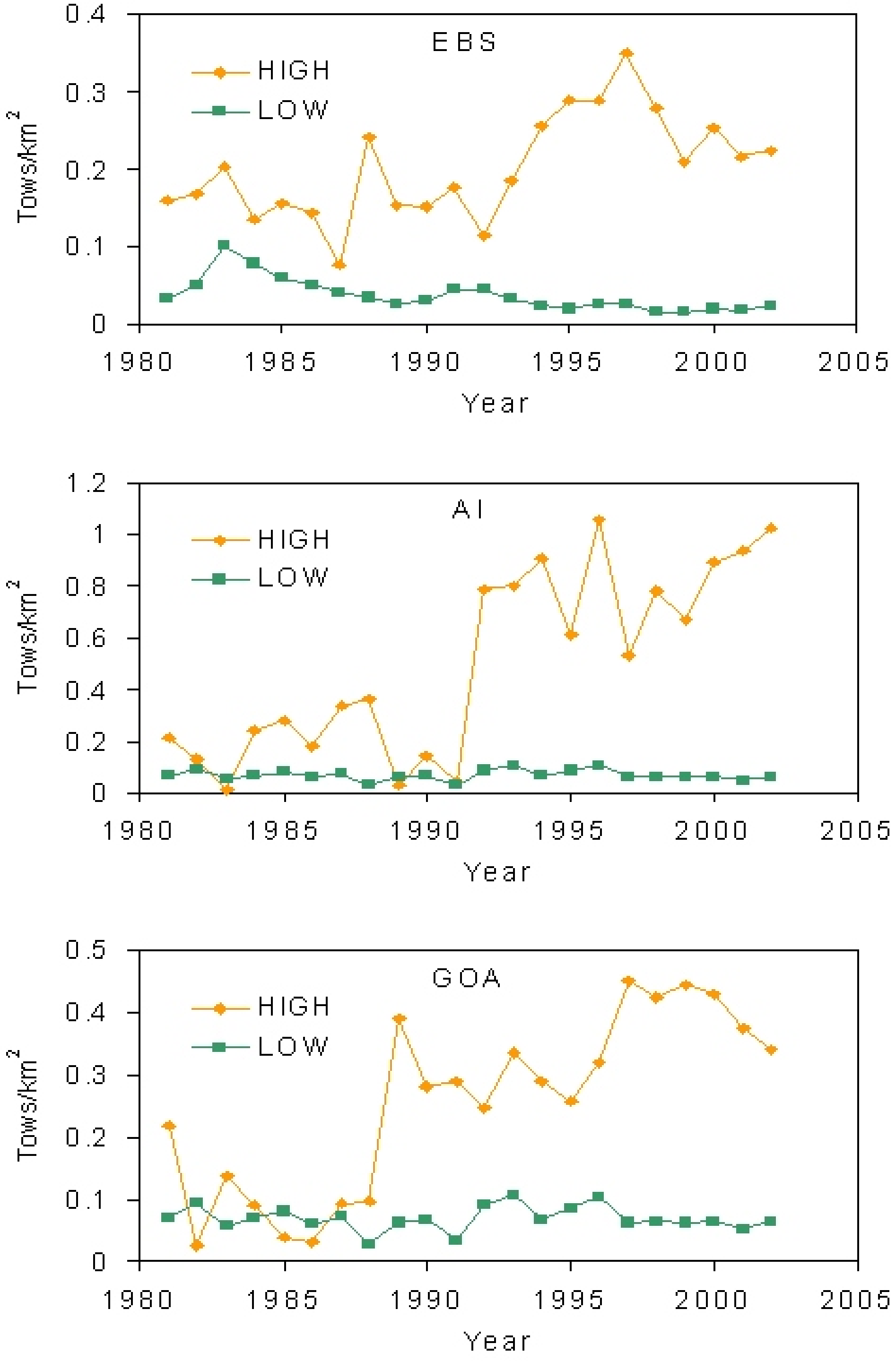
Figure B.3.3.1-1. Mean Log (CPUE +1) from Summer Bottom Trawl Surveys in the BSAI and the GOA by High, Low, and No Effort Areas





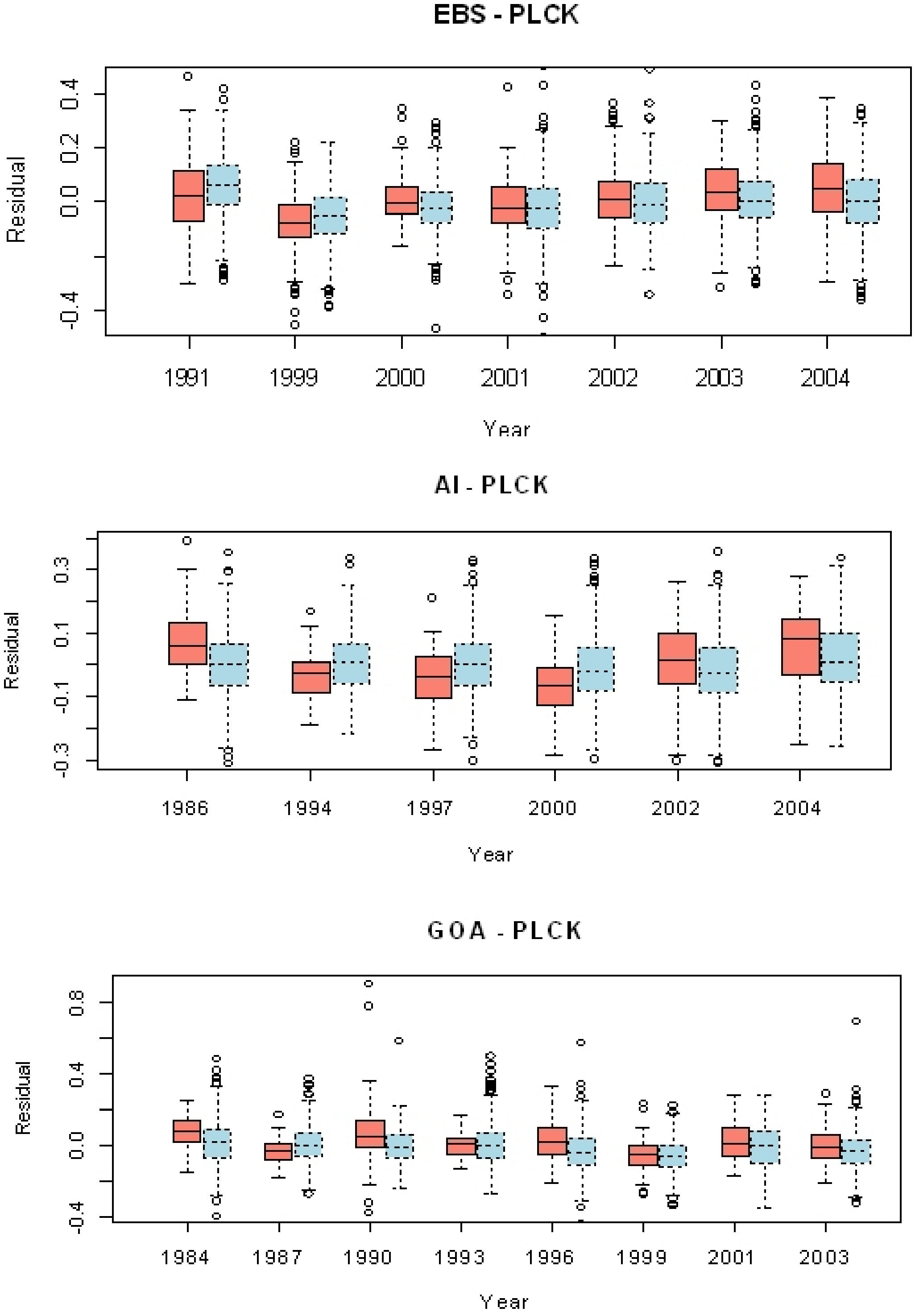
Source: NMFS bottom trawl surveys, multiple years.

Figure B.3.3.1-2. Non-pollock Fishing Effort (tows/km^2) from 1981 to 2002 in Areas Designated as High and Low Effort Areas in the GOA, AI, and BS Based on the 5-year Period from 1998 to 2002



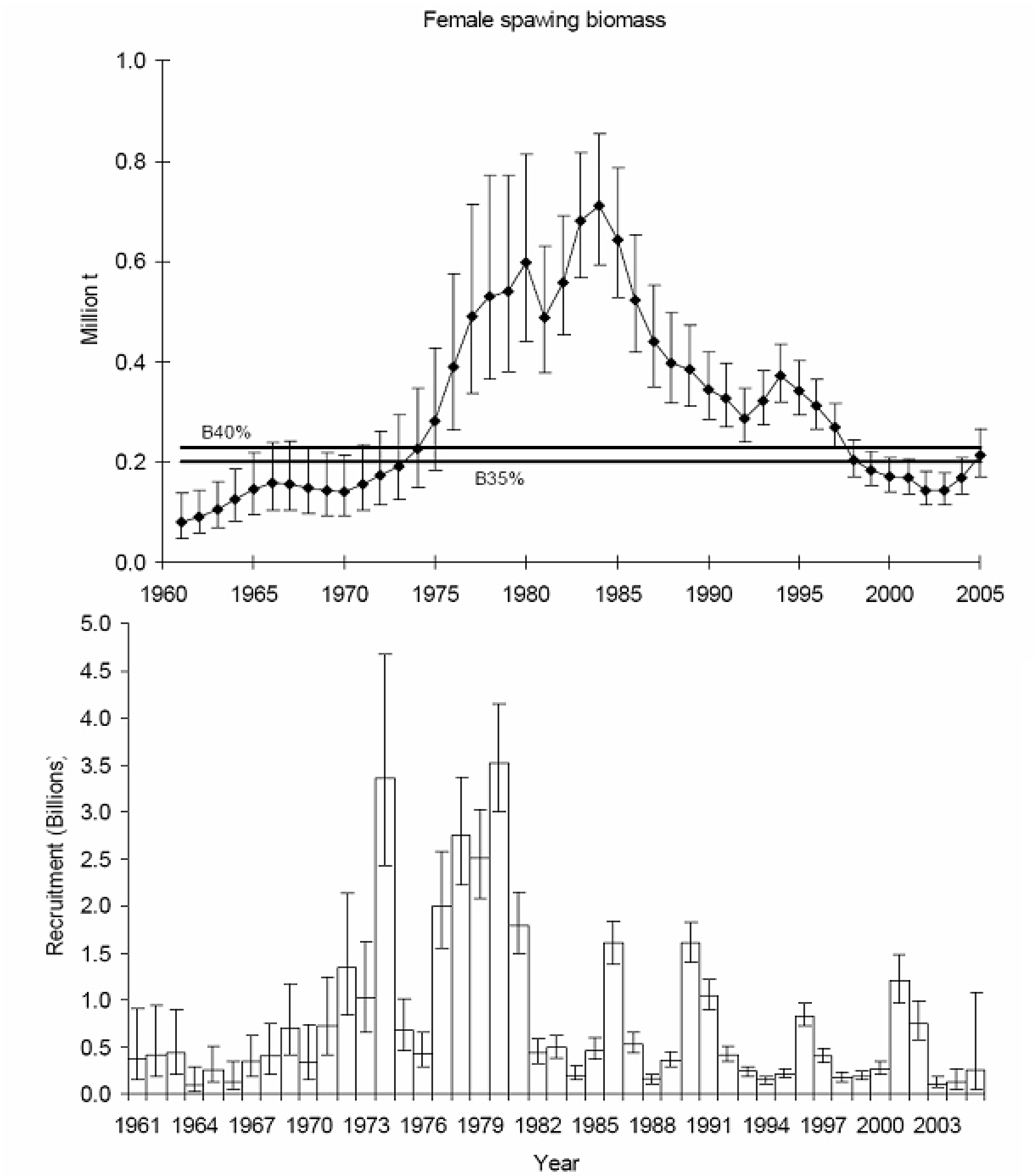
Source: NMFS Data

Figure B.3.3.1-3. Box Plots of Weight Residuals (deviations from mean weight by length and sex) for High-effort (left) and Low-effort Areas (right) by Year and Region



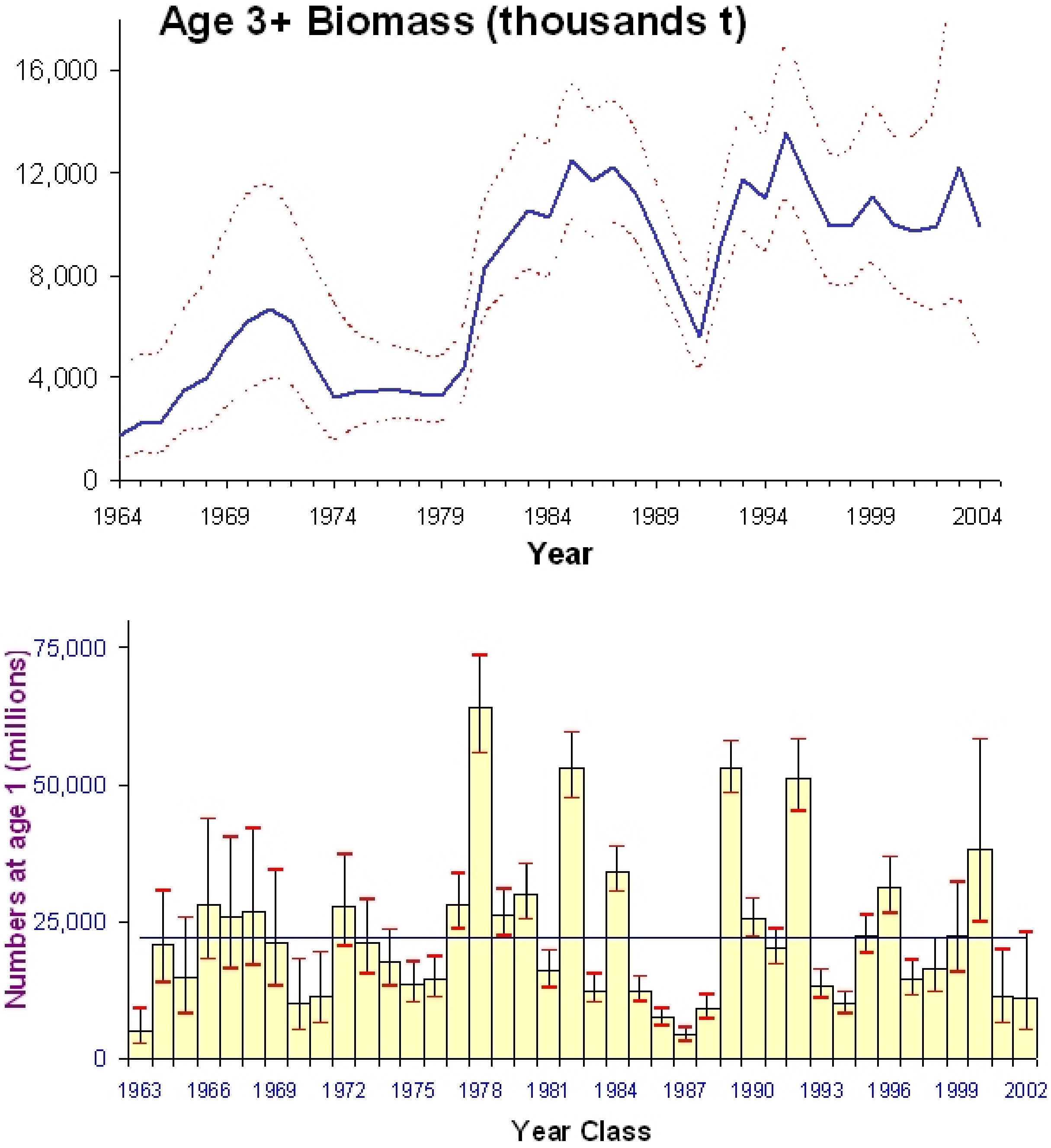
Source: NMFS Survey Data

Figure B.3.3.1-4. GOA Pollock Spawning Biomass (million tons [t], top) and Age 2 Recruitment (billions of fish, bottom) from 1961 to 2005



Note: Vertical bars represent two standard deviations. The $B_{35\%}$ and $B_{40\%}$ lines represent the current estimates of these benchmarks.
Source: NMFS Survey Data

Figure B.3.3.1-5. EBS Pollock Stock Biomass (thousands of t, top) and Age-1 Recruitment (millions of fish, bottom) from 1961 to 2005



Note: Vertical bars represent two standard deviations.
Source: NMFS

Figure B.3.3.3-1. Retrospective Estimates of 40 Percent Biomass via Three Alternative Averaging Methods

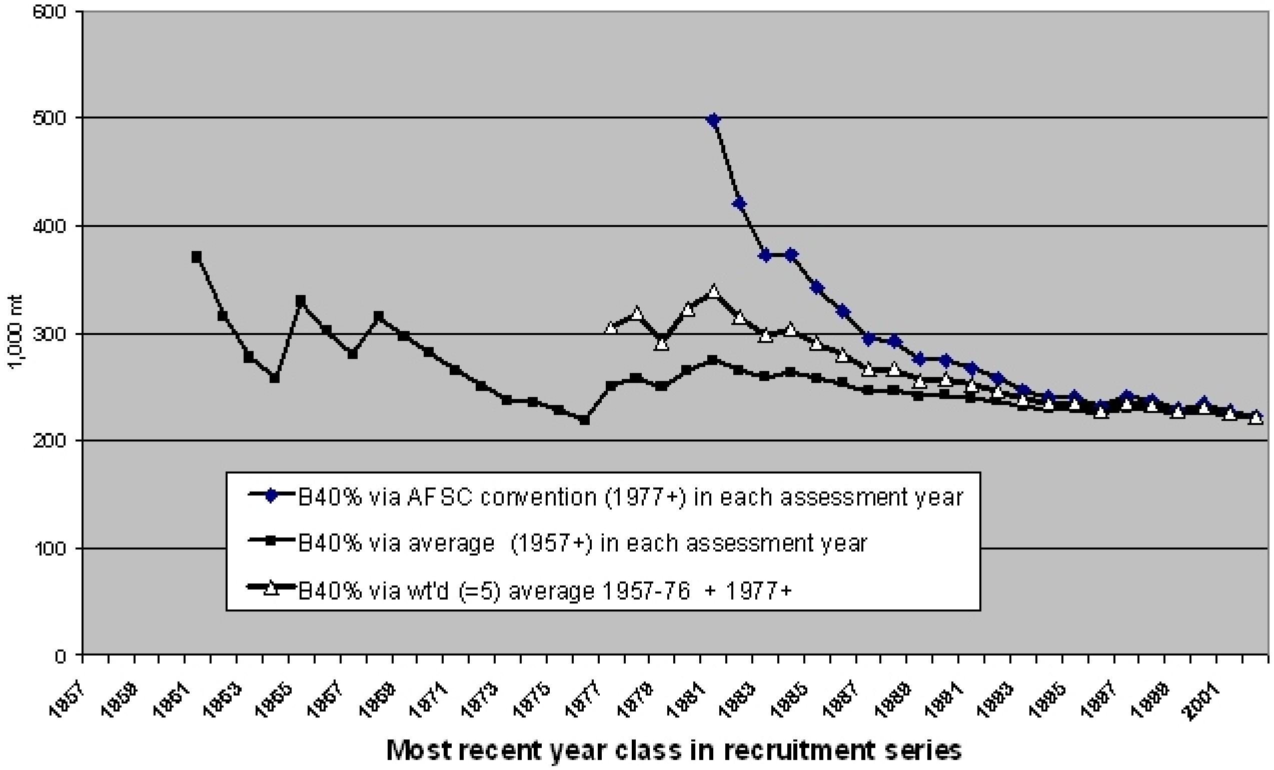
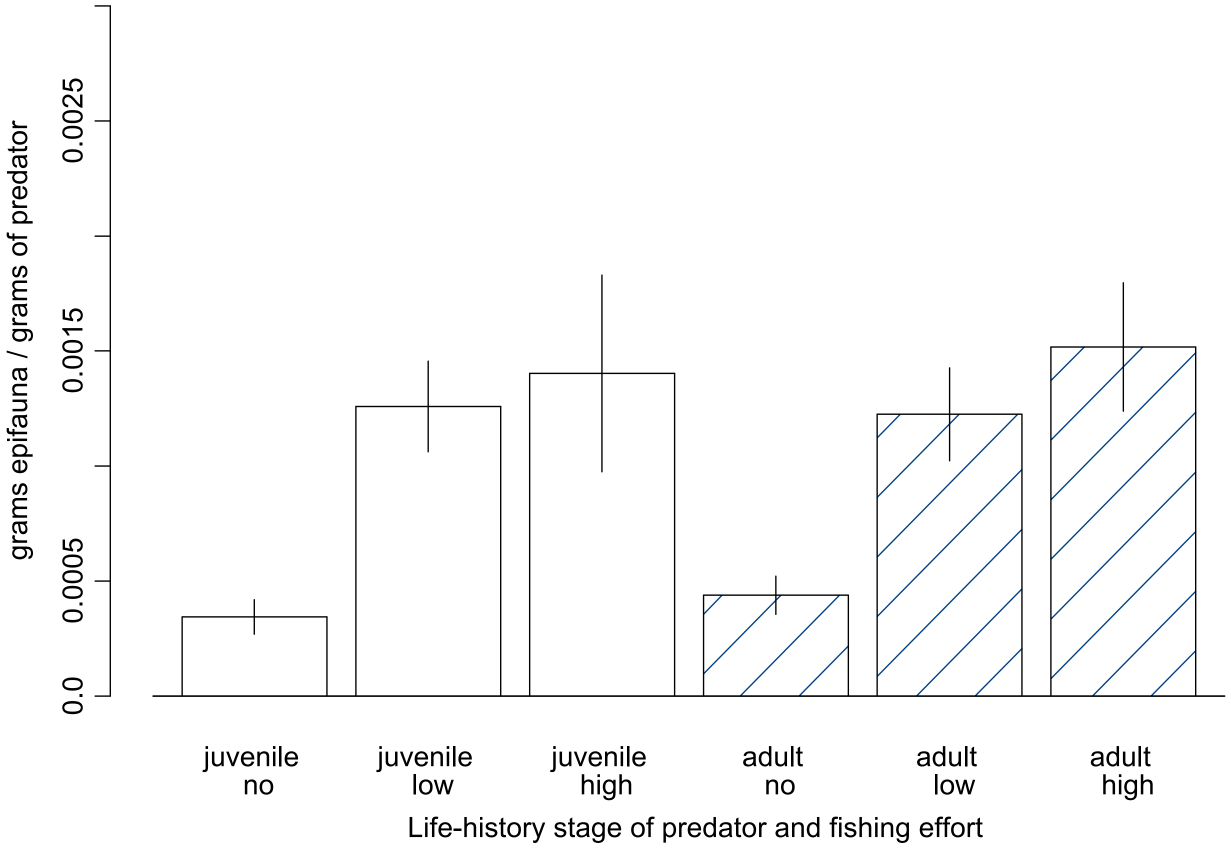
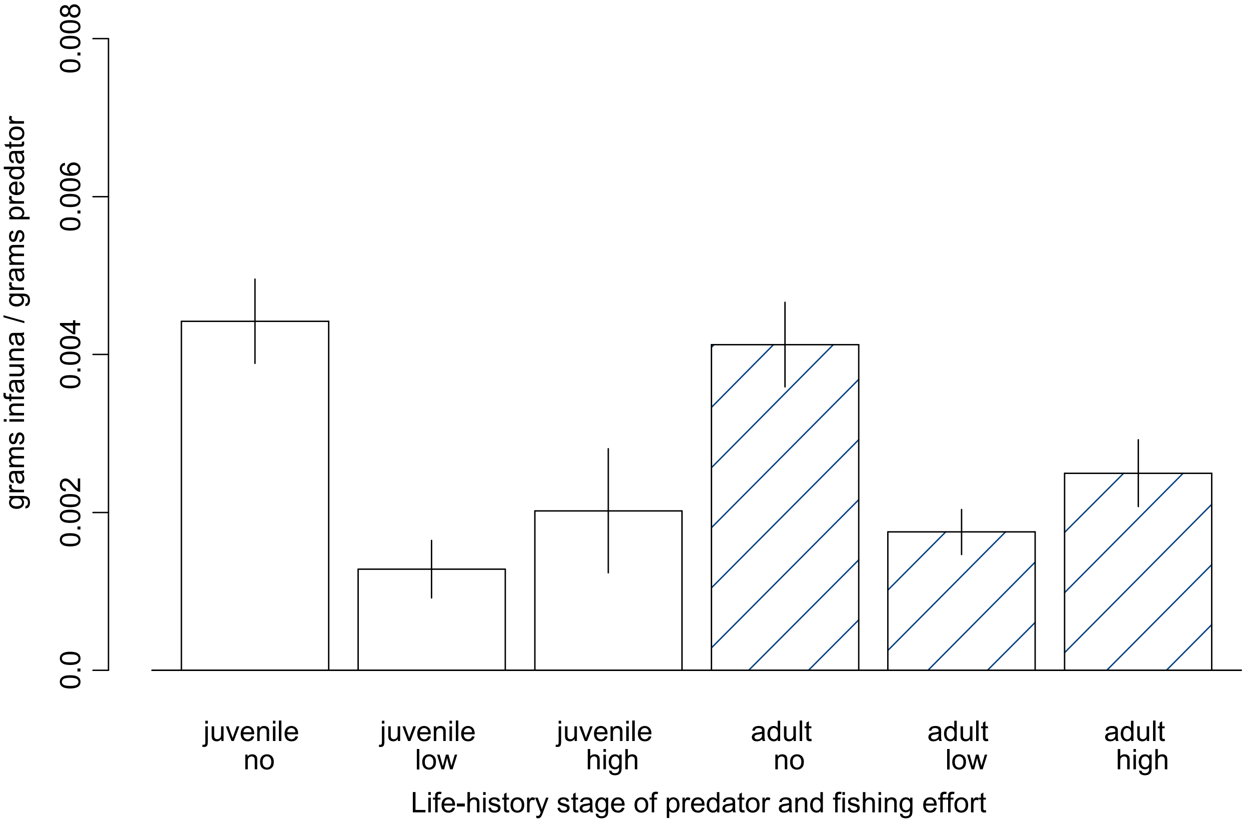


Figure B.3.3.5-1. Yellowfin Sole (BSAI): Grams Epifauna/Grams Predator and 95 Percent Confidence Interval



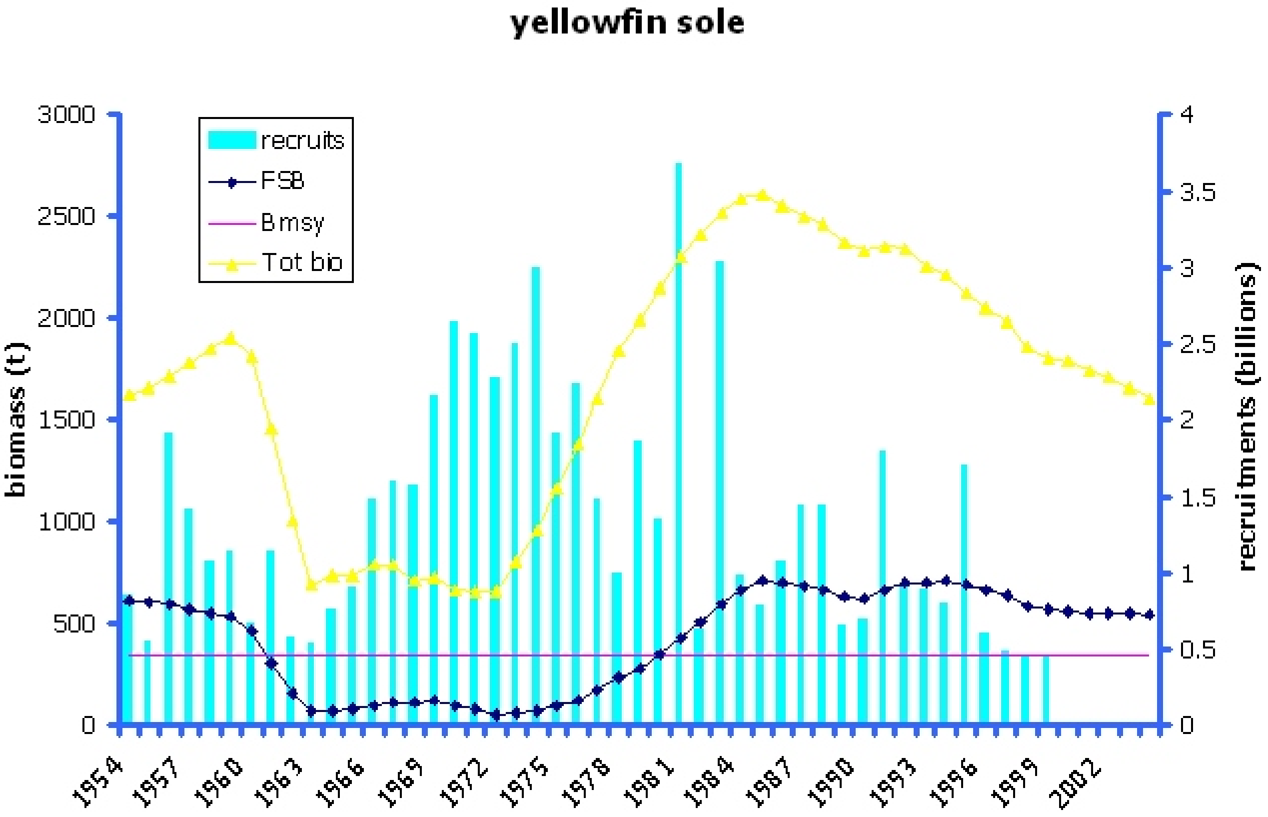
Source: NMFS Data

Figure B.3.3.5-2. Yellowfin Sole (BSAI): Grams Infauna/Grams Predator and 95 Percent Confidence Interval



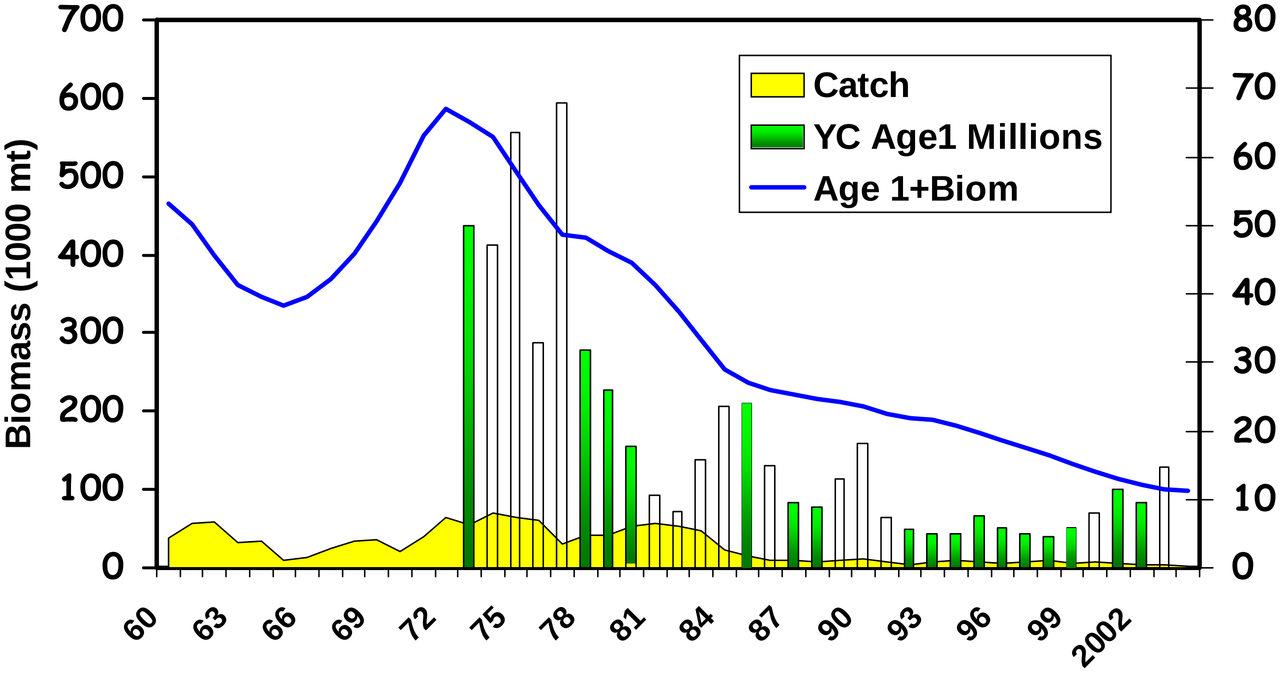
Source: NMFS Data

Figure B.3.3.5-3. Stock Assessment Model Results of Recruitment, Female Stock Spawning Biomass, B_{MSY}, and Total Stock Biomass



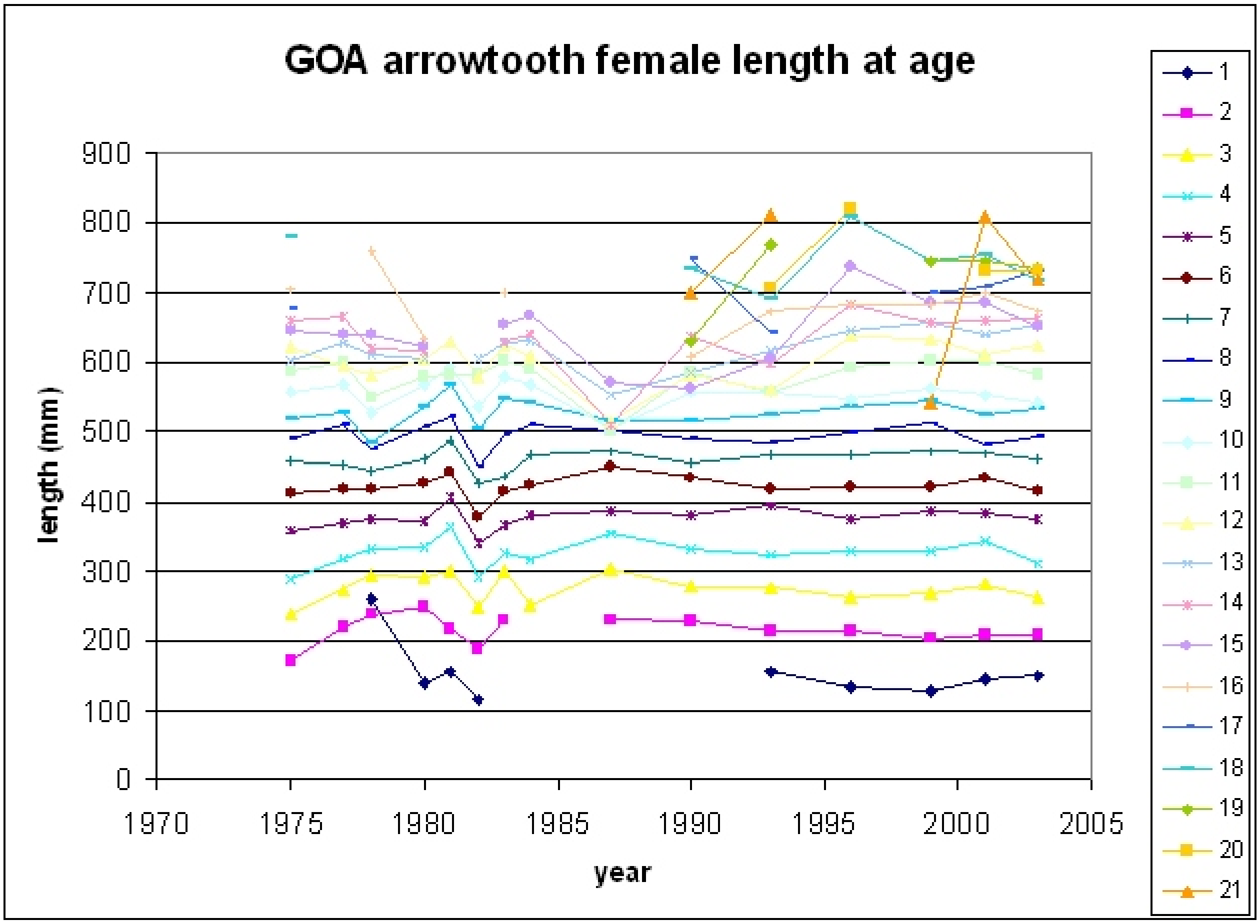
Source: NMFS Data

Figure B.3.3.6-1. Estimates of Greenland Turbot Catch, Year Class at Age 1, and Biomass of Age 1+ Fish



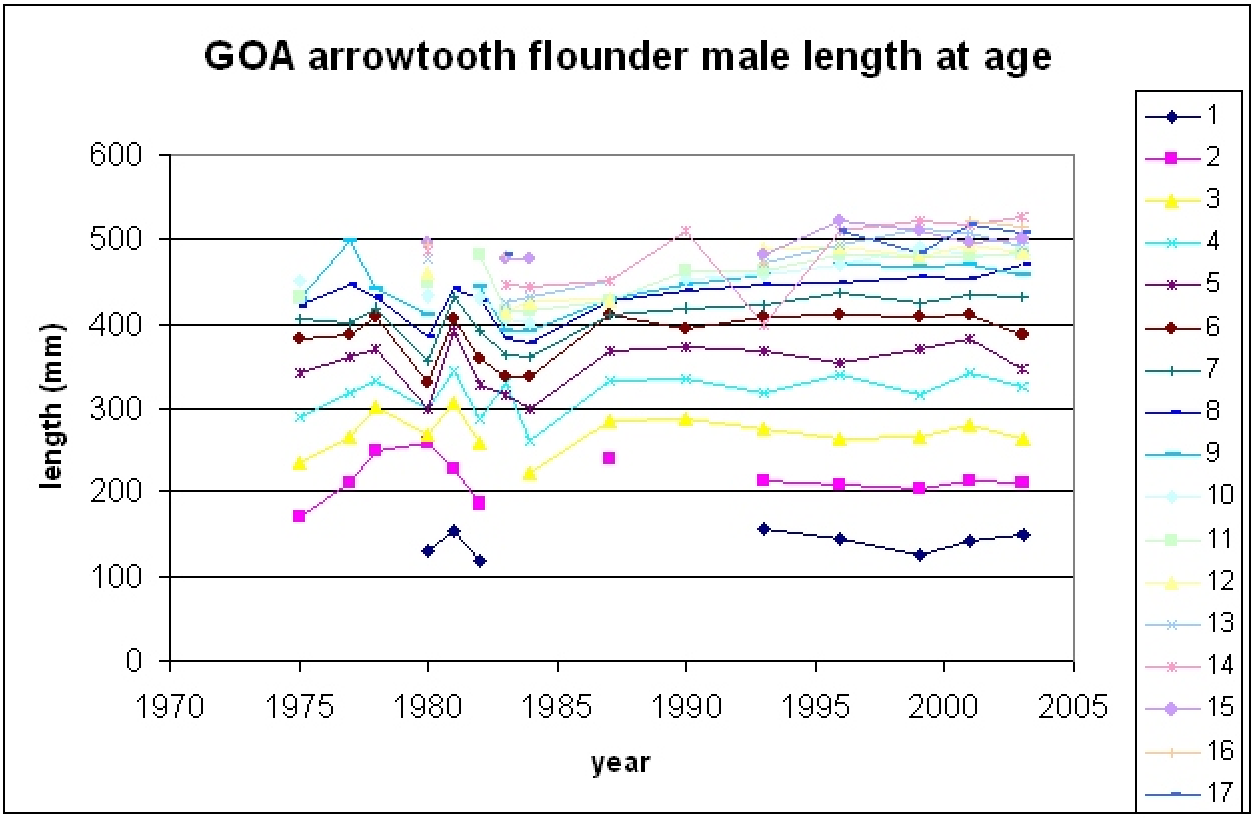
Source: NMFS Data

Figure B.3.3.7-1. Arrowtooth Flounder (GOA) Female Length at Age



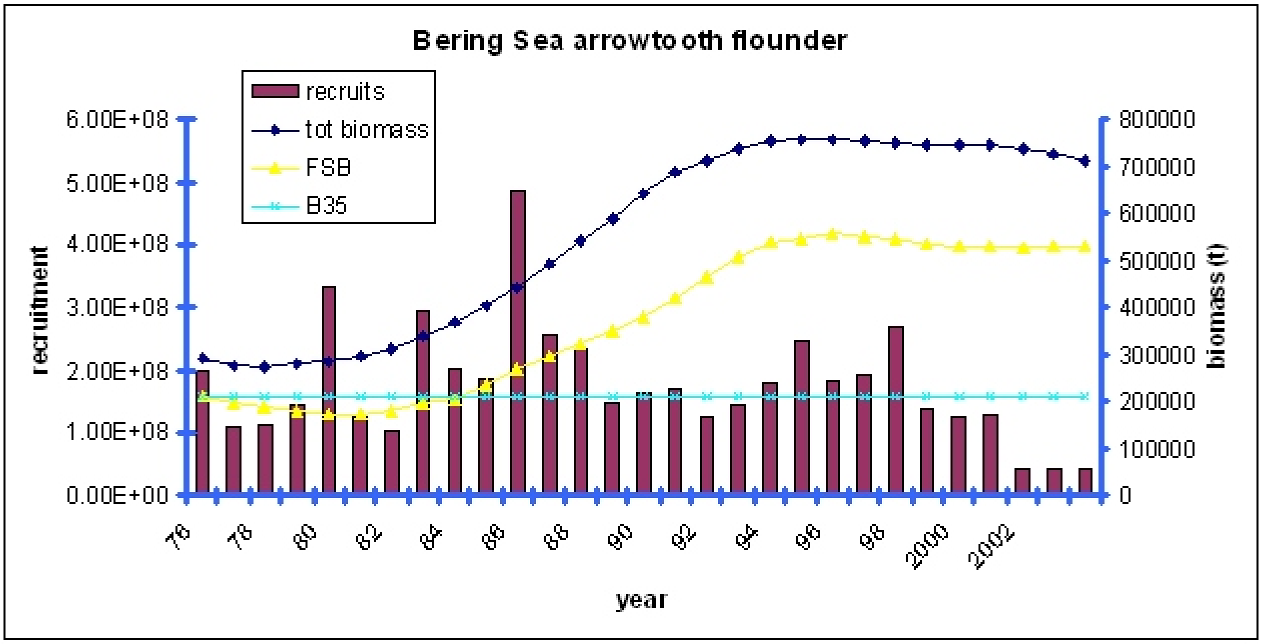
Source: NMFS Data

Figure B.3.3.7-2. Arrowtooth Flounder (GOA) Male Length at Age



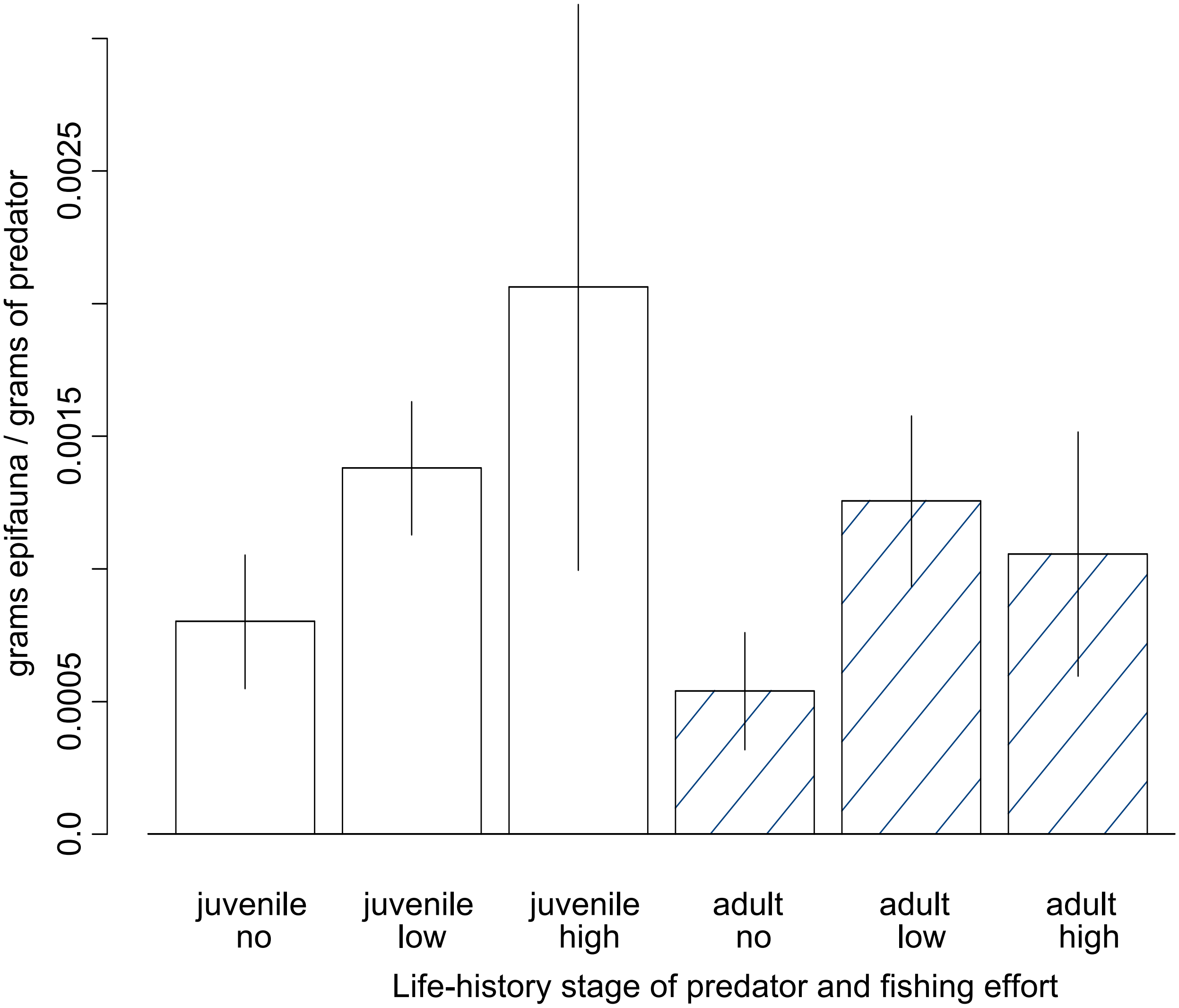
Source: NMFS Data

Figure B.3.3.7-3. Stock Assessment Model Results of Recruitment, Total Biomass, Female Spawning Biomass, and the 35 Percent Biomass Level



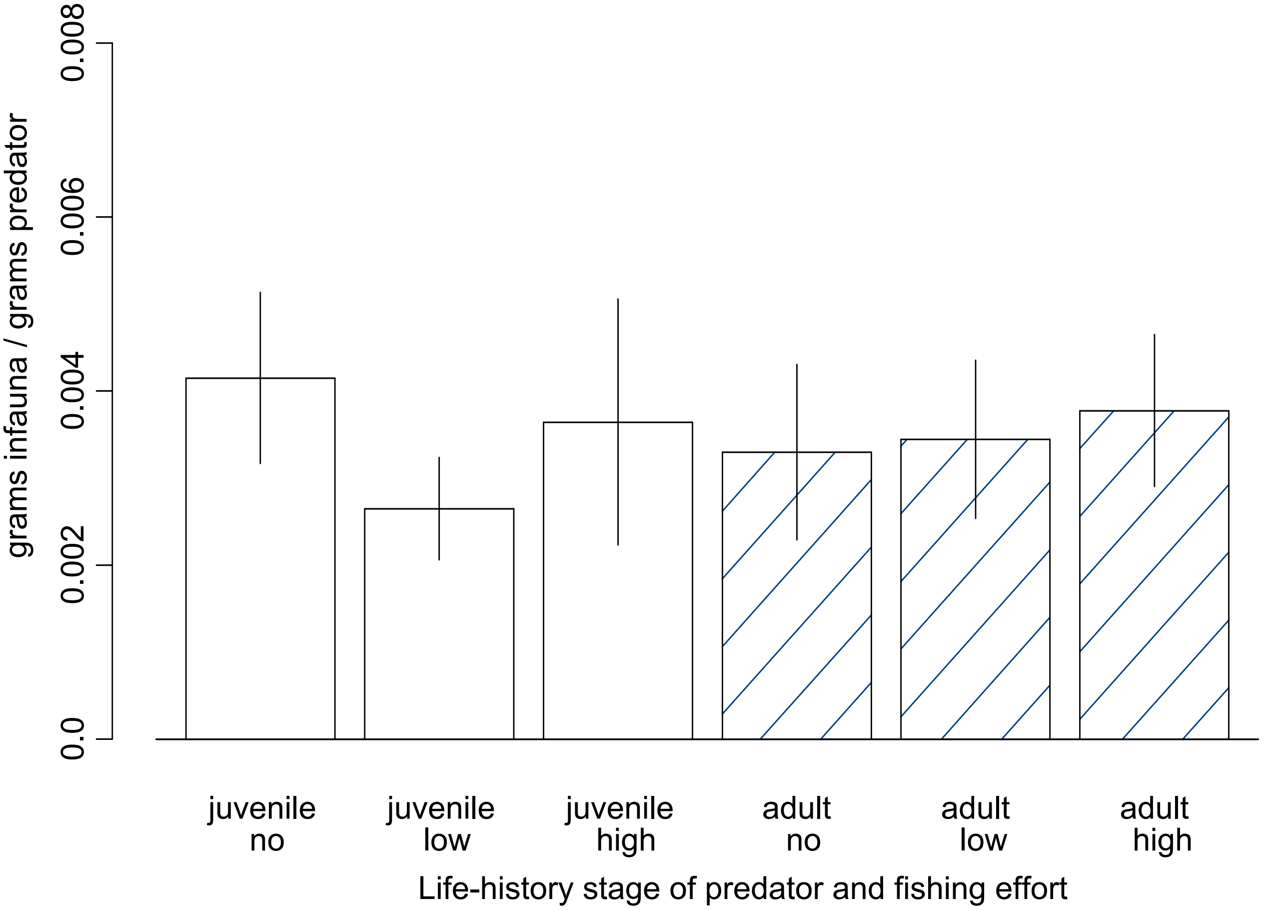
Source: NMFS Data

Figure B.3.3.8-1. Northern Rock Sole: Grams Epifauna/Grams Predator and 95 Percent Confidence Intervals



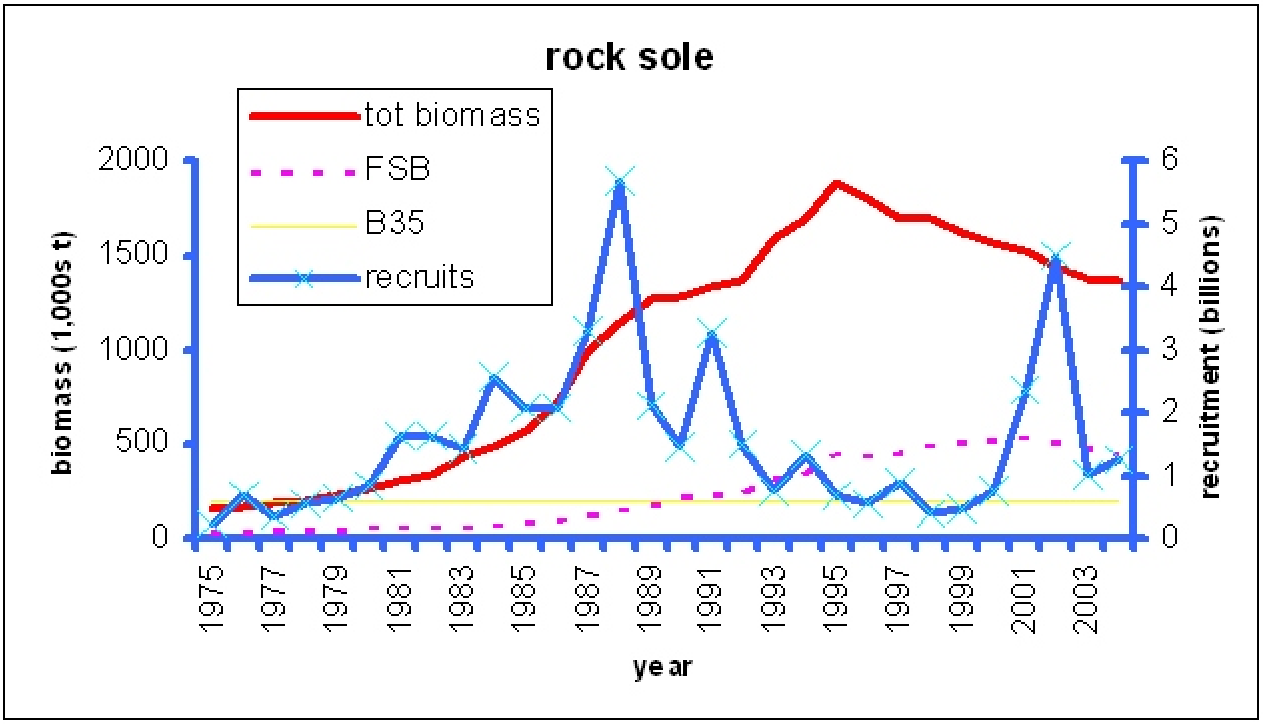
Source: NMFS Data

Figure B.3.3.8-2. Northern Rock Sole: Grams Infauna/Grams Predator and 95 Percent Confidence Intervals



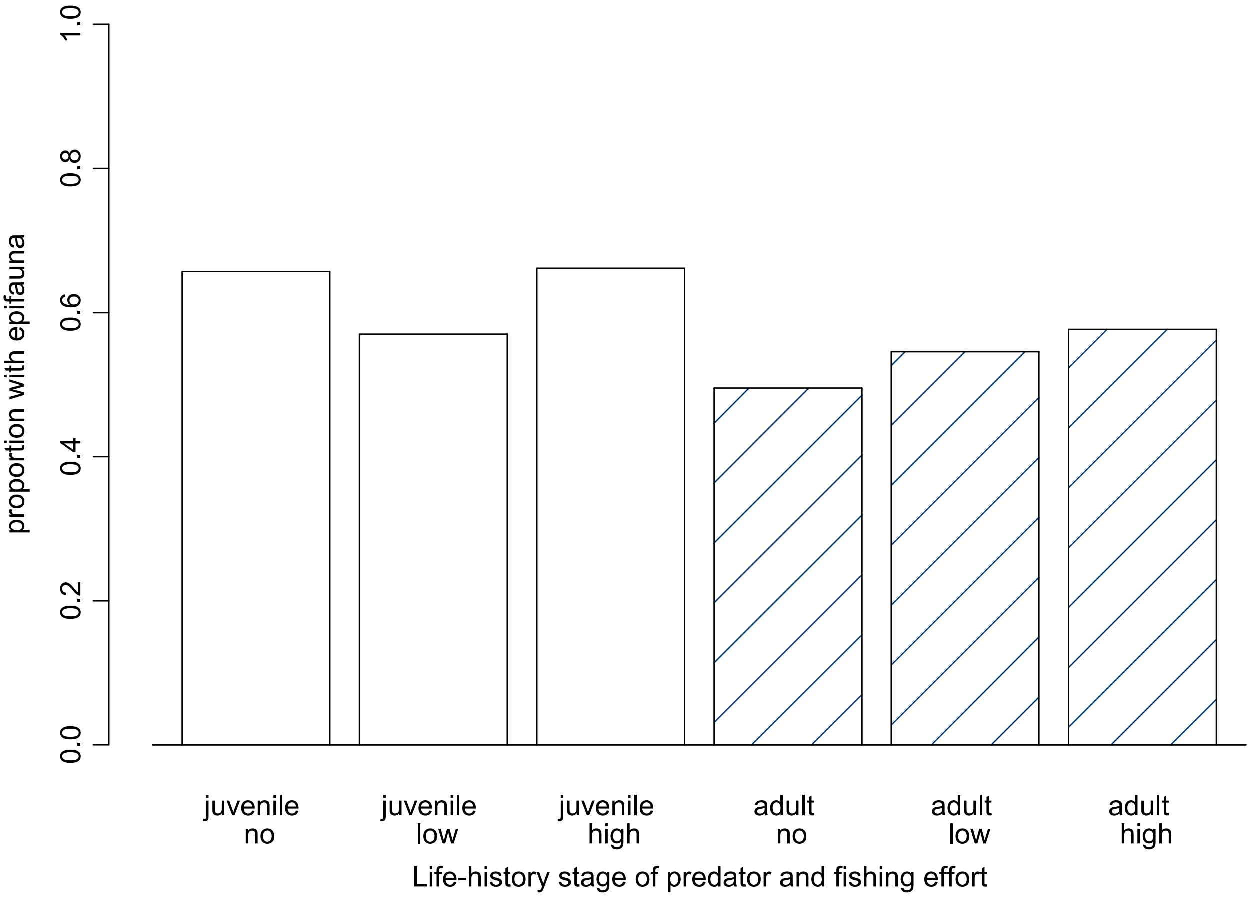
Source: NMFS Data

Figure B.3.3.8-3. Rock Sole Stock Assessment Model Results of Total Biomass, Female Spawning Biomass, 35 Percent Biomass Stock Level, and Number of Recruits



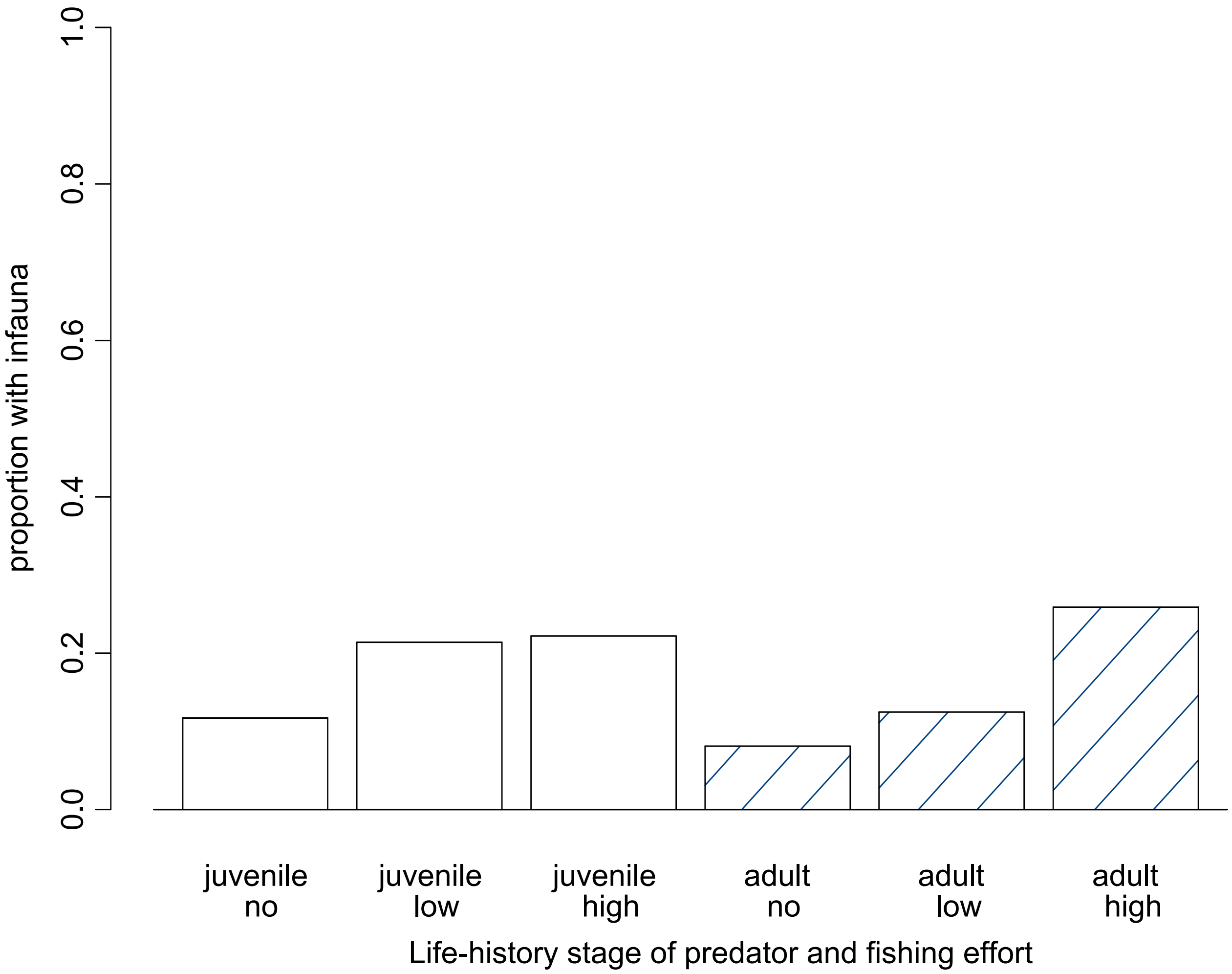
Source: NMFS Data

Figure B.3.3.9-1. Flathead Sole: Proportion with Epifauna



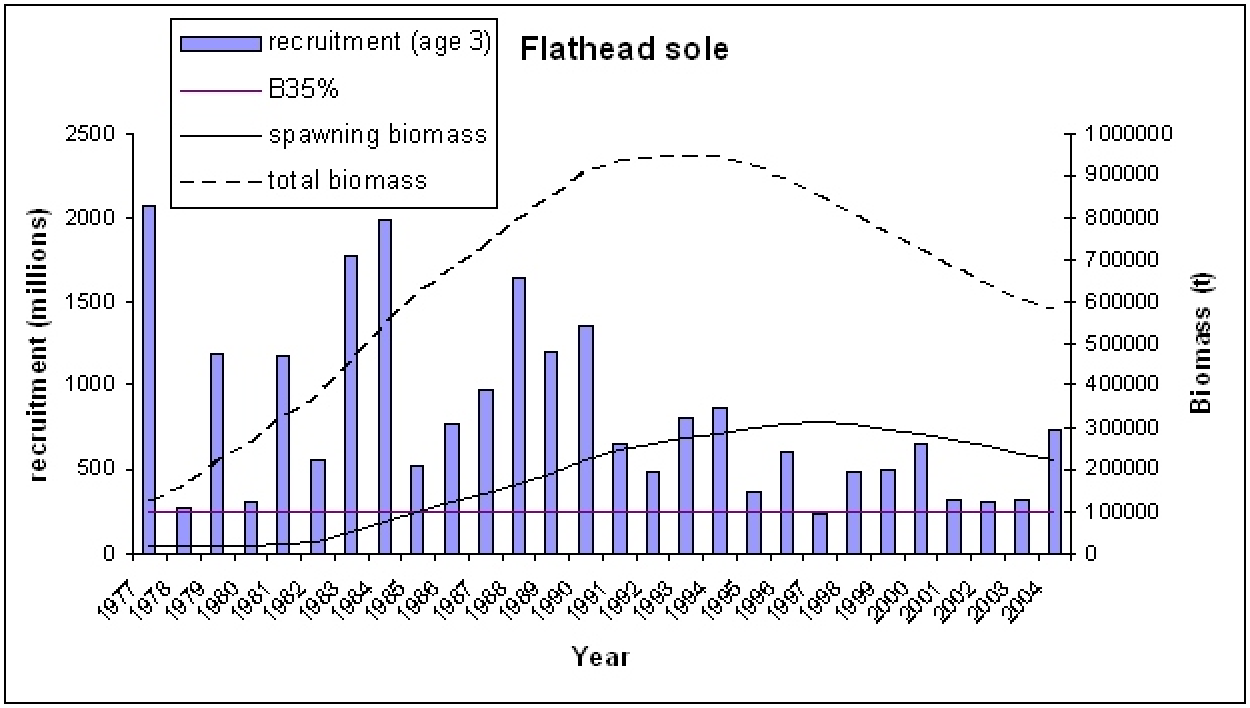
Source: NMFS Data

Figure B.3.3.9-2. Flathead Sole: Proportion with Infauna



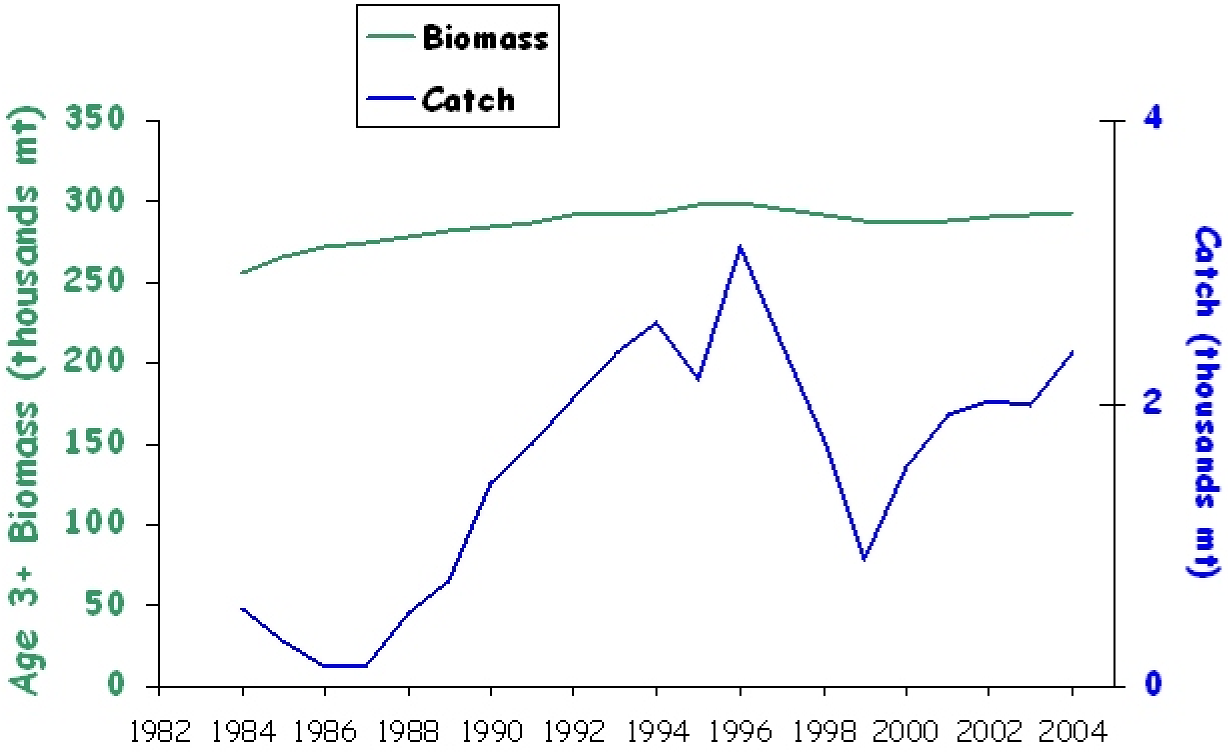
Source: NMFS Data

Figure B.3.3.9-3. Stock Assessment Model Results of Recruitment, the 35 Percent Biomass Level, Spawning Biomass, and Total Biomass



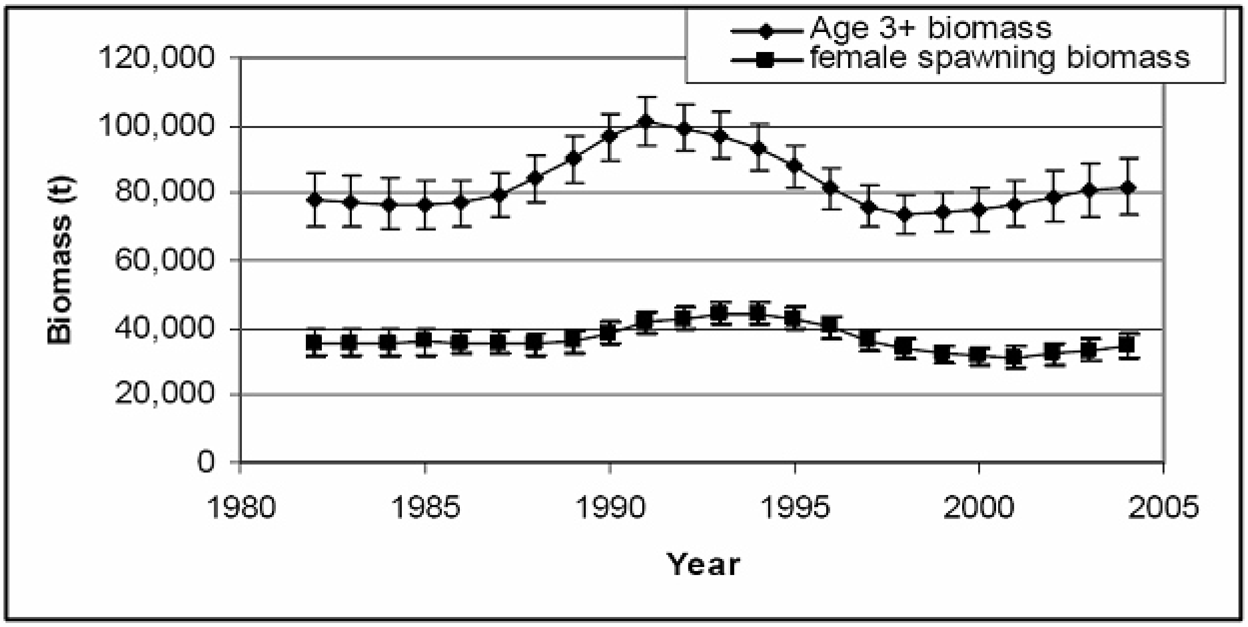
Soruce: NMFS Data

Figure B.3.3.10-1. GOA Flathead Sole Stock Assessment Model Results of Age 3+ Biomass and Catch



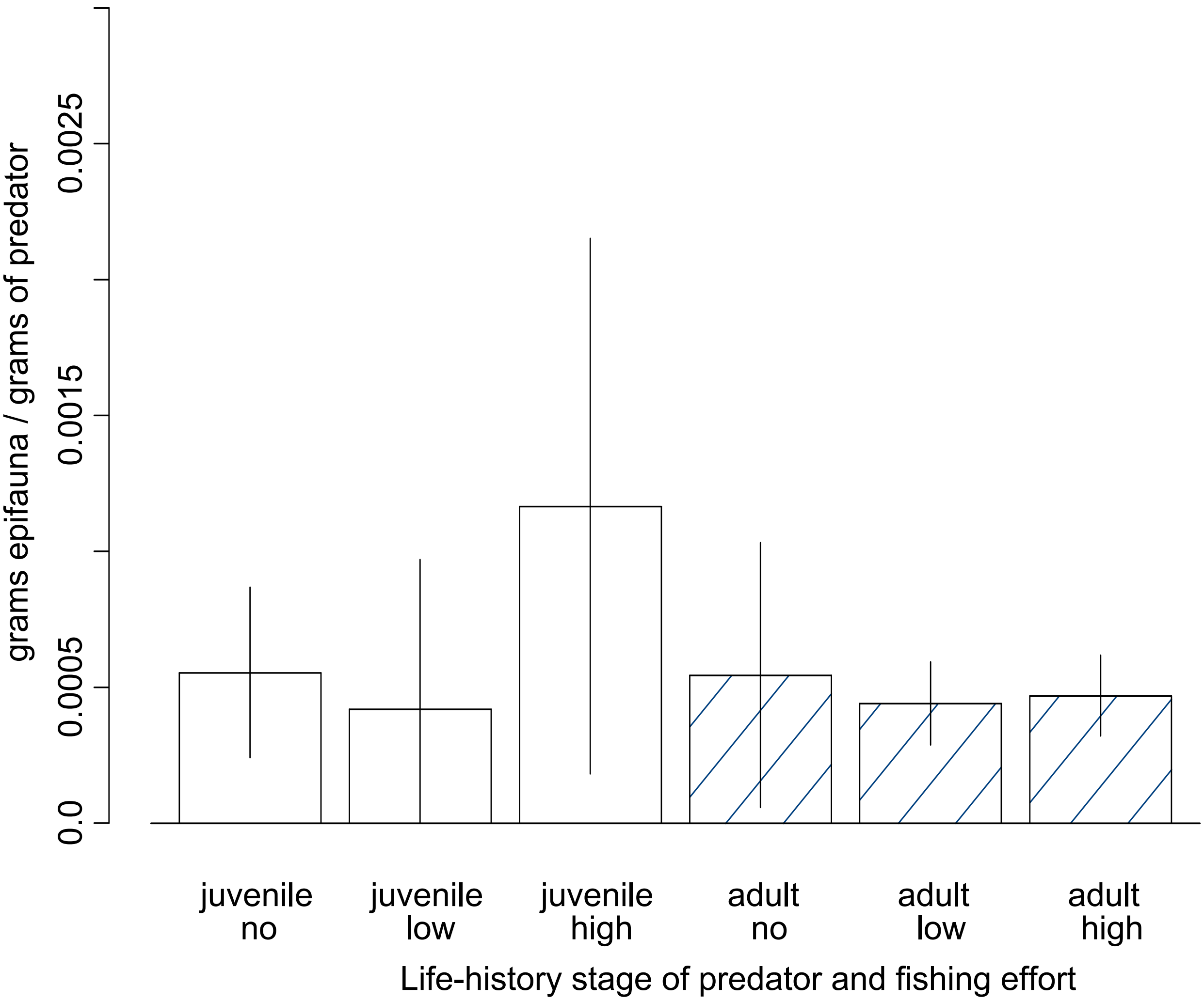
Note: The projected 2004 female spawning biomass is estimated at 109,980 t, well above the B_{MSY} level for this stock estimated at 47,700 t.
Source: NMFS Data

Figure B.3.3.11-1. Rex Sole Stock Assessment Model Estimates of Age 3+ Biomass and Female Spawning Biomass



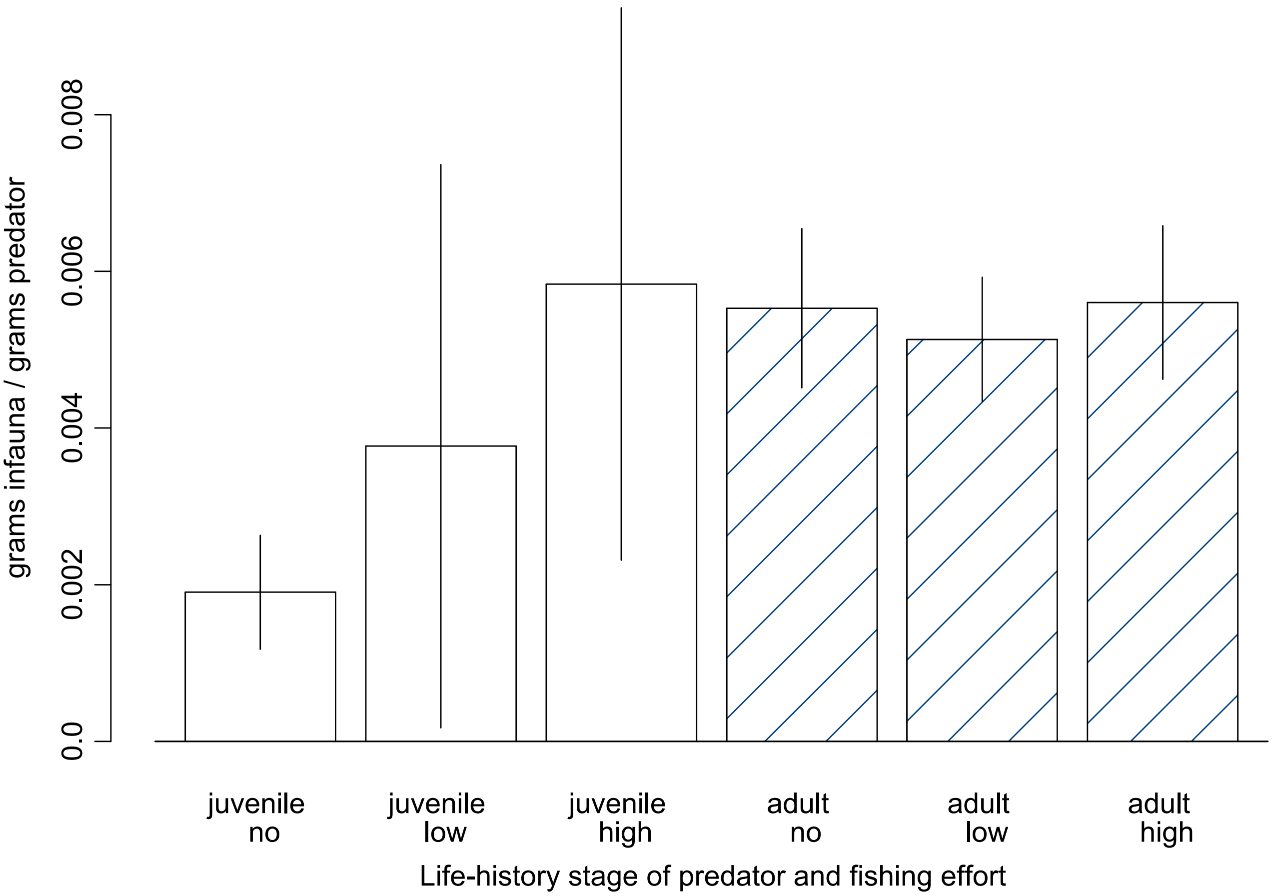
Source: NMFS Data

Figure B.3.3.12-1. Alaska Plaice: Grams Epifauna/Grams Predator and 95 Percent Confidence Intervals



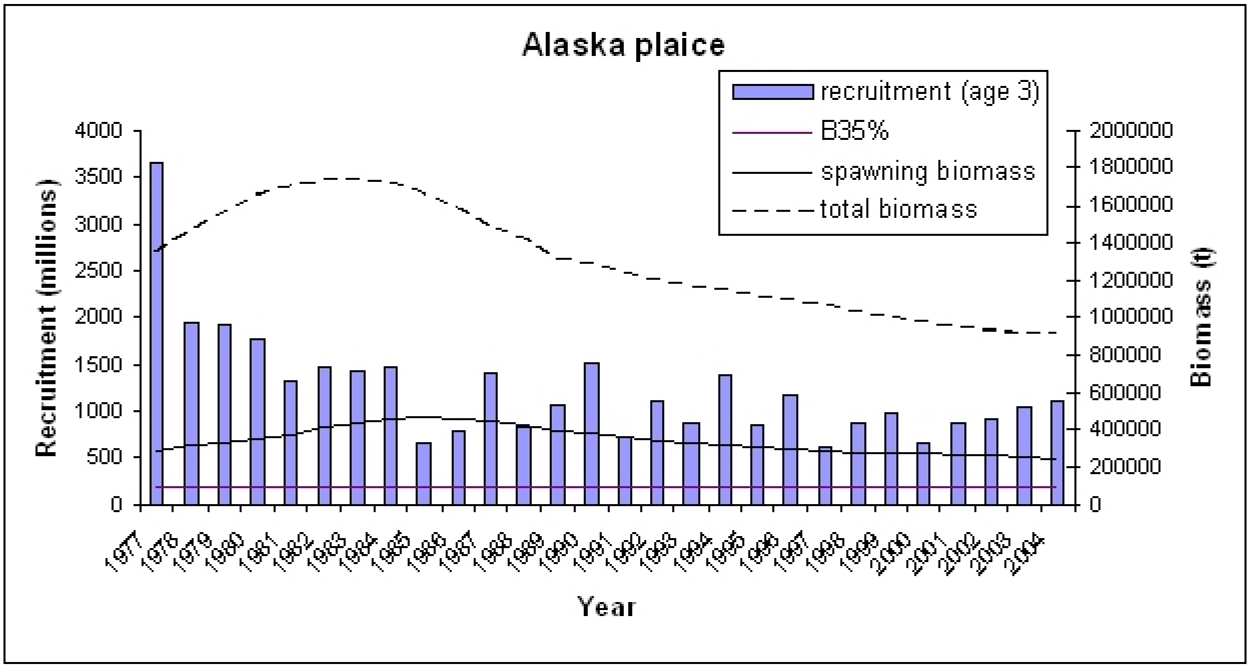
Source: NMFS Data

Figure B.3.3.12-2. Alaska Plaice: Grams Infauna/Grams Predator and 95 Percent Confidence Intervals



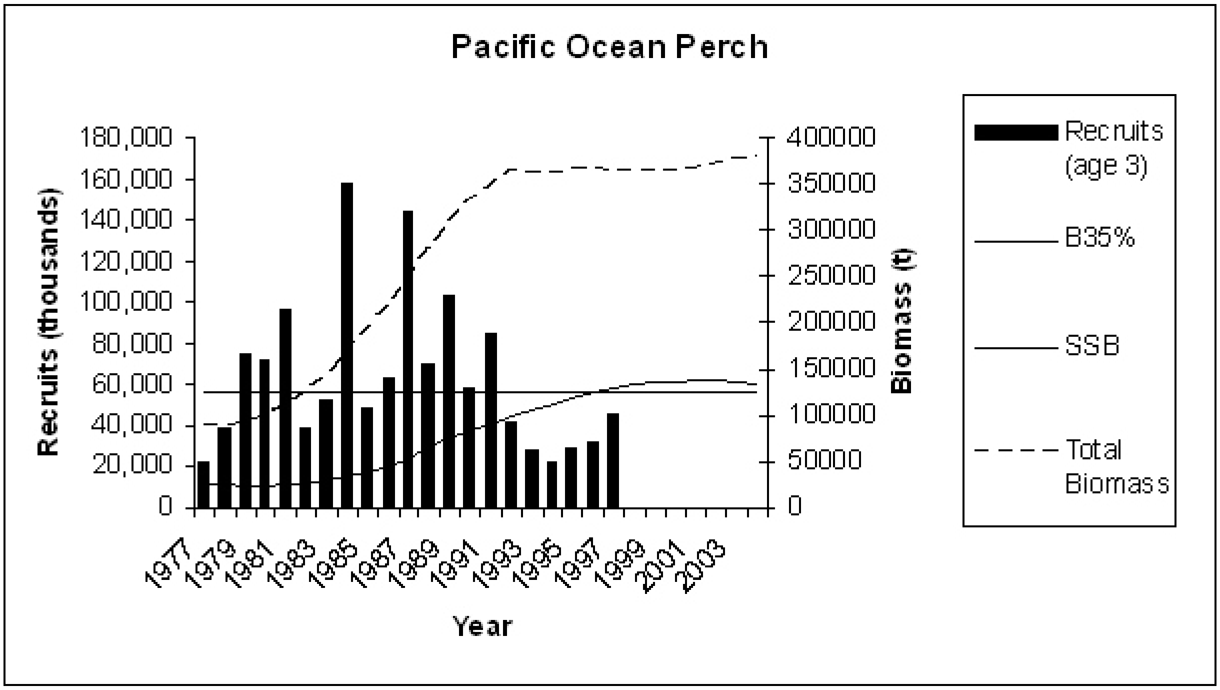
Source: NMFS Data

Figure B.3.3.12-3. Alaska Plaice Stock Assessment Model Results of Recruitment, the 35 Percent Biomass Level, Spawning Biomass, and Total Biomass



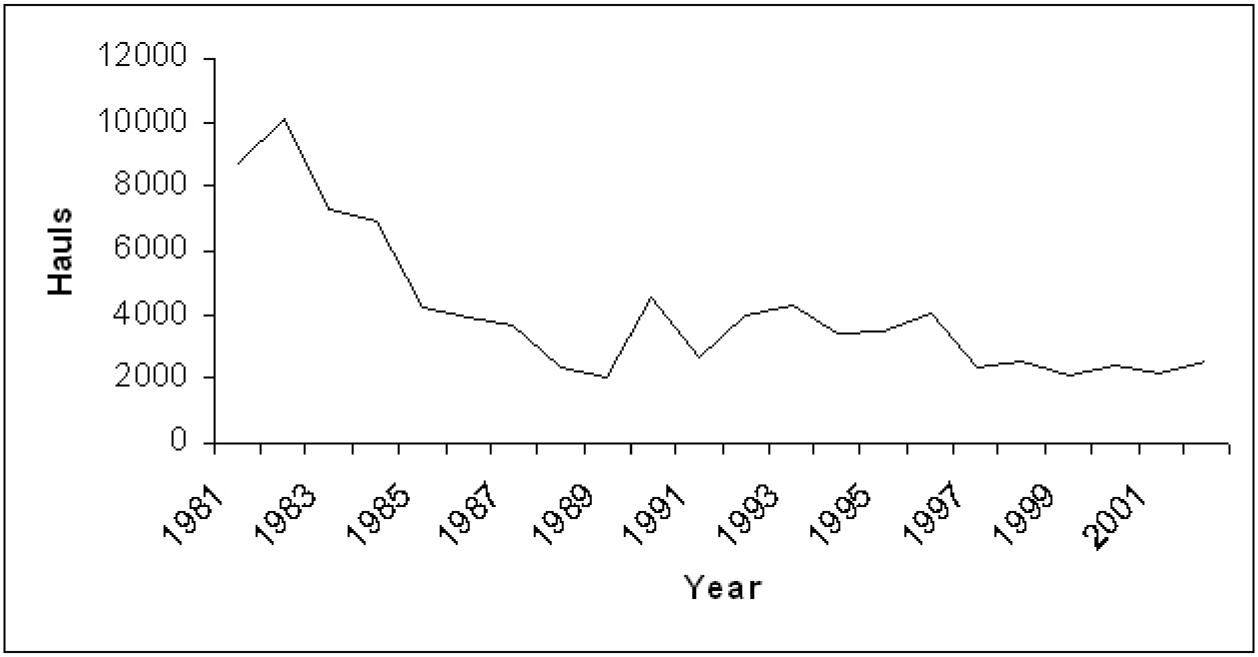
Source: NMFS Data

Figure B.3.3.15-1. Stock Assessment Model Estimates of Age-3 Recruits (thousands), Total Biomass (t), Spawning Stock Biomass (t), and 35 Percent Biomass (t) for Pacific Ocean Perch



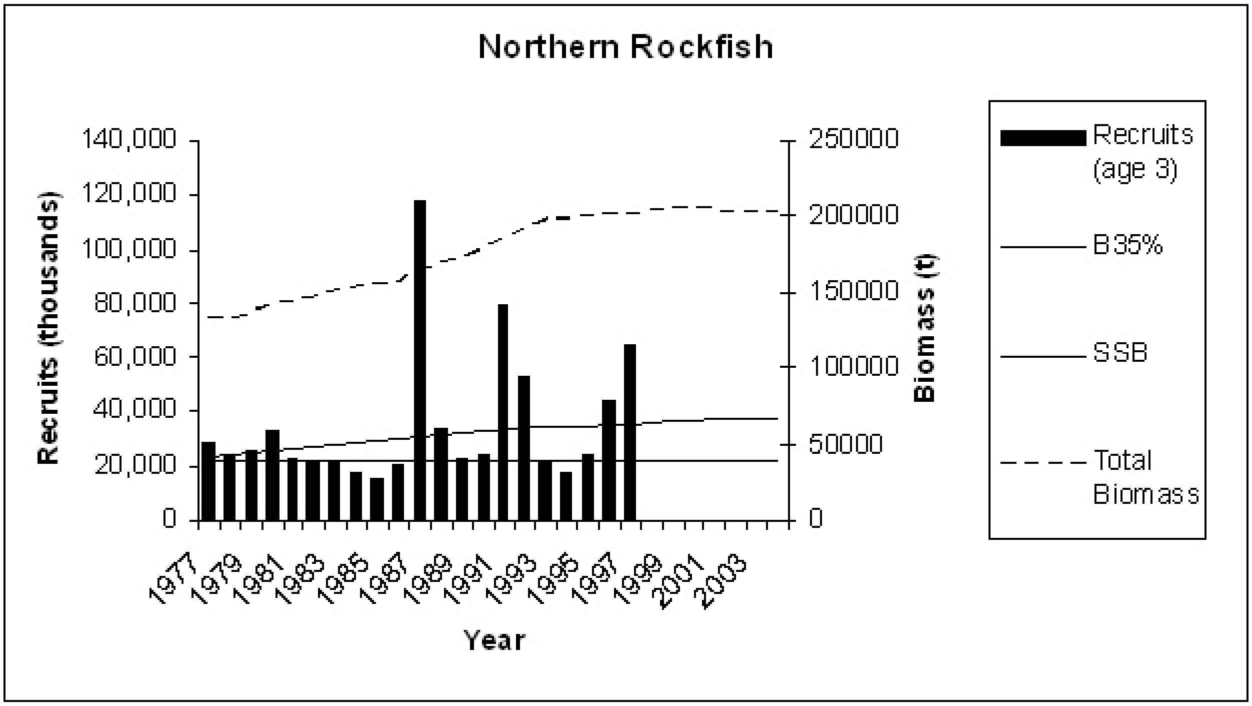
Source: NMFS Data

Figure B.3.3.15-2. Estimated Number of Hauls in the AI by Year



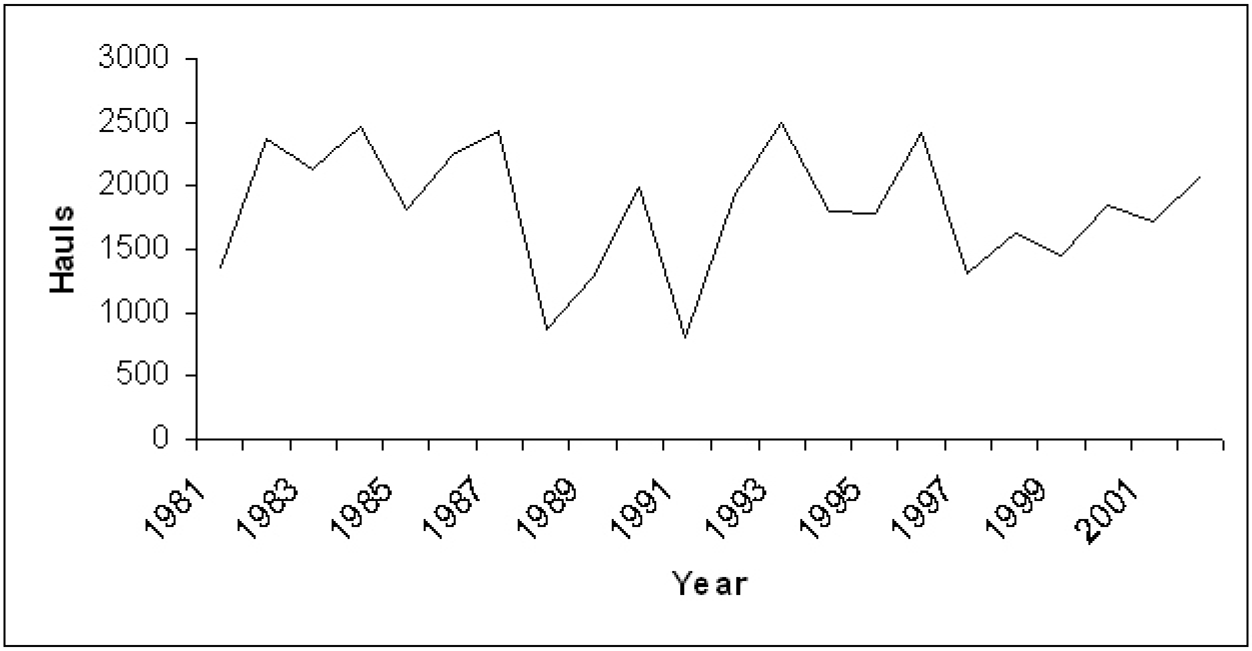
Source: NMFS Data

Figure B.3.3.19-1. Stock Assessment Model Results of Age-3 Recruits (thousands), Total Biomass (t), Spawning Stock Biomass (t), and 35 Percent Biomass (t) for Northern Rockfish



Source: NMFS Data

Figure B.3.3.19-2. Estimated Number of Hauls in the AI Shallow Habitat by Year



Source: NMFS Data

Table B.2-1. Effects of I (=q*f) and Rho Parameters on Estimates of Long-term Habitat Reduction

Habitat Effect (Percent Reduction)										
Recovery	Avg. Effect Rate (I)									Rec. Time
Rate = D	0.001	0.01	0.04	0.06	0.08	0.1	0.15	0.2	0.3	R = 1/D
0.01	9	50	81	86	90	92	95	96	98	100
0.02	5	34	68	76	81	85	90	92	95	50
0.04	2	20	51	61	68	73	81	86	91	25
0.1	1	9	29	39	46	52	64	71	80	10
0.2	0	5	17	24	30	36	47	55	67	5
0.4	0	2	9	14	18	22	30	38	50	3
1	0	1	4	6	8	10	15	20	29	1
2	0	1	2	3	4	5	8	11	17	1
4	0	0	1	2	2	3	4	6	9	0

Table B.2-2. A Summary of the Fishing Effects Analysis Process, Including Input Data Matricies, Calculation Steps, and Output Matrices

Indices
i - block
g - fishery
j - feature
k - habitat

Input Data

Fishing Intensity matrix (f_{ig}) - proportion of each block's area swept by the gear used by each fishery in an average year.

Sensitivity matrix ($q_{g(j\bullet k)}$) - proportion by which each feature's function in each habitat is reduced by one pass of the gear used in each fishery.

Recovery matrix ($\rho_{(j\bullet k)}$) - recovery rate for the function of each habitat feature within each habitat.

Block categorization matrix (C_{ik}) - The area (km^2) of each block estimated to be within each habitat.

Area vector (A_k) - The area (km^2) covered by each habitat.

Analysis Steps

1. Multiply effort matrix (f_{ig}) and sensitivity matrix ($q_{g(j\bullet k)}$) to get effect rate matrix ($I_{i\,(j\bullet k)}$)

$$I_{i\,(j\bullet k)} = \sum_g (q_{g(j\bullet k)} * f_{ig})$$

2. Apply effect equation to effect rate matrix ($I_{i\,(j\bullet k)}$) and recovery vector ($\rho_{(j\bullet k)}$) to get effect matrix ($Heq_{i\,(j\bullet k)}$)

$$Heq_{i\,(j\bullet k)} = \rho_{(j\bullet k)} S/(I_{i\,(j\bullet k)} + \rho_{(j\bullet k)} S), \qquad \text{where } S=e^{-Ii\,(j\bullet k)}$$

3. Multiply 1 minus each cell of the effect ($Heq_{i\,(j\bullet k)}$) matrix by the corresponding cell of the block categorization matrix (C_{ik}) to get the proportional decrease of that feature in that habitat type occurring in that block , long-term effect index($LEI_{i\,(j\bullet k)}$)

$$LEI_{i\,(j\bullet k)} = (1 - Heq_{i\,(j\bullet k)})*C_{ik}$$

4. Sum $E_{i\,(j\bullet k\bullet d)}$ matrix across blocks (i) and divide by the total area of each habitat type (A_k) to get the total proportional decrease of that feature in that habitat type ($LEI_{(j\bullet k)}$)

$$LEI_{(j\bullet k)} = \sum_i LEI_{i\,(j\bullet k)}/A_k$$

Output - Long-term Effect Index ($LEI_{i\,(j\bullet k)}$, $LEI_{(j\bullet k)}$)

The proportion by which habitat is reduced (adverse effect) for each habitat feature for each block and across each habitat type if recent fishery intensity and distribution were continued at current levels to equilibrium.

Table B.2-3. Fisheries Considered in the Analysis of Fishing Effects on Essential Fish Habitat

Target	Gear
Bering Sea	
Scallop*	Dredge
Red King Crab*	Pot
Tanner Crab*	Pot
Snow Crab*	Pot
Flathead Sole and Other Flatfish	Bottom Trawl
Cod	Bottom Trawl
Pollock	Bottom Trawl
Rock Sole	Bottom Trawl
Rockfish	Bottom Trawl
Sablefish / Turbot	Bottom Trawl
Yellowfin sole	Bottom Trawl
Pollock	Pelagic Trawl
Cod	Longline
Sablefish / Turbot	Longline
Cod	Pot
Cod*	Jig
Aleutians	
Red King Crab*	Pot
Golden King Crab*	Pot
Atka Mackerel	Bottom Trawl
Cod	Bottom Trawl
Pollock	Bottom Trawl
Rockfish	Bottom Trawl
Sablefish/Turbot	Trawl
Pollock	Pelagic Trawl
Cod	Longline
Sablefish/Turbot	Longline
Cod	Pot
Gulf of Alaska	
Shallow Flatfish	Bottom Trawl
Rockfish	Bottom Trawl
Rockfish	Pelagic Trawl
Pollock	Bottom Trawl
Pollock	Pelagic Trawl
Cod	Bottom Trawl
Cod	Pot
Cod	Longline
Sablefish/Turbot	Longline
Deep Flatfish	Bottom Trawl
Cod*	Jig

* Not included in detailed analysis

Table B.2-4. Derivation of Fishing Effort Adjustments from Units Recorded by Observers to km ^{2}

Gear	Vessel Class (feet)	Width (meters)	Speed (knots)	Observer Coverage	Distance (m)	Distance per Hook (m)	Proportion on Bottom	Unit	Area (km ^{2})/Unit
Bottom Trawl	Gt 125	166	3.6	1	N/A	N/A	1	hour	1.11
	Lt 125	90	3.3	0.32	N/A	N/A	1	hour	1.72
Rough Bottom	Gt 125	50	3.6	1	N/A	N/A	1	hour	0.33
Trawls (Aleutian)	Lt 125	50	3.3	0.32	N/A	N/A	1	hour	0.95
Pelagic Trawl	Gt 125	136	3.9	1	N/A	N/A	0.44	hour	0.43
	Lt 125	75	3.5	0.23	N/A	N/A	0.44	hour	0.93
Longline	Gt 125	2	N/A	1	N/A	1.28	1	hook	0.000003
	Lt 125	2	N/A	0.3	N/A	1.28	1	hook	0.000009
Pot	All	2.13	N/A	0.3	4.26	N/A	1	pot	0.000030

Notes: km - kilometer; m - meter; km ^{2} - square kilometer; GT - greater than; LT - less than

Table B.2-5. Estimates of the Q Parameter Used in the Analysis of Fishing Effects on Essential Fish Habitat

	Low Effect Estimate %	Central Estimate %	High Effect Estimate %	Quality Score	Comments
Bottom Trawls					
Infaunal prey	5	11	21	6	several related studies
Soft Substrates					
Epifaunal prey	4	10	17	6	several related studies
Living structure	1	15	21	5	some related studies
Non-living structure	0	2	5	4	value metric vague
Hard Substrates					
Epifaunal prey	16	18.5	22	5	some related studies
Living structure	10	20	30	5	some related studies
Non-living structure	1	2	5	4	value metric vague
Hard corals	22	27	35	4	few related studies
Pelagic Trawls (when contacting seafloor)					
Soft Substrates					
Infaunal prey	4	21	36	4	two related studies
Epifaunal prey	4	16.5	25.5	2	indirect rationale
Living structure	10	20	30	2	indirect rationale
Non-living structure	10	20	30	2	indirect rationale
Hard Substrates	0, not used on hard substrates (effort rescaled to reflect all efforts on soft portion)				
Longlines					
Infaunal prey		0.05		3	rationale for low effect
Soft Substrates					
Epifaunal prey		0.05		3	rationale for low effect
Living structure		5		1	very indirect rationale
Non-living structure		0.05		3	rationale for low effect
Hard Substrates					
Epifaunal prey		0.05		3	rationale for low effect
Living structure		10		1	very indirect rationale
Non-living structure		0.05		2	indirect rationale
Hard coral		0.05		1	very indirect rationale
Pots					
Infaunal prey		26		2	indirect rationale
Epifaunal prey		21.5		1	very indirect rationale
Living structure		25		1	very indirect rationale
Non-living structure		25		1	very indirect rationale
Hard coral		35		1	very indirect rationale

Table B.2-6. Estimates of the Rho Parameter Used in the Analysis of Fishing Effects on Essential Fish Habitat

Substrate	Habitat Features	Low Effect Estimate %	Central Estimate %	High Effect Estimate %	Quality Score
Sand (soft substrate)	Infaunal prey	8	4	3	4
	Epifaunal prey	8	4	3	4
	Living shelter	0.26	0.18	0.1	2
	Non-living shelter	8	2	1	3
Mud - sand mix (soft substrate)	Infaunal prey	2	1.33	1	4
	Epifaunal prey	2	1.33	1	4
	Living shelter	0.26	0.18	0.1	2
	Non-living shelter	2	1	0.66	4
Mud - silt (soft substrate)	Infaunal prey	2	1	0.66	4
	Epifaunal prey	2	1	0.66	4
	Living shelter	0.26	0.18	0.1	2
	Non-living shelter	2	0.5	0.33	3
Pebble to rock (hard substrate)	Infaunal prey	2	1	0.66	3
	Epifaunal prey	2	1	0.66	3
	Living shelter	0.09	0.05	0.01	3
	Non-living shelter	0.02	0.01	0.005	3
	Hard coral	0.02	0.01	0.005	3

Table B.2-7. Areas of Habitat Types Used in the Analysis of Fishing Effects on Essential Fish Habitat

Habitat Type	Area (km^2)	Split Percent	Quality Score
Bering Sea			
Sand	265,099	N/A	7
Sand/mud	294,244	N/A	7
Mud	97,058	N/A	7
Norton Sound +	103,091	N/A	7
Slope	25,762	N/A	7
Bering Sea Total	**785,254**	**N/A**	
Aleutians			
Shallow			3
Sand	8,378	20%	1
Hard	33,510	80%	1
Shallow total	41,117	100%	3
Deep			
Sand/mud	13,760	20%	1
Hard	55,042	80%	1
Deep total	68,802	100%	3
AleutianTotal	**109,919**	**N/A**	
Gulf of Alaska			
Shallow			
Sand	106,310	81%	1
Hard	24,937	19%	1
Shallow total	131,247	100%	3
Shelf Deeps			
Sand/mud	143,900	95%	1
Hard	7,574	5%	1
Shelf deep total	151,474	100%	3
Slope			
Sand/mud	37,647	90%	1
Hard	4,183	10%	1
Slope total	41,830	100%	3
Gulf of Alaska Total	**324,550**	**N/A**	
Grand Total	**1,175,801**	**N/A**	

Table B.2-8. Proportions of Shelf Area (<1,000 m) in Blocks Experiencing Different Levels of Combined Fishing Intensity (1998 to 2002).

Region	Unfished blocks	Untrawled blocks	Block Intensity1				
			< 0.1	0.1 - 0.5	0.5 - 1	1.0-2.0	>2.0
Bering Sea	61.3%	68.8%	82.1%	12.1%	3.4%	1.7%	0.8%
Aleutian Islands	47.0%	78.3%	93.3%	4.8%	1.1%	0.5%	0.3%
Gulf of Alaska	64.0%	74.2%	89.6%	7.9%	1.6%	0.6%	0.3%

[1] Total area per year of all fishing ending in each block divided by block area

Table B.2-9. Long-term Effect Indices (LEI* in % reduction) for Fishing Effects on Benthic Habitat Features of Alaska Marine Waters by Habitat Type (low and high LEIs in parentheses)

	Soft Substrates (mud - gravel)									Hard Substrates (pebble - rock)				
Habitat	**Bering Sea**				**Aleutians**		**Gulf of Alaska**			**Aleutians**		**Gulf of Alaska**		
Features	**Sand**	**Sand/Mud**	**Mud**	**Slope**	**Shallow**	**Deep**	**Shallow**	**Deep Shelf**	**Slope**	**Shallow**	**Deep**	**Shallow**	**Deep Shelf**	**Slope**
Infauna Prey	0 (0-1)	2 (0-4)	0 (0-0)	3 (1-7)	0 (0-1)	1 (0-2)	0 (0-1)	1 (0-1)	1 (0-2)	0 (0-1)	0 (0-0)	1 (0-1)	0 (0-1)	0 (0-1)
Epifauna Prey	0 (0-1)	2 (0-3)	0 (0-0)	3 (0-6)	0 (0-1)	1 (0-2)	0 (0-0)	0 (0-1)	0 (0-1)	1 (0-1)	0 (0-0)	1 (0-1)	1 (0-1)	1 (0-1)
Living Structure	4 (1-6)	11 (3-19)	0 (0-1)	11 (4-19)	4 (1-7)	3 (1-4)	3 (1-5)	3 (1-6)	4 (0-7)	7 (3-17)	2 (1-7)	5 (2-10)	6 (3-13)	9 (4-21)
Non-living Structure	0 (0-1)	1 (0-3)	0 (0-0)	4 (1-7)	1 (0-1)	0 (0-0)	0 (0-1)	0 (0-1)	0 (0-1)	5 (5-11)	2 (1-4)	3 (1-7)	4 (2-9)	5 (2-14)
Hard Coral	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16 (11-20)	6 (4-9)	10 (8-12)	13 (10-16)	20 (14-25)

* LEI - Estimated eventual reduction in a class of habitat feature if recent fishing intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium).

Table B.2-10. Long-term Effect Indicies (LEI*) Indicating the Effects of Fishing on Habitat Features by Fishery for the Features with the Highest LEIs in Each Region

Bering Sea (soft substrate)	**Sand/Mud Biostructure**	**Slope Biostructure**
Pollock Pelagic Trawl	4.6%	7.2%
Yellowfin Sole Trawl[1]	2.9%	0.2%
Flathead Sole/Flatfish Trawl[1]	1.8%	1.6%
Rock Sole Trawl[1]	0.9%	0.2%
Pollock Bottom Trawl[1]	0.4%	0.6%
Pacific Cod Trawl[1]	0.2%	0.4%
Sablefish/Turbot Trawl[1]	0.1%	0.7%
Pacific Cod Longline	0.0%	0.0%
Rockfish Trawl[1]	0.0%	0.0%
Pot	0.0%	0.0%
Sablefish/Turbot Longline	0.0%	0.0%
Total	**10.9%**	**10.9%**
[1] Total Bottom Trawl	6.3%	3.7%

Gulf of Alaska (hard substrate)	**Slope Biostructure**
Rockfish BottomTrawl	4.2%
Deep-water Flatfish Trawl	4.1%
Pacific Cod Trawl	0.2%
Shallow-water Flatfish Trawl	0.1%
Sablefish/Turbot Longline	0.1%
Pollock Bottom Trawl	0.0%
Pacific Cod Longline	0.0%
Pot	0.0%
Pollock Pelagic Trawl	0.0%
Rockfish Pelagic Trawl	0.0%
Total	**8.7%**

Aleutian Islands (hard substrate)	**Shallow Biostructure**
Pacific Cod Trawl	4.2%
Atka Mackeral Trawl	2.5%
Sablefish/Turbot Trawl	0.2%
Rockfish Trawl	0.2%
Pollock Bottom Trawl	0.1%
Pacific Cod Longline	0.1%
Sablefish/Turbot Longline	0.0%
Pot	0.0%
Pollock Pelagic Trawl	0.0%
Total	**7.3%**

* LEI - Estimated eventual reduction in a class of habitat feature if recent fishing intensity and distribution were continued until fishing effect rates and habitat recovery rates equalized (equilibrium).

Table B.3-1 Connections Between Life Stages of Managed Species and Habitat Features and Types Used in the Fishing Effects Analysis

		Soft Substrates									Hard Substrates					
Species &		Bering Sea				Aleutian Islands		Gulf of Alaska			Aleutian Islands		Gulf of Alaska			Any Substrate Any Region
Life Stage		Sand	Sand/Mud	Mud	Slope	Shallow	Deep	Shallow	Deepshelf	Slope	Shallow	Deep	Shallow	Deepshelf	Slope	Any Habitat
Red king crab									*					*		
egg	attached to female															
larvae	pelagic															
juvenile	benthic	**C, D**				**C**					**C**					**C,D**
adult	benthic	**A,B**	**A,B**			**A,B**					**A,B**					**A,B**
Blue king crab									*					*		
egg	attached to female															
larvae	pelagic															
juvenile	benthic	**C, D**	**C, D**													**C,D**
adult	benthic	**A,B**	**A,B**													**A,D**
Golden king crab									*					*		
egg	attached to female															
larvae	pelagic															
juvenile	benthic				**D**		**D**					**D**				**D**
adult	benthic				**A,B,C,D**		**A,B,C,D**					**A,B,C,D**				**A,B,C,D**
Scarlet king crab									*					*		
egg	attached to female															
larvae	pelagic															
juvenile	benthic				unknown		unknown					unknown				
adult	benthic				unknown		unknown					unknown				
Tanner crab									*					*		
egg	attached to female															
larvae	pelagic															
juvenile	benthic		**A,B**	**A,B**		**A,B**					**A,B**					**A,B**
adult	benthic		**A,B**	**A,B**		**A,B**					**A,B**					**A,B**
Snow crab									*					*		
egg	attached to female															
larvae	pelagic															
juvenile	benthic		**A,B**	**A,B**												**A,B**
adult	benthic		**A,B**	**A,B**												**A,B**
Deepwater Tanner crab									*					*		
egg	attached to female															
larvae	pelagic															
juvenile	benthic				unknown		unknown					unknown				
adult	benthic				unknown		unknown					unknown				
Walleye pollock																
egg	demersal															
larvae	pelagic															
juvenile	demersal/semi-pelagic															
adult	demersal/semi-pelagic															

Table B.3-1 Connections Between Life Stages of Managed Species and Habitat Features and Types Used in the Fishing Effects Analysis (cont.)

Species & Life Stage		**Soft Substrates**									**Hard Substrates**					**Any Substrate Any Region Any Habitat**
		Bering Sea				**Aleutian Islands**		**Gulf of Alaska**			**Aleutian Islands**		**Gulf of Alaska**			
		Sand	**Sand/Mud**	**Mud**	**Slope**	**Shallow**	**Deep**	**Shallow**	**Deepshelf**	**Slope**	**Shallow**	**Deep**	**Shallow**	**Deepshelf**	**Slope**	
Pacific cod																
egg	demersal															
larvae	pelagic															
juvenile	demersal	**A,B**	**A,B**	**A,B**		**A,B**	**A,B**	**A,B**	**A,B**		**A,B**		**A,B**	**A,B**		**A,B**
adult	demersal	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**	**A,B**
Sablefish																
egg	pelagic															
larvae	epipelagic															
juvenile	pelagic nearshore, then bent	**A,B**	**A,B**	**A,B**		**A,B**		**A,B**	**A,B**		**A,B**		**A,B**	**A,B**		**A,B**
adult	benthic slope				**A,B**		**A,B**			**A,B**		**A,B**			**A,B**	**A,B**
Atka mackerel																
egg	deposited in benthic nests										**D**		**D**[1]			**D**
larvae	pelagic															
juvenile	pelagic/benthic										**D**			**D**		**D**
adult	pelagic/benthic										**C,D,E**			**C,D,E**		**C,D,E**
BSAI yellowfin sole									*					*		
egg	pelagic															
larvae	pelagic															
juvenile	benthic	**B**				**B**					**B**					**B**
adult	benthic	**A,B**	**A,B**			**A,B**					**A,B**					**A,B**
BSAI Greenland turbot									*					*		
egg	pelagic															
larvae	pelagic															
juvenile	benthic	**B**	**B**			**B**										**B**
adult	benthic	**A,B**	**A,B**		**A,B**	**A,B**	**A,B**				**A,B**	**A,B**				**A,B**
BSAI arrowtooth flounder									*					*		
egg	pelagic															
larvae	pelagic															
juvenile	benthic	**B**				**B**					**B**					**B**
adult	benthic	**A,B**	**A,B**		**A,B**	**A,B**	**A,B**				**A,B**	**A,B**				**A,B**
GOA arrowtooth flounder																
egg	pelagic															
larvae	pelagic															
juvenile	benthic							**B**					**B**			**B**
adult	benthic							**A,B**	**A,B**	**A,B**			**A,B**	**A,B**	**A,B**	**A,B**
BSAI rock sole									*					*		
egg	benthic															
larvae	pelagic															
juvenile	benthic	**B**				**B**					**B**					**B**
adult	benthic	**A,B**	**A,B**			**A,B**					**A,B**					**A,B**

1 / Atka mackerel nests with eggs have not been observed in the GOA, but the assumption is made that eggs would be found in the same substrate as observed in the AI.

Table B.3-1 Connections Between Life Stages of Managed Species and Habitat Features and Types Used in the Fishing Effects Analysis (cont.)

Species & Life Stage		Soft Substrates									Hard Substrates					Any Substrate Any Region Any Habitat
		Bering Sea				Aleutian Islands		Gulf of Alaska			Aleutian Islands		Gulf of Alaska			
		Sand	Sand/Mud	Mud	Slope	Shallow	Deep	Shallow	Deepshelf	Slope	Shallow	Deep	Shallow	Deepshelf	Slope	
Flathead sole																
egg	pelagic															
larvae	pelagic															
juvenile	benthic	**B**				**B**		**B**			**B**		**B**			**B**
adult	benthic	**A,B**	**A,B**			**A,B**		**A,B**	**A,B**		**A,B**		**A,B**	**A,B**		**A,B**
GOA rex sole																
egg	pelagic															
larvae	pelagic															
juvenile	benthic							**B**					**B**			**B**
adult	benthic							**A,B**	**A,B**				**A,B**	**A,B**		**A,B**
BSAI Alaska plaice									*					*		
egg	polagic															
larvae	pelagic															
juvenile	benthic	**B**				**B**					**B**					**B**
adult	benthic	**A,B**	**A,B**			**A,B**					**A,B**					**A,B**
GOA shallow water flatfish																
egg	benthic/pelagic															
larvae	pelagic															
juvenile	benthic							**B**					**B**			**B**
adult	benthic							**A,B**					**A,B**			**A,B**
GOA deep water flatfish																
egg	pelagic															
larvae	pelagic															
juvenile	benthic								**B**	**B**				**B**	**B**	**B**
adult	benthic								**A,B**	**A,B**				**A,B**	**A,B**	**A,B**
Pacific Ocean Perch																
egg	NA															
larvae	pelagic															
juvenile	demersal				**C,D**	**C,D**	**C,D**				**C,D**	**C,D**	**C,D**	**C,D**	**C,D**	**C,D**
adult	demersal				**D**	**D**	**D**		**C,D**	**C,D**	**D**	**D**		**C,D**	**C,D**	**C,D**
Rougheye/Shortraker																
egg	NA															
larvae	pelagic															
juvenile	demersal				**A,C,D**	**A,C,D**	**A,C,D**	**A,C,D**	**A,C,D**		**A,C,D**	**A,C,D**	**A,C,D**	**A,C,D**		**A,C,D**
adult	demersal				**A,C,D**		**A,C,D**					**A,C,D**			**C,D,E**	**A,C,D,E**
Northern Rockfish																
egg	NA															
larvae	pelagic															
juvenile	demersal				**C,D**	**C,D**		**C,D**	**C,D**		**C,D**		**C,D**	**C,D**		**C,D**
adult	demersal				**D**	**D**		**D**	**D**		**D**		**D**	**D**		**D**

Table B.3-1 Connections Between Life Stages of Managed Species and Habitat Features and Types Used in the Fishing Effects Analysis (cont.)

		Soft Substrates									Hard Substrates					Any Substrate
Species &		Bering Sea				Aleutian Islands		Gulf of Alaska			Aleutian Islands		Gulf of Alaska			Any Region
Life Stage		Sand	Sand/Mud	Mud	Slope	Shallow	Deep	Shallow	Deepshelf	Slope	Shallow	Deep	Shallow	Deepshelf	Slope	Any Habitat
GOA Light dusky rockfish			*			*					*					
egg	inside female															
larvae / postlarv	pelagic															
young juvenile	unknown															
older juvenile	demersal							C,D	C,D				C, D, E	C, D, E		C,D,E
adult	demersal								C,D					C, D		C,D
BSAI Dusky Rockfish			*			*					*					
egg	inside female															
larvae / postlarv	pelagic															
young juvenile	unknown															
older juvenile	demersal										C, D, E	C, D, E				C,D,E
adult	demersal				C, D							C, D				C,D
BSAI Shortspine Thornyheads			*			*					*					
egg	pelagic															
larvae / postlarv	pelagic															
young juvenile	unknown															
older juvenile	demersal				C, D							C, D, E				C,D,E
adult	demersal				C, D							C, D				C,D
Combined Tally	**Habitat Feature**	**Number of species / life stages connected with each habitat feature**														
	Epifauna prey	12	16	7	7	12	8	6	7	4	13	7	7	7	4	23
	Infauna prey	19	17	7	5	17	6	11	8	5	17	5	10	8	5	30
	Living structure	2	1		4	4	5	1	1	1	4	4	4	6	2	11
	Non-living structure	2	1		6	5	5	1	1	1	8	6	5	9	3	16
	Hard corals												1	1	1	2

* - Not an FMP species in this region (they may be managed as part of an FMP species group).

☐ -Habitat types / features with long-term effect indices > 5%.

All blank cells indicate that no connection was noted.

Key:

Habitat Feature:

A. epifauna prey (e.g., diverse crustaceans, ophiuroids, snails)
B. infauna prey (e.g., clams, ploychaetes)
C. living structure (e.g., anemones, sponges, large ascidians, soft corals)
D. non-living structure (e.g., sand waves, rocks)
E. hard corals (e.g., Primnoa, some gorgonians)

Habitat Type:

Bering Sea: Sand, mixed sand and mud, and mud substrates and the outer slope (200 to 1,000 m)
Gulf of Alaska: Shallow (0 to 100 m), deeper shelf areas (100 to 300 m) and slope (200 to 1,000 m) each separated into sand to gravel (soft) substrates and (hard) pebble to rock substrates
Aleutian Islands: Shallow (0 to 200 m) and deep (200 to 1,000 m) both separated into soft and hard substrates

Table B.3-2. Criteria for Assessing the Effects of Fishing on Essential Fish Habitat

	Intensity of Effect			
Issue	**MMNT**	**MT**	**B**	**U**
Spawning/Breeding: Potential for adverse effects on the reproductive success of stocks	Effects of fishing expected to have an adverse effect on essential spawning, nursery, or settlement habitat which is more than minimal and not temporary	Fishing anticipated to have either minimal, temporary or no effects on essential spawning, nursery, or settlement habitat	Effects of fishing expected to have a positive effect on essential spawning, nursery, or settlement habitat which is more than minimal and not temporary	Magnitude and/or direction of effects unknown
Feeding: Potential for adverse effects on availability of significant prey resources for FMP species	Effects of fishing on habitat expected to have an adverse effect on essential prey availability which is more than minimal and not temporary	Fishing anticipated to have either minimal, temporary or no effects on essential prey availability.	Effects of fishing on habitat expected to have a positive effect on essential prey availability which is more than minimal and not temporary	Magnitude and/or direction of effects unknown
Growth to Maturity: Potential for changing the survival rates of managed species as they are growing to maturity	Effects of fishing on essential habitat expected to have an adverse effect on survival of fish to maturity which is more than minimal and not temporary	Fishing anticipated to have either minimal, temporary or no effects on the survival of fish to maturity	Effects of fishing on essential habitat expected to have a positive effect on survival of fish to maturity is expected which is more than minimal and not temporary	Magnitude and/or direction of effects unknown

MMNT = More than minimal and not temporary, MT = Minimal or Temporary, B = Beneficial, U = Unknown

The standard for MMNT or B ratings is that they are neither minimal nor temporary. These terms are described in more detail below. Effects based on the analysis of LEIs are intrinsically not temporary. Essential habitat is that necessary for the managed species to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. For purposes of this assessment, the ability to support a sustainable fishery is to be judged on the stock's ability to produce MSY over the long term.

Additional information on minimal and temporary: The standard provided in the regulations for whether fisheries adversely affect EFH enough to require Council action is that such effects are more than minimal and not temporary. No numerical standards for minimal or temporary were provided. A commentary included with the final rule describes temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. No time scale was attached to the term 'limited duration.' Therefore, the analysis of fishing effects was based on effects that would occur if current fishing levels were continued until affected habitat features reached an equilibrium level. Therefore, such effects would not be of limited duration and could persist (not recover) as long as the fishery continued at that level.

The same commentary describes minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. In the EFH context, the terms 'environment' and 'function' refer to the features of the environment necessary for the spawning, breeding, feeding, and growth to maturity of the managed species and the function of those features in providing that support. Therefore, a change in a habitat feature estimated in the effects-of-fishing analysis (LEI) that would significantly change its support of the species' spawning, breeding, feeding, or growth to maturity would be considered more than minimal and not temporary.

Table B.3-3. LEIs (percent reduction) of Habitat Features within Intersections of Species Distributions and Habitat Types

			Percent Reduction (General Distribution [95%]/Concentration [75%])									
	% of Area		Infauna Prey		Epifauna Prey		Living Structure		Non-living Structure		Hard Coral	
Habitat	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)
Red King Crab												
AI Deep	0	0	0	0	1	0	7	2	4	1	16	8
AI Shallow	2	1	0	0	0	0	6	3	3	1	17	10
BS Sand	**68**	**74**	**1**	**1**	**1**	**1**	**8**	**9**	**1**	**1**	**0**	**0**
BS Sand/Mud	**30**	**25**	**7**	**7**	**6**	**6**	**35**	**35**	**5**	**5**	**0**	**0**
BS Slope	0	0	42	0	34	0	82	0	51	0	0	0
Total	100	100	3	3	2	2	16	16	2	2	0	0
Blue King Crab												
BS Mud	**27**	**20**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
BS Sand	**17**	**32**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
BS Sand/Mud	**57**	**48**	**1**	**0**	**0**	**0**	**4**	**1**	**1**	**0**	**0**	**0**
Total	100	100	0	0	0	0	2	0	0	0	0	0
Golden King Crab												
AI Deep	**56**	**45**	**0**	**0**	**0**	**1**	**3**	**5**	**2**	**3**	**9**	**14**
AI Shallow	**24**	**24**	**1**	**1**	**1**	**2**	**8**	**11**	**5**	**7**	**20**	**25**
BS Sand	3	11	4	3	3	3	17	17	6	6	0	0
BS Sand/Mud	1	2	1	1	1	1	8	7	1	1	0	0
BS Slope	10	18	3	4	3	3	14	15	4	4	0	0
GOA Deep Shelf	2	0	0	0	0	0	3	0	1	0	18	0
GOA Slope	4	0	1	0	1	0	5	0	2	0	21	0
GOA Shallow	0	0	0	0	0	0	0	0	0	0	0	0
Total	100	100	1	1	1	1	6	10	3	4	11	13
Tanner Crab												
AI Deep	0	0	3	0	4	0	35	0	22	0	60	0
AI Shallow	0	0	1	0	1	0	11	0	7	0	25	0
BS Mud	1	0	1	0	1	0	7	0	3	0	0	0
BS Sand	**26**	**32**	**2**	**2**	**2**	**1**	**11**	**11**	**1**	**1**	**0**	**0**
BS Sand/Mud	**71**	**68**	**3**	**4**	**2**	**3**	**15**	**20**	**2**	**3**	**0**	**0**
BS Slope	2	0	4	17	4	14	16	44	5	24	0	0
Total	100	100	3	3	2	3	14	17	2	3	0	0
Snow Crab												
BS Mud	**28**	**36**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
BS Sand	**7**	**7**	**2**	**0**	**2**	**0**	**9**	**4**	**1**	**0**	**0**	**0**
BS Sand/Mud	**65**	**57**	**2**	**1**	**2**	**1**	**10**	**7**	**1**	**1**	**0**	**0**
BS Slope	0	0	0	0	0	0	2	0	1	0	0	0
Total	100	100	1	1	1	1	7	5	1	0	0	0
Walleye Pollock												
AI Deep	6	6	0	0	0	0	3	3	2	2	7	8
AI Shallow	4	5	1	1	1	1	7	7	4	4	16	16
BS Mud	10	8	0	0	0	0	0	0	0	0	0	0
BS Sand	21	22	1	1	1	1	6	6	1	1	0	0
BS Sand/Mud	**28**	**28**	**2**	**2**	**2**	**2**	**12**	**13**	**2**	**2**	**0**	**0**
BS Slope	3	3	2	2	2	2	9	9	2	2	0	0
GOA Deep Shelf	13	13	1	1	1	1	5	5	1	1	16	16
GOA Slope	4	4	1	1	1	1	5	5	1	1	23	23
GOA Shallow	11	12	0	0	0	0	4	4	1	1	12	12
Total	100	100	1	1	1	1	7	7	1	1	5	6

Table B.3-3. LEIs (percent reduction) of Habitat Features within Intersections of Species Distributions and Habitat Types (cont.)

			Percent Reduction (General Distribution [95%]/Concentration [75%])									
	% of Area		Infauna Prey		Epifauna Prey		Living Structure		Non-living Structure		Hard Coral	
Habitat	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)
Pacific Cod												
AI Deep	4	2	1	1	1	1	5	8	3	5	11	19
AI Shallow	4	4	1	1	1	1	8	10	5	6	19	24
BS Mud	7	6	0	0	0	0	1	1	0	0	0	0
BS Sand	21	23	1	1	1	1	6	7	1	1	0	0
BS Sand/Mud	**32**	**36**	**2**	**2**	**2**	**2**	**11**	**13**	**2**	**2**	**0**	**0**
BS Slope	2	3	2	2	2	2	10	10	3	3	0	0
GOA Deep Shelf	15	14	1	1	1	1	4	6	1	1	15	19
GOA Slope	2	1	1	2	1	1	7	9	2	2	31	43
GOA Shallow	13	12	0	0	0	0	4	5	1	1	11	15
Total	100	100	1	1	1	1	7	8	1	2	6	6
Sablefish												
AI Deep	17	10	0	0	1	1	4	5	2	3	8	12
AI Shallow	3	2	2	2	2	4	15	26	9	16	32	54
BS Sand	3	0	17	0	15	0	56	0	14	0	0	0
BS Sand/Mud	11	1	5	20	4	18	21	66	4	7	0	0
BS Slope	9	1	2	0	2	0	9	1	3	0	0	0
GOA Deep Shelf	**35**	**47**	**1**	**1**	**1**	**1**	**6**	**8**	**1**	**1**	**21**	**31**
GOA Slope	**16**	**32**	**1**	**1**	**1**	**1**	**4**	**5**	**1**	**1**	**21**	**24**
GOA Shallow	6	7	1	1	1	2	10	11	2	3	27	31
Total	100	100	2	1	2	1	9	8	2	2	14	27
Atka Mackerel												
AI Deep	**33**	**37**	**2**	**3**	**2**	**3**	**15**	**20**	**10**	**13**	**32**	**40**
AI Shallow	**44**	**50**	**1**	**2**	**2**	**3**	**14**	**20**	**8**	**13**	**30**	**40**
BS Sand	1	2	37	38	31	32	81	84	37	38	0	0
GOA Deep Shelf	8	5	0	0	0	0	3	3	0	1	20	20
GOA Slope	2	2	1	1	1	1	7	7	1	1	38	37
GOA Shallow	11	4	0	0	0	0	3	1	1	0	17	8
Total	100	100	2	3	2	4	13	20	8	12	28	37
Yellowfin Sole												
AI Deep	0	0	14	17	14	18	49	56	36	42	69	80
AI Shallow	0	0	8	8	9	9	34	37	23	23	38	39
BS Mud	1	0	0	0	0	0	0	0	0	0	0	0
BS Sand	**53**	**61**	**1**	**0**	**0**	**0**	**5**	**5**	**0**	**0**	**0**	**0**
BS Sand/Mud	**43**	**39**	**2**	**3**	**2**	**3**	**13**	**18**	**1**	**2**	**0**	**0**
BS Slope	0	0	18	17	15	15	56	56	20	18	0	0
GOA Deep Shelf	0	0	6	0	5	0	39	0	9	0	0	0
Shallow	3	0	0	0	0	0	3	2	1	0	6	1
Total	100	100	1	2	1	1	8	10	1	1	0	0

Table B.3-3. LEIs (percent reduction) of Habitat Features within Intersections of Species Distributions and Habitat Types (cont.)

			Percent Reduction (General Distribution [95%]/Concentration [75%])									
	% of Area		Infauna Prey		Epifauna Prey		Living Structure		Non-living Structure		Hard Coral	
Habitat	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)
Greenland Turbot												
AI Deep	11	6	0	1	0	1	3	5	2	3	7	9
AI Shallow	4	2	1	2	1	3	11	15	7	9	23	26
BS Mud	18	14	0	0	0	0	0	1	0	0	0	0
BS Sand	6	4	5	11	4	10	21	39	4	9	0	0
BS Sand/Mud	**56**	**65**	**2**	**3**	**2**	**2**	**12**	**14**	**2**	**2**	**0**	**0**
BS Slope	5	9	2	2	2	2	9	9	2	2	0	0
GOA Deep Shelf	0	0	2	0	2	0	11	0	3	0	51	0
GOA Slope	0	0	4	0	3	0	18	0	6	0	53	0
GOA Shallow	0	0	0	0	0	0	0	0	0	0	1	0
Total	100	100	2	2	2	2	9	12	2	3	2	1
Arrowtooth Flounder												
AI Deep	6	2	1	2	1	2	5	11	3	7	11	21
AI Shallow	4	1	1	2	1	3	10	23	6	14	22	42
BS Mud	1	0	1	2	1	1	4	9	1	3	0	0
BS Sand	7	4	3	10	3	8	20	39	3	8	0	0
BS Sand/Mud	**33**	**34**	**3**	**4**	**2**	**3**	**16**	**20**	**2**	**3**	**0**	**0**
BS Slope	**3**	**5**	**2**	**3**	**2**	**2**	**10**	**12**	**3**	**3**	**0**	**0**
GOA Deep Shelf	**24**	**35**	**1**	**1**	**1**	**1**	**4**	**5**	**1**	**1**	**13**	**17**
GOA Slope	6	7	1	1	1	1	5	7	1	2	24	32
Shallow	16	11	0	1	0	1	4	9	1	2	13	26
Total	100	100	2	2	1	2	10	13	2	3	8	12
Rock Sole												
AI Deep	3	1	1	3	1	3	7	16	4	11	16	32
AI Shallow	6	3	1	1	1	1	7	10	4	6	17	22
BS Mud	4	1	0	0	0	0	1	0	0	0	0	0
BS Sand	**28**	**37**	**1**	**1**	**1**	**1**	**6**	**6**	**1**	**1**	**0**	**0**
BS Sand/Mud	**37**	**41**	**2**	**3**	**2**	**2**	**13**	**15**	**2**	**2**	**0**	**0**
BS Slope	2	1	3	2	2	1	11	9	3	2	0	0
GOA Deep Shelf	6	3	1	3	1	2	9	14	2	3	27	38
GOA Slope	1	0	1	1	1	1	8	8	2	2	41	45
GOA Shallow	13	13	0	1	0	1	5	6	1	2	14	17
Total	100	100	1	2	1	1	8	10	2	2	5	4
Flathead Sole												
AI Deep	1	1	2	3	2	3	10	12	7	8	18	19
AI Shallow	2	1	1	1	1	2	10	10	6	6	21	19
BS Mud	12	7	0	0	0	0	0	1	0	0	0	0
BS Sand	16	16	1	2	1	2	9	12	1	1	0	0
BS Sand/Mud	**35**	**41**	**2**	**3**	**2**	**2**	**13**	**15**	**2**	**2**	**0**	**0**
BS Slope	3	4	2	3	2	2	10	11	3	3	0	0
GOA Deep Shelf	15	15	1	1	1	1	5	6	1	1	17	19
GOA Slope	2	1	1	2	1	2	9	10	2	3	39	40
GOA Shallow	15	14	0	0	0	0	4	5	1	1	12	14
Total	100	100	1	2	1	2	8	10	1	2	5	6

Table B.3-3. LEIs (percent reduction) of Habitat Features within Intersections of Species Distributions and Habitat Types (cont.)

			Percent Reduction (General Distribution [95%]/Concentration [75%])									
	% of Area		Infauna Prey		Epifauna Prey		Living Structure		Non-living Structure		Hard Coral	
Habitat	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)
Alaska Plaice												
AI Deep	0	0	18	17	20	18	64	57	48	43	86	77
AI Shallow	0	0	12	10	13	11	46	39	33	27	53	45
BS Mud	5	5	0	0	0	0	0	0	0	0	0	0
BS Sand	**42**	**42**	**1**	**0**	**1**	**0**	**5**	**4**	**0**	**0**	**0**	**0**
BS Sand/Mud	**52**	**52**	**2**	**2**	**2**	**2**	**12**	**10**	**1**	**1**	**0**	**0**
BS Slope	1	1	2	0	1	0	7	2	2	1	0	0
GOA Deep Shelf	0	0	2	0	1	0	10	0	2	0	14	0
GOA Shallow	1	1	1	0	0	0	6	0	1	0	15	0
Total	100	100	1	1	1	1	9	7	1	1	0	0
Rex sole												
AI Deep	3	2	1	4	1	4	8	18	5	13	16	33
AI Shallow	2	2	2	4	2	4	16	25	10	16	32	44
BS Sand	7	6	6	18	5	16	31	61	5	15	0	0
BS Sand/Mud	**29**	**9**	**4**	**9**	**3**	**7**	**21**	**37**	**4**	**9**	**0**	**0**
BS Slope	**5**	**5**	**3**	**6**	**2**	**5**	**12**	**22**	**3**	**6**	**0**	**0**
GOA Deep Shelf	**34**	**51**	**1**	**1**	**1**	**1**	**5**	**8**	**1**	**1**	**17**	**31**
GOA Slope	9	14	1	1	1	1	6	9	1	2	28	39
GOA Shallow	11	10	1	1	1	1	8	12	2	3	24	34
Total	100	100	2	3	2	3	12	16	3	4	12	26
Dover Sole												
AI Deep	3	0	1	7	1	7	7	24	5	18	13	32
AI Shallow	1	0	1	5	2	6	13	36	7	23	25	54
BS Sand	2	1	17	10	14	9	70	72	14	6	0	0
BS Sand/Mud	1	0	11	13	9	11	49	55	10	13	0	0
BS Slope	0	0	17	0	14	0	47	0	19	0	0	0
GOA Deep Shelf	**57**	**58**	**1**	**1**	**1**	**1**	**5**	**5**	**1**	**1**	**16**	**18**
GOA Slope	**17**	**19**	**1**	**1**	**1**	**1**	**5**	**5**	**1**	**1**	**22**	**22**
GOA Shallow	20	21	1	1	1	1	7	8	2	2	21	24
Total	100	100	1	1	1	1	7	7	2	1	17	20
Pacific Ocean perch												
AI Deep	**21**	**26**	**1**	**1**	**1**	**1**	**5**	**9**	**3**	**5**	**12**	**21**
AI Shallow	10	13	1	1	2	2	13	17	8	10	28	38
BS Sand	2	2	12	3	10	3	32	15	15	6	0	0
BS Sand/Mud	5	4	2	1	1	1	9	6	2	1	0	0
BS Slope	6	7	3	2	2	1	12	7	4	2	0	0
GOA Deep Shelf	**32**	**30**	**1**	**1**	**1**	**1**	**7**	**10**	**1**	**1**	**29**	**46**
GOA Slope	16	16	1	1	1	1	6	9	1	2	27	43
GOA Shallow	8	2	1	0	1	0	5	3	1	1	20	17
Total	100	100	1	1	1	1	8	10	3	4	20	31

Table B.3-3. LEIs (percent reduction) of Habitat Features within Intersections of Species Distributions and Habitat Types (cont.)

			Percent Reduction (General Distribution [95%]/Concentration [75%])									
	% of Area		Infauna Prey		Epifauna Prey		Living Structure		Non-living Structure		Hard Coral	
Habitat	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)	(95%)	(75%)
Shortraker & Rougheye Rockfish												
AI Deep	**22**	**36**	**0**	**0**	**0**	**1**	**3**	**5**	**2**	**3**	**8**	**13**
AI Shallow	16	12	1	1	1	2	7	12	4	7	17	27
BS Sand	1	0	20	5	17	4	40	16	24	8	0	0
BS Sand/Mud	1	0	1	1	1	1	6	5	1	1	0	0
BS Slope	5	2	3	3	2	3	11	13	3	4	0	0
GOA Deep Shelf	**33**	**14**	**1**	**1**	**1**	**1**	**5**	**7**	**1**	**1**	**17**	**37**
GOA Slope	**16**	**34**	**1**	**1**	**1**	**1**	**5**	**6**	**1**	**2**	**21**	**30**
GOA Shallow	6	1	1	0	1	0	6	5	1	1	16	28
Total	100	100	1	1	1	1	6	7	2	3	15	24
Northern Rockfish												
AI Deep	19	17	1	1	1	2	6	13	4	8	16	28
AI Shallow	**27**	**21**	**1**	**1**	**1**	**2**	**8**	**16**	**5**	**10**	**19**	**34**
BS Sand	3	1	5	1	4	1	24	20	6	2	0	0
BS Sand/Mud	3	1	3	0	3	0	15	3	4	0	0	0
BS Slope	2	0	3	2	2	2	12	10	4	3	0	0
GOA Deep Shelf	**26**	**37**	**2**	**1**	**1**	**1**	**10**	**10**	**1**	**1**	**41**	**42**
GOA Slope	8	10	2	2	1	1	10	9	2	2	43	43
GOA Shallow	13	13	0	0	1	0	6	5	1	1	24	22
Total	100	100	1	1	1	1	9	11	3	4	25	35
Dusky Rockfish												
AI Deep	3	1	4	4	6	6	26	39	18	26	45	63
AI Shallow	3	1	4	3	6	4	35	31	23	20	61	55
BS Sand	3	0	22	0	19	0	66	0	15	0	0	0
BS Sand/Mud	1	0	6	0	5	0	23	0	7	0	0	0
BS Slope	0	0	2	0	2	0	12	0	3	0	0	0
GOA Deep Shelf	**57**	**69**	**1**	**1**	**1**	**1**	**8**	**10**	**1**	**1**	**31**	**46**
GOA Slope	14	19	1	1	1	1	8	10	2	2	38	45
GOA Shallow	20	11	1	1	1	1	7	8	2	2	25	38
Total	100	100	2	1	2	1	11	10	3	2	31	45
Thornyheads												
AI Deep	**27**	**23**	**0**	**0**	**0**	**1**	**3**	**4**	**2**	**2**	**7**	**9**
AI Shallow	7	5	1	1	1	2	11	12	6	7	24	27
BS Sand	1	1	20	17	17	14	42	38	22	20	0	0
BS Sand/Mud	2	1	1	1	1	1	7	7	1	1	0	0
BS Slope	10	12	2	2	2	1	8	8	2	2	0	0
GOA Deep Shelf	**30**	**33**	**1**	**1**	**1**	**1**	**5**	**4**	**1**	**1**	**20**	**18**
GOA Slope	**19**	**22**	**1**	**1**	**1**	**1**	**4**	**5**	**1**	**1**	**21**	**23**
GOA Shallow	4	2	0	0	0	0	4	2	1	1	15	14
Total	100	100	1	1	1	1	6	5	2	2	14	15

Note: Data include the percent of each species' distribution within each habitat type (habitat types containing 25% or more of either general or concentration areas are in bold face).

Table B.3-4. Stock Assessment Model Estimates of Age 3+ Biomass, Female Spawning Biomass, and Age 3 Recruits

Year	Age 3+ Biomass	Female Spawning Biomass	Age 3 Recruits (1,000's)
1984	166,843	54,537	18,397
1985	167,311	55,901	14,822
1986	167,913	57,398	19,075
1987	167,325	59,030	14,397
1988	165,770	60,705	10,799
1989	162,382	61,750	9,260
1990	158,001	62,307	9,089
1991	152,440	62,050	9,202
1992	139,092	57,560	6,129
1993	127,531	53,550	7,222
1994	121,276	51,798	11,378
1995	115,174	50,262	6,149
1996	111,096	49,023	11,634
1997	108,293	47,482	19,048
1998	104,501	44,912	17,378
1999	102,188	43,024	12,223
2000	100,747	40,997	16,046
2001	100,262	39,696	12,610
2002	100,837	38,685	15,823
2003	101,611	37,792	16,803
2004	101,991	36,898	15,406

Table B.4-1. Ratings of the Effects of Fishing on Essential Fish Habitat by Species and Life-history Process

Life -History Process	Salmon Species	Weathervane Scallops	Red King Crab	Blue King Crab	Golden King Crab	Scarlet King Crab	Tanner Crab	Snow Crab	Deepwater Tanner Crab
Spawning/Breeding	MT	MT	MT	MT	MT	MT	MT	U	MT
Feeding	MT	U	U	U	U	U	MT	MT	U
Growth to Maturity	MT	MT	MT	MT	U	U	MT	MT	U

Life -History Process	Walleye Pollock	Pacific Cod	Sablefish	Atka Mackerel	Yellowfin Sole (BSAI)	Greenland Turbot (BSAI)	Arrowtooth Flounder	Rock Sole (BSAI)	Flathead Sole	Rex Sole (GOA)	Alaska Plaice (BSAI)	Shallow Water Flatfish (GOA)	Deep Water Flatfish (GOA)	Pacific Ocean Perch (BSAI)	Pacific Ocean Perch (GOA)	Shortraker/Rougheye Rockfish (BSAI)	Shortraker/Rougheye Rockfish (GOA)	Northern Rockfish (BSAI)	Northern Rockfish (GOA)	Pelagic Shelf Rockfish (GOA)	Shortspine Thornyheads (GOA)	Dusky Rockfish	Shortspine Thornyheads (BSAI)
Spawning/Breeding	MT	MT	MT	MT	MT	MT	MT	MT	MT	MT	MT	U	U	MT	U	MT	U	MT	MT	MT	MT	U	MT
Feeding	MT	MT	U	MT	MT	MT	MT	MT	MT	MT	MT	U	U	MT	MT	MT	MT	MT	MT	MT	MT	MT	MT
Growth to Maturity	MT	MT	U	MT	MT	MT	MT	MT	MT	MT	MT	U	U	U	U	U	U	U	U	U	MT	U	MT

Life -History Process	Sharks	Skates	Sculpins	Squids	Octopi	Osmeridae	Myctophidae	Ammodytidae	Trichodontidae	Pholidae	Stichaeidae	Gonostomatidae	Euphausiacea
Spawning/Breeding	U	U	U	U	U	MT	MT	MT	MT	MT	MT	MT	MT
Feeding	U	U	U	U	U	MT	MT	MT	U	MT	MT	MT	MT
Growth to Maturity	U	U	U	U	U	MT	MT	MT	U	MT	MT	MT	MT

Rating codes: MMNT - More than Minimal and Not TemporaryA - Adverse, MT - Minimal, Temporary or None, B - Beneficial, U - Unknown effect

Table B.4-2. Summary of the Effects of Status Quo Fishing Activities on EFH for Managed Species[1]

Area	Species	Overall Evaluation	Comments/Concerns
Alaska	Salmon	MT	Habitat types used by salmon species are not substantially affected by fishing.
Alaska	Weathervane Scallops	MT/U	This species does not depend upon any habitat feature vulnerable to groundfish fishing activities. Based on the overlap of fisheries with juvenile and adult scallop stock distribution, there appear to be minimal effects on the weathervane scallop habitat.
Alaska	Red King Crab	MT/U	Fishing activities are considered to have overall minimal and temporary effects on EFH for red king crab. Non-habitat related direct mortality due to historical trawl bycatch may have been a factor in red king crab declines; however, this mortality has been mitigated by establishment of trawl closure areas.
Alaska	Blue King Crab	MT/U	Although both the Pribilof Islands stock and St. Matthew stock of blue king crabs are considered to be below MSST, habitat loss or degradation by fishing activities is not thought to have played any role in the decline of these stocks.
Alaska	Golden King Crab	MT/U	Fishing activities are considered to have overall minimal and temporary effects on the EFH of golden king crab. Groundfish trawl fishing in the Bering Sea slope is of some concern; however, any effects are thought to be minimal.
Alaska	Scarlet King	MT/U	This is a deepwater species with almost no overlap with commercial fisheries, so habitat effects are unlikely.
Alaska	Tanner Crab	MT	Fishing activities are considered to have overall minimal and temporary effects on EFH for Tanner crabs.
Alaska	Snow Crab	MT	Fishing effects on EFH are considered to have overall minimal and temporary effects on the EFH for snow crabs.
Alaska	Deepwater Tanner Crabs	MT/U	These are deepwater species with almost no overlap with commercial fisheries, so habitat effects are unlikely.
BSAI	Walleye Pollock	MT	Low association with benthic habitats. Pollock eggs, older juveniles, and adults are not primarily associated with benthic habitats.
BSAI GOA	Pacific cod	MT	Effects of fishing on habitat are insufficient to impair the ability of the BSAI or GOA Pacific cod stocks to sustain themselves at or near the MSY level.

Table B.4-2. Summary of the Effects of Status Quo Fishing Activities on EFH for Managed Species[1] (continued)

Area	Species	Overall Evaluation	Comments/Concerns
BSAI GOA	Sablefish	U	The estimated productivity and sustainable yield of sablefish has declined steadily since the late 1970's. This is demonstrated by a decreasing trend in recruitment and subsequent estimates of biomass reference points and the inability of the stock to rebuild to target biomass levels inspite of the decreasing level of the targets and fishing rates below the target fishing rate. While years of strong young of the year survival has occurred in the 1980-90's, the failure of strong recruitment to the mature stage suggests a decreased survival of juveniles during their residence as 2-4 year olds on the continental shelf. While climate related changes are a possible cause for reduced productivity, a variety of observations noted above are consistent with possible effects of fishing on habitat and resulting changes in the juvenile ecology of sablefish, possibly through increased competition for food and space. Given concern for the decline in the sustainable yield of sablefish, the possibility of the role of fishing effects on juvenile sablefish habitat, and the need for a better understanding of the possible causes, a MT rating is not merited and sablefish growth to maturity and feeding is rated UNKNOWN.
BSAI GOA	Atka Mackerel	MT	There is no evidence that the cumulative effects of fishing activities on habitat have impaired the stock's ability to produce MSY since 1977. Spawning stock biomass is at a peak level, the stock has produced several years of above average recruitment since 1977, and recent recruitment has been strong. Nor is there evidence to suggest that habitat disturbance has adversely impacted the spawning/breeding, growth to maturity, and feeding success of Atka mackerel. Therefore, the overall impact of habitat disturbance on Atka mackerel is minimal and temporary.
BSAI	Yellowfin Sole	MT	The yellowfin sole stock is currently at a high level of abundance, and well above BMSY. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.
BSAI	Greenland Turbot	MT	The Greenland turbot stock is currently at a level of abundance above the BMSY level. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.

Table B.4-2. Summary of the Effects of Status Quo Fishing Activities on EFH for Managed Species[1] (continued)

Area	Species	Overall Evaluation	Comments/Concerns
BSAI GOA	Arrowtooth Flounder	MT	The arrowtooth flounder stock is currently at a high level of abundance is both sea areas, well above the estimated BMSY level. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.
BSAI	Rock Sole	MT	The rock sole stock is currently at a high level of abundance, and well above BMSY. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.
BSAI	Flathead Sole	MT	The flathead sole stock is currently at a high level of abundance, and well above BMSY. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.
GOA	Flathead Sole	MT	The flathead sole stock is currently at a high level of abundance, and well above BMSY. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.
GOA	Rex Sole	U	The rex sole stock is currently at a high level of abundance, and well above BMSY. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.
BSAI	Alaska Plaice	MT	The rex sole stock is currently at a high level of abundance, and well above BMSY. The effects of the reductions in habitat features are either minimal or temporary relative to spawning, adult feeding, juvenile survival and growth to maturity.
GOA	Shallow Water Flatfish	U	The level of information available for the eight species of this complex are insufficient to estimate the stock size relative to BMSY. It is unknown what the effects of the reductions in habitat features are relative to spawning, adult feeding, juvenile survival and growth to maturity.
GOA	Deep Water Flatfish	U	With the exception of Dover sole, the level of information available for the three species of this complex are insufficient to estimate the stock size relative to BMSY. It is therefore unknown what the effects of the reductions in habitat features are relative to spawning, adult feeding, juvenile survival and growth to maturity for these species in aggregate.

Table B.4-2. Summary of the Effects of Status Quo Fishing Activities on EFH for Managed Species[1] (continued)

Area	Species	Overall Evaluation	Comments/Concerns
BSAI	Pacific Ocean Perch	MT/U	The effects of fishing on the habitat of BSAI Pacific ocean perch are rated as either unknown or minimal and temporary. There is little information to suggest that these habitat reductions would affect spawning/breeding or feeding in a manner that is more than minimal or temporary, although much is unknown about these processes. Regarding growth to maturity, the LEI percentages do not exceed 13% for the living and non-living substrates, although these figures should be interpreted as rough guidelines that are estimated with some error and relate to entire BSAI stock. Examination of LEI maps indicate that finer scale impacts do occur and could be important for stocks such as POP which are thought to show population structure on small spatial scales.
GOA	Pacific Ocean perch	MT/U	The effects of fishing on the habitat of Pacific ocean perch are either unknown or negligible. The LEI analysis suggests that bottom trawling may have a negative impact on benthic habitats, especially sponges and hard corals. If a strong association exists between these substrates and Pacific ocean perch during any life stage, then there should be concern regarding the effects of fishing on the habitat. There is some evidence of these linkages, but habitat usage by Pacific ocean perch at different life stages is mostly unknown. Current stock status trends show no indications of fishing impacting the ability of the stock to maintain MSY.
BSAI	Shortraker and Rougheye rockfish	MT/U	The effects of fishing on the habitat of BSAI rougheye and shortraker rockfish are rated as either unknown or minimal and temporary. There is little information to suggest that these habitat reductions would affect spawning/breeding or feeding in a manner that is more than minimal or temporary, although much is unknown for these processes. Regarding growth to maturity, juvenile red rockfish have been observed to use living and non-living structures, with one specific use being the ability to find refuge from predators. Although the LEI percentages do not exceed 7% for the living and non-living substrates, higher percent reductions have been estimated for hard corals and studies on habitat associations have indicated that rougheye rockfish are associated with hard corals. Examination of LEI maps indicate that finer scale impacts do occur, although the extent to which habitat impacts occur at smaller scales and the importance of these impacts to the overall BSAI population are unknown.

Table B.4-2. Summary of the Effects of Status Quo Fishing Activities on EFH for Managed Species[1] (continued)

Area	Species	Overall Evaluation	Comments/Concerns
GOA	Shortraker and Rougheye Rockfish	MT/U	There is not enough information available to determine whether the habitat impacts of fishing affect spawning or growth to maturity. However, the known association of shortraker and rougheye rockfish with corals raises concern that fishing could have a negative impact on the habitat of these fish. Fishing appears to have a negligible effect on feeding of shortraker and rougheye rockfish.
BSAI	Northern rockfish	MT/U	The effects of fishing on the habitat of BSAI northern rockfish are rated as either unknown or minimal and temporary. There is little information to suggest that these habitat reductions would affect spawning/breeding or feeding in a manner that is more than minimal or temporary, although much is unknown about these processes. Regarding growth to maturity, juvenile red rockfish have been observed to use living and non-living structures, with one specific use being the ability to find refuge from predators. Although the LEI percentages do not exceed 8% for the living and non-living substrates, these figures should be interpreted as rough guidelines that are estimated with some error and relate to entire BSAI stock. Examination of LEI maps indicate that finer scale impacts do occur, although the extent to which these finer scale impacts may be important for northern rockfish is dependent upon the spatial scale of their population structure, which is currently unknown.
GOA	Northern Rockfish	MT/U	Fishing probably has little or no effect on prey availability and spawning/breeding behavior of northern rockfish in the Gulf of Alaska. A reduction in living and non-living structure could plausibly jeopardize growth to maturity due to a reduction of refuge habitat for juvenile northern rockfish. However, habitat requirements for the various life stages are mostly unknown, consequently, the effects of fishing on growth to maturity are also unknown.
GOA	Pelagic Shelf Rockfish	MT/U	The effects of fishing on the habitat of dusky rockfish and the pelagic shelf rockfish assemblage are either unknown or negligible. The LEI analysis indicates that bottom trawling may have a negative impact on the benthic habitat of pelagic shelf rockfish, especially corals and sponges. If a strong association exists between these substrates and pelagic shelf rockfish of any life stage then there should be concern regarding the effects of fishing on the habitat.

Table B.4-2. Summary of the Effects of Status Quo Fishing Activities on EFH for Managed Species[1] (continued)

Area	Species	Overall Evaluation	Comments/Concerns
GOA	Thornyhead Rockfish	MT	Thornyhead juveniles and adults are associated with benthic habitats, specifically, on the deep shelf and slope in any type of non-living substrate, but they may prefer hard, non-living substrate according to limited studies in the eastern Gulf of Alaska.
BSAI	Other Rockfish	U	Studies conducted in the Bering Sea or Aleutian Islands are inconclusive as to whether fishing activities have an effect on the habitat (relative to spawning/breeding, feeding, and growth to maturity) of light dusky rockfish and BSAI thornyhead rockfish.
BSAI	Other Species	U	Because appropriate information is lacking for the “other species” (i.e., sharks, skates, sculpins, squids, and octopi), it is impossible to assess whether the fisheries, as they are currently conducted off Alaska, are affecting habitat that is essential to the welfare of the species in question in a way that is more than minimal and not temporary.
Alaska	Forage Species	MT/U	Most of the forage species (i.e., Osmeridae, Myctophidae, Ammodytidae, Trichodontidae, Pholidae, Stichaeidae, Gonostomatidae, and Euphausiacea) do not overlap with known areas of intensive fishing, and/or there is little evidence that survival depends habitat affected by fishing.

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[1] Based on information contained in Appendix B, Section 3.3. Evaluation notation is as follows: MT = minimal, temporary, or no effect; U = unknown; MMNT = more than minimal and not temporary.

Appendix C
Regulatory Impact Review/Initial Regulatory Flexibility Analysis

Prepared by

Tetra Tech EC, Inc.
Natural Resources Consultants (NRC)
EDAW, Inc.
National Marine Fisheries Service

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ACRONYMS AND ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
AEB	Aleutians East Borough
AED	Alaska Enforcement Division
AFA	American Fisheries Act
BSAI	Bering Sea and Aleutian Islands Area
CDQ	community development quotas
CG	Central Gulf of Alaska
Coast Guard	U.S. Coast Guard
Council	North Pacific Fishery Management Council
CPUE	catch-per-unit-effort
CVM	contingent value' method
EA	Environmental assessment
EBS	Eastern Bering Sea (that portion of the Bering Sea within the United States EEZ)
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EG	Eastern Gulf of Alaska
EIS	Environmental impact statement
EO	Executive Order
EPIRB	Emergency Position Indicating Radio Beacon
ESA	Endangered Species Act
FCVP	Federal Crab Vessel Permit
FFP	Federal Fishery Permit
FMP	Fishery management plan
GHL	guideline harvest limit
GHR	guideline harvest range
GOA	Gulf of Alaska
GPS	global positioning system
H&G	headed and gutted
HAPCs	habitat areas of particular concern
IPHC	International Pacific Halibut Commission
IFQ	individual fishing quota
LOA	length overall
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MMPA	Marine Mammal Protection Act
NEPA	National environmental policy act
NIOSH	National Institute of Occupational Safety and Health
NMFS	National Marine Fisheries Service
NMFS Enforcement	NOAA Fisheries Office for Law Enforcement
NPT	non-pelagic trawl
OY	optimum yield
PRA	Paperwork Reduction Act
PTR	pelagic trawl gear
Regional Councils	Regional Fishery Management Councils
RFA	Regulatory Flexibility Act
RIR	Regulatory Impact Review
SAR	search and rescue
SBA	small business administration
Secretary	Secretary of Commerce

SSL	Steller sea lion
SVD	single vessel database
TAC	total allowable catch
VMS	vessel monitoring systems
WG	Western Gulf of Alaska
WPR	weekly production report

An Analytical Clarification

A benefit/cost framework is the appropriate way to evaluate the relative economic and socioeconomic merits of the alternatives under consideration in this RIR. When performing a benefit/cost analysis, the principal objective is to derive informed conclusions about probable net effects of each alternative under consideration (e.g., net revenue impacts). However, in the present case, necessary empirical data (e.g., operating costs, capital investment, debt service, opportunity costs) are not available to the analysts, making a quantitative net benefit analysis impossible. Furthermore, empirical studies bearing on other important aspects of these alternative actions (e.g., passive-use values, domestic and international seafood demand) are also unavailable, and time and resource constraints prevent their preparation for use in this analysis.

Nonetheless, the following regulatory impact review, initial regulatory flexibility analysis, and supporting text use the best available information and quantitative data, combined with accepted economic theory and practice, to provide the fullest possible assessment (both quantitative and qualitative) of the potential economic benefits and presumptive costs attributable to each alternative action. Based upon this analysis, conclusions are offered concerning the likely economic and socioeconomic effects that may derive from each of the alternatives. This analytical approach is consistent with applicable policy and established practice for implementing Executive Order (EO) 12866.

As noted, one would ideally wish to derive empirically based net economic impact estimates. For the reasons cited, this is not presently possible. Therefore, this comparative analysis is, by default, predicated on gross level effects. The analysts do not assert that gross and net measures are effective proxies for one another. However, given considerable empirical experience with these fisheries, anecdotal information from well informed sources, and accepted economic theory, gross effects (e.g., gross revenues-at-risk) can provide useful insights into the probable relative impacts of the alternative actions under consideration, in the absence of net impact measures.

Furthermore, to paraphrase EO 12866, “... costs and benefits are, herein, understood to include, and have been assessed on the basis of, both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nonetheless essential to consider.” The EO continues: “... in choosing among alternative regulatory approaches, agencies should select... (presumably, based upon the combined interpretation of the quantitative and qualitative measures explicitly provided for in the preceding sentence from the EO)...those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity)... .”

NMFS’ *Guidelines for Economic Analysis of Fishery Management Actions* (as revised August 16, 2000) states, “Economists may use several analytical options to meet the spirit and requirements of EO 12866, the RFA, and other applicable laws. The appropriate options depend on the circumstances to be analyzed, available data, the accumulated knowledge of the fishery and of other potentially affected entities, and on the nature of the regulatory action.”

Elsewhere, the guidelines state, “... the analyst is expected to make a reasonable effort to organize the relevant information and supporting analyses, (but)... at a minimum, the RIR and RFAA should include a good qualitative discussion of the economic effects of the selected alternatives. Quantification of these effects is desirable, but the analyst needs to weigh such quantification against the significance of the issue and available studies and resources. Generally, a good qualitative discussion of the expected effects would be better than poor quantitative analyses." This RIR/IRFA has been prepared consistent with these prescriptions.

For clarity of presentation, a simple analytical convention is adopted for the gross revenue-at-risk assessment (presented below), in which the 2001 fisheries are reexamined, in succession, as if each of the proposed EFH fishery impact minimization alternatives had been in place in that year. This convention is adopted, in large part, to reduce the inherent risk of introducing parameter bias, associated with the analysts speculating on, for example, future catch distributions, species catch composition, ex-vessel and first wholesale prices, and costs, etc. By using this technique, the analysis can be performed using official, empirically observed and recorded, catch and value data sets. The 2001 records are used because they represent the most recent complete data sets for the fisheries in question.

The analysis of the suite of EFH fishery impact minimization alternatives presented in this appendix, is explicitly framed within the prevailing open-access management context. As such, the implications of each proposed alternative have been interpreted within the (now familiar) limits of the Olympic or derby fishing system. Within the RIR, open-access management is acknowledged to impose unavoidable inefficiencies upon participants, inducing economic and operational behavior which would not, voluntarily, be observed, were the fisheries rationalized. Open access inefficiencies potentially result in excess capacity, increased economic and physical risk taking, a dissipation of resource rents, and greater potential economic vulnerability and instability in the effected sectors. Except in the few instances when economic rationalization has occurred (e.g., halibut and sablefish IFQs, AFA fisheries) the analysis that follows reflects the implications of the continuing race for fish, which prevails in most of the GOA, EBS, and AI commercial fisheries.

C.1 INTRODUCTION

The federal groundfish, crab, salmon, and scallop fisheries conducted off Alaska in the 3- to 200-nautical mile United States Exclusive Economic Zone (EEZ) are managed under the Fishery Management Plan (FMP) for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area (BSAI), the FMP for the Groundfish of the Gulf of Alaska (GOA), the FMP for the King and Tanner Crab Fisheries in the BSAI, the FMP for Scallop Fisheries Off Alaska, and the FMP for Salmon off Alaska. These FMPs and their amendments are developed under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). The purpose of the FMPs is to manage the fisheries for optimum yield (OY) and to allocate harvest among user groups.

Amendments to the Magnuson-Stevens Act in 1996 set forth new mandates for the National Marine Fisheries Service (NMFS) and Regional Fishery Management Councils (Regional Councils) to identify and protect important marine and anadromous fish habitat. The Regional Councils, with assistance from NMFS, were required to delineate essential fish habitat (EFH) for all managed species. EFH is defined in the Magnuson-Stevens Act as "...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

In response to the amended Magnuson-Stevens Act and based on guidelines for the EFH contents of FMPs (50 CFR part 600 subpart J), the North Pacific Fishery Management Council (Council) completed preparation of the following five EFH FMP amendments in 1998:

- Amendment 55 to the Fishery Management Plan for the Groundfish Fishery of the BSAI
- Amendment 55 to the FMP for Groundfish of the GOA
- Amendment 8 to the FMP for the King and Tanner Crab Fisheries in the BSAI

- Amendment 5 to the FMP for Scallop Fisheries Off Alaska
- Amendment 5 to the FMP for the Salmon Fisheries in the EEZ Off the Coast of Alaska (Amendments 55/55/8/5/5)

These EFH FMP amendments were reviewed, approved by the Secretary of Commerce, and took effect on January 20, 1999 (64 FR 20216).

In June 1999, there was a federal court challenge of the scope and substance of the environmental assessment (EA) prepared for Amendments 55/55/8/5/5 (American Oceans Campaign et al. v. Daley, Civ. No. 99-982(D.D.C.)). On September 14, 2000, the U.S. District Court issued an opinion finding the EA insufficient in scope and analytical substance and requiring NMFS to prepare an analysis that would be legally sufficient under NEPA. Therefore, NMFS is reevaluating the EFH components originally developed as part of Amendments 55/55/8/5/5.

The proposed action to be addressed in this supplemental Environmental Impact Statement (EIS) is the development of the mandatory EFH provisions of the affected FMPs as described in section 303(a)(7) of the Magnuson-Stevens Act and based on the guidance in 50 CFR part 600 subpart J. The three-part purpose of this action is to analyze a range of potential alternatives within each fishery to 1) identify and describe EFH for managed species, 2) identify other actions to encourage the conservation and enhancement of EFH, and 3) minimize to the extent practicable adverse effects of fishing on EFH. The scope of the new EIS covers all the required EFH components of the FMPs, as well as the description of a process to identify HAPCs.

This Regulatory Impact Review (RIR) evaluates, to the extent practicable, the economic and socioeconomic impacts of the proposed alternative measures that have been identified to minimize adverse effects of fishing on EFH. A detailed discussion of the environmental and management context for this action is contained in the EIS, which precedes this RIR. The economic and socioeconomic context of this action is presented in the following sections.

C.1.1 Statutory Authority

Under the Magnuson-Stevens Act, the United States has exclusive fishery management authority over all marine fishery resources found within the EEZ, which extends between 3 and 200 nautical miles from the baseline used to measure the territorial sea. The management of these marine resources is vested in the Secretary of Commerce (Secretary) and in the Regional Councils. In the Alaska Region, the Council has the responsibility for preparing FMPs for the marine fisheries it finds that require conservation and management and for submitting their recommendations to the Secretary. Upon approval by the Secretary, NMFS is charged with carrying out the federal mandates of the Department of Commerce with regard to marine and anadromous fish. The groundfish fisheries in the EEZ off Alaska are managed under the FMP for the Groundfish Fisheries of the GOA and the FMP for the Groundfish Fisheries of the BSAI. The crab fisheries in the EEZ off Alaska are managed under the FMP for the Crab Fisheries of the BSAI. The scallop fisheries in the EEZ off Alaska are managed under the FMP for the Scallop Fisheries of Alaska. The salmon fisheries in the EEZ off Alaska are managed under the FMP for the Salmon Fisheries of Alaska. Actions taken to amend FMPs or implement other regulations governing these fisheries must meet the requirements of federal laws and regulations. In addition to the Magnuson-Stevens Act, the most important of these are the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), EO (EO 12866), the Regulatory Flexibility Act (RFA), and the American Fisheries Act (AFA).

While the EFH requirements of the Magnuson-Stevens Act convey no legal authority to the Council and/or NMFS to take similar actions in State of Alaska waters, several of the fishing impact minimization alternatives under consideration would involve fishing closures and other restrictions in state waters. The economic and socioeconomic analyses conducted in this RIR assume that the State of Alaska will adopt the measures in these fishing impact minimization alternatives within its waters, where necessary and appropriate.

C.1.2 Regulatory Impact Review Requirements

This RIR provides the analysis required under EO 12866. The following statement from the EO summarizes the requirements of an RIR:

> In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environment, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.

EO 12866 requires that the Office of Management and Budget review proposed regulatory programs that are considered to be significant. A significant regulatory action is one that is likely to achieve the following:

1. Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities.
2. Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency.
3. Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof.
4. Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this EO.

C.1.3 Purpose and Need

NMFS determined that an EIS was the appropriate NEPA analysis document for the proposed federal action being considered. The determination was based both on the fact that significant impacts may result from implementation of the action and that the action is controversial. The document is a supplemental EIS (rather than an EIS) because it is supplemental to prior EISs that were prepared for the BSAI and GOA groundfish FMPs in 1981 and 1979, respectively. The scoping process used to identify analytical issues and alternatives to meet the identified purpose and need is documented in Appendix A of the EIS.

The actions considered in the EIS are needed to meet the EFH requirements of the Magnuson-Stevens Act section 303(a)(7) and the regulatory guidelines developed by NMFS in accordance with section 305(b)(1)(A). The Magnuson-Stevens Act requires amending FMPs to identify and describe EFH for each of the managed species and their life stages. In December 2002, the Council adopted a draft problem statement to guide the analysis.

The actions are designed to strengthen the ability of NMFS and the Council to protect and conserve habitat of finfish, mollusks, and crustaceans. An important theme within the 1996 reauthorization of the Magnuson-Stevens Act is sustainable and risk-averse management of fisheries; it emphasizes the importance of habitat protection to healthy fisheries. Congress recognized that the greatest long-term threat to the viability of commercial, subsistence, and recreational fisheries is the continued loss of marine, estuarine, and other aquatic habitats.

The primary purpose of the proposed action, covered in this RIR, is the modification of the BSAI and GOA federally managed fisheries to minimize, to the extent practicable, adverse effects on EFH caused by fishing. If more than one alternative accomplishes the primary purpose of this action, a secondary objective is to modify the fisheries such that the actions taken also minimize the adverse economic and social impacts imposed on the commercial fishing industry and associated communities.

C.1.4 EFH Alternatives

The EIS includes analyses of six alternatives for the description and identification of EFH, five alternatives for the identification of habitat areas of particular concern (HAPCs), and six alternatives for the minimization of adverse effects on EFH caused by fishing (fishing impact minimization alternatives). Any of the EFH description alternatives would trigger the need for consideration of measures to minimize the adverse effects of fishing on EFH; thus, the effects of describing and identifying EFH are reflected in the effects of the alternatives to minimize the adverse effects of fishing on EFH, which are the focus of this RIR. Only the minimization alternatives have regulatory actions associated with their adoption and implementation, due to their potential to have a direct effect on the management of federal FMP fisheries. They are, therefore, the only EFH alternatives analyzed in this RIR. When (and/or if) subsequent regulatory actions are proposed in connection with the suite of EFH description and/or HAPC alternatives, a complete RIR will be prepared on those specific actions. The following is a brief description of each of the six fishing impact minimization alternatives. EIS Chapter 2 contains a complete and detailed treatment of the alternatives, as well as charts showing the affected geographic areas under each fishing impact minimization alternative. Table 1.4-1 shows the total area currently available to the fisheries and the area that would be closed under each alternative.

Alternative 1: Status Quo and No Action—Under this alternative, no additional measures would be taken at this time to minimize the effects of fishing on EFH.

Alternative 2: Gulf Slope Bottom Trawl Closures—This alternative would amend the GOA Groundfish FMP to prohibit the use of bottom trawls to target rockfish in 11 designated areas of the GOA slope (200 to 1,000 meters [m]), but would allow vessels endorsed for trawl gear to fish for rockfish in these areas with fixed gear or pelagic trawl gear.

Alternative 3: Upper Slope Bottom Trawl Prohibition for GOA Slope Rockfish—This alternative would amend the GOA Groundfish FMP to prohibit the use of bottom trawl gear for targeting GOA slope rockfish species on all upper slope areas of the GOA (200 to 1,000 m), but would allow vessels endorsed for trawl gear to fish for slope rockfish with fixed gear or pelagic trawl gear.

Alternative 4: Bottom Trawl Closures in All Management Areas—This alternative would amend the GOA and the BSAI Groundfish FMPs to prohibit the use of bottom trawl gear in designated areas of the

EBS, AI, and GOA. In the EBS only, bottom trawl gear used in the remaining open areas would have to have disks/bobbins on trawl sweeps and footropes. Area-specific measures are detailed below.

Gulf of Alaska: This alternative would prohibit the use of bottom trawl gear for rockfish fisheries in 11 designated sites of the GOA slope (200 to 1,000 m), but would allow vessels endorsed for trawl gear to fish for rockfish in these areas with fixed gear or pelagic trawl gear.

Bering Sea: This alternative would prohibit the use of bottom trawl gear for all groundfish fisheries in the EBS, except within a designated open area. The open area would be designated based upon historic bottom trawl effort. Within the open area, there would be a rotating closure to bottom trawl gear in five areas to the west, north, and northwest of the Pribilof Islands. Closure areas would be designated in Blocks 1, 2, 3, 4, and 6, with 10-year closed periods for 25 percent of each block. After 10 years, the closed portion of each block would re-open and a different 25 percent of each block would close for 10 years, and so on thereafter. After 40 years, all areas within each block would have been subjected to a 10-year closure, and the rotating area closure would start over.

Aleutian Islands: This alternative would prohibit the use of bottom trawl gear for all groundfish fisheries in designated areas of the AI. Closure areas would be designated in the areas of Stalemate Bank, Bowers Ridge, Seguam Foraging Area, and Semisopochnoi Island.

Alternative 5A: Expanded Bottom Trawl Closures in All Management Areas—This alternative would amend the GOA and BSAI Groundfish FMPs to prohibit the use of bottom trawl gear in designated areas of the EBS, AI, and GOA. In the EBS only, bottom trawl gear used in the remaining open areas would have to have disks/bobbins on trawl sweeps and footropes. Area-specific measures are detailed below.

Gulf of Alaska: This alternative would prohibit the use of bottom trawl gear for all groundfish fisheries in ten designated sites of the GOA slope (200 to 1,000 m). Additionally, it would prohibit the use of bottom trawls for targeting slope rockfish on the GOA slope (200 to 1,000 m), but would allow vessels endorsed for trawl gear to fish for rockfish in these areas with fixed gear or pelagic trawl gear.

Bering Sea: This alternative would prohibit the use of bottom trawl gear for all groundfish fisheries in the EBS, except within a designated open area. The open area would be designated based on historic bottom trawl effort. Within the open area, there would be a rotating closure to bottom trawl gear in five areas to the west, north, and northwest of the Pribilof Islands. Closure areas would be designated in Blocks 1, 2, 3, 4, and 6, with 5-year closed periods for 33.3 percent of each block. After 5 years, the closed area would re-open, and the next 33.3 percent of each block would close for 5 years, and so on thereafter. After 15 years, all areas within each block would have been subject to a 5-year closure, and the rotating area closures would start over. Additionally, bottom trawl gear used in the remaining areas open to trawling in the EBS would have to have disks/bobbins on trawl sweeps and footropes.

Aleutian Islands: This alternative would prohibit the use of bottom trawl gear for all groundfish fisheries in designated areas of the AI. Closure areas would be designated in the areas of Stalemate Bank, Bowers Ridge, Seguam Foraging Area, Yunaska Island, and Semisopochnoi Island. These closure areas would extend to the northern and southern boundaries of the AI management unit.

Alternative 5B: Expanded Bottom Trawl Closures in All Management Areas with Sponge and Coral Closures in the Aleutian Islands—Alternative 5B would amend the GOA and BSAI Groundfish FMPs to prohibit the use of bottom trawl gear, year-round, in designated areas of the EBS and GOA just like Alternative 5A. Existing closure areas would not be affected by this alternative; they would remain closed. In the AI, a system of open and closed areas would be established to reduce the effects of trawling on corals and sponges. Additionally, for the EBS only, bottom trawl gear used in the remaining areas open to trawling would be required to have disks/bobbins on trawl sweeps and footropes. The management measures established by this alternative would be in addition to existing habitat protection measures (e.g., area closures, gear restrictions, and limitations on fishing effort). Area-specific regulations are detailed below.

Bering Sea: This alternative would prohibit the use of bottom trawl gear for all groundfish fisheries in the EBS, except within a designated open area. The open area would be designated based on historic bottom trawl effort, and no areas currently closed would be open. Within the open area, there would be a rotating closure to bottom trawl gear in five areas to the west, north, and northwest of the Pribilof Islands. Closure areas would be designated in Blocks 1, 2, 3, 4, and 5, with 5-year closed periods for 33.3 percent of each block. After 5 years, the closed area would reopen, and the next 33.3 percent area of each block would close for 5 years, and so on, thereafter. After 15 years, all areas within each block would have been subject to a 5-year closure, and the rotating closure areas would start over. Additionally, bottom trawl gear used in the remaining areas open to trawling in the EBS would be required to have disks/bobbins on trawl sweeps and footropes.

Aleutian Islands: Alternative 5B would include one of three options for the Aleutian Islands, as described below.

Option 1

1. Open areas would be designated where bottom trawling would be allowed in the AI. These areas would be based on areas of higher effort distribution from 1990 through 2001. Bottom trawling would be prohibited in all remaining sections of the AI management area. Pelagic trawls could be used outside of the designated open areas, but only in the off-bottom mode. The boundaries of open areas, as first designated by the data analysis, were converted to latitude/longitude coordinates (and most were adjusted into a rectangle shape) to facilitate enforcement.

2. TAC reductions would be made for individual stocks or species complexes, based on analysis of 1998 to 2002 data (see Appendix H for analysis methodology). This methodology would result in a 10 percent reduction in the BSAI Pacific cod TAC, a 6 percent reduction in the AI Atka mackerel TAC, and a 12 percent reduction in the rockfish TACs. No TAC reduction would be made for pollock, as this species would be harvested with pelagic trawl gear and, thus, would not be subject to closures.

3. Coral/bryozoan and sponge bycatch limits would be imposed to close specific fisheries and areas, if necessary. If a bycatch limit were reached (all species of corals and bryozoans, or all species of sponges) by a fishery within a regulatory area, the regulatory area would be closed to that fishery for the remainder of the fishing year. Closure areas would be based on AI regulatory areas 541, 542, and 543. Fisheries that would be included in this program comprise the trawl fisheries for Pacific cod, Atka mackerel, and rockfish. Bycatch limits would be based on levels of coral/bryozoans and sponges historically taken by these fisheries in these areas (see Appendix H for data analysis methodology). The limits are as follows.

Fishery	541	542	543
Atka mackerel			
sponge	10 mt	20 mt	66 mt
coral/bryozoans	2 mt	3 mt	8 mt
Pacific cod			
sponge	11 mt	22 mt	22 mt
coral/bryozoans	2 mt	1 mt	6 mt
Rockfish			
sponge	13 mt	5 mt	0 mt
coral/bryozoans	1 mt	1 mt	8 mt

4. Additional fishery monitoring measures would be implemented, including a requirement for 100 percent observer coverage and an electronic vessel monitoring system (VMS) on vessels fishing for groundfish in the AI. These measures would require that vessels use specially trained and experienced observers when possible.

5. A comprehensive plan for research and monitoring would be developed in the AI. The plan would include seafloor mapping, benthic research, and habitat impact assessment for all bottom tending gears, annual habitat assessment reports, and experimental fishing permits to identify additional open areas.

Option 2

1. Open areas would be designated where bottom trawling would be allowed in the AI. These areas would be based on the methodology used in Option 1 above, with eight specific modifications, based on data analysis and input from fishermen and Aleutian Islands residents, as recommended by Oceana. The specific modifications would involve the following areas: Buldir Island, Murray Canyon, South Amchitka, Petrel Bank, Gusty Bay, Kanaga Island, Adak South, and Atka Pass. Bottom trawling would be prohibited in all remaining sections of the AI management area. Pelagic trawls could be used outside of the designated open areas, but only in the off-bottom mode.

2. TAC reductions would be made for individual stocks or species complexes, based on analysis of 1998 to 2002 data (see Appendix H for analysis methodology). This methodology would result in a 6 percent reduction in the AI Atka mackerel TAC and a 12 percent reduction in the rockfish TACs. No TAC reduction would be made for Pacific cod or pollock.

3. Coral/bryozoan and sponge bycatch limits would be imposed to close specific fisheries and areas, if necessary, as specified in Option 1 above.

4. Additional fishery monitoring measures would be implemented, as specified in Option 1 above.

5. A comprehensive plan for research and monitoring would be developed in the AI, as specified in Option 1 above.

6. All bottom contact fishing would be prohibited in six coral garden sites, located off Semisopochnoi Island, Bobrof Island, Cape Moffet, Great Sitkin Island, Ulak Island, and Adak Canyon.

Option 3

1. Open areas would be designated where bottom trawling would be allowed in the AI. These areas would be based on the methodology used in Option 1 above, with specific modifications based on data analysis and input from Aleutian Islands trawl fishermen, as recommended by the Groundfish Forum. Bottom trawling would be prohibited in all remaining sections of the AI management area. Pelagic trawls could be used outside of the designated open areas, but only in the off-bottom mode.

2. Additional fishery monitoring measures would be implemented, as specified in Option 1 above.

Gulf of Alaska: Alternative 5B would prohibit the use of bottom trawl gear for all groundfish fisheries in designated sites of the GOA upper to intermediate slope (200 to 1,000 m). Additionally, it would prohibit the use of bottom trawls for targeting GOA slope rockfish on the GOA upper to intermediate slope (200 to 1,000 m), but would allow vessels endorsed for trawl gear to fish for rockfish in these areas with fixed or pelagic trawl gear. These areas would be permanent, year-round closures.

Objectives
The overall goal of Alternative 5B is to reduce the effects of fisheries on benthic epifauna, namely corals and sponges, via two specific objectives. The first objective is to prevent the expansion of bottom trawl effort into unfished areas, through the use of designated open areas. The second objective is to allow habitat recovery in a relatively large portion of the AI by eliminating bottom trawling that had occurred with low effort, outside of the designated open areas. Options 1 and 2 have two additional objectives: to control fishing effort (and hence habitat impacts) within the remaining open areas, by setting TACs proportional to the amount traditionally taken from these areas, and to reduce the bycatch of benthic epifauna by 1) establishing bottom trawl closure areas where coral, bryozoans, and sponges had previously been taken as bycatch and 2) establishing bycatch limits for these invertebrates. This alternative would also increase monitoring for enforcement.

Rationale
The rationale for including this alternative for analysis is the same as that identified for Alternative 5A, but would include more restrictions to minimize potential effects on corals and sponges due to trawling in the AI.

Alternative 5C: Expanded Closures in the Aleutian Islands and Gulf of Alaska (Preferred Alternative)—Alternative 5C would amend the FMPs to prohibit the use of certain bottom contact fishing gear in designated areas of the AI and GOA to reduce the effects of fishing on corals, sponges, and hard bottom habitats. The management measures established by this alternative would be in addition to existing habitat protection measures (e.g., area closures, gear restrictions, and limitations on fishing effort). Area-specific regulations are detailed below.

> *Aleutian Islands*: Open areas would be designated where bottom trawling would be allowed. The open areas would be based on high fishing effort from 1990 through 2001 with specific modifications based on data analysis and input from Aleutian Islands trawl fishermen and additional modifications to reduce the open areas to avoid coral habitat. The open areas would be the same as those in Alternative 5B Option 3, except for two areas with coral habitat (one south of Attu Island and the other on Petrel Bank near Semisopochnoi Island) that would be closed. Bottom trawling would be prohibited in all remaining sections of the AI management area. Pelagic trawls could be used outside of the designated open areas, but only in the off-

bottom mode. Additionally, all bottom contact fishing would be prohibited in six coral garden sites located off Semisopochnoi Island, Bobrof Island, Cape Moffet, Great Siskin Island, Ulak Island, and Adak Canyon. Fishery monitoring measures would include existing levels of observer coverage, plus a requirement for a vessel monitoring system on all commercial fishing vessels operating in the AI.

Gulf of Alaska: Bottom trawl gear would be prohibited for all groundfish fisheries in ten designated areas of the GOA upper to intermediate slope (200 to 1,000 m). Fishery monitoring measures would include existing levels of observer coverage, plus NMFS would add to a requirement to Alternative 5C for a vessel monitoring system on all commercial fishing vessels with bottom-contact gear in the GOA, to ensure adequate enforcement.

Objectives

The primary objective for Alternative 5C is to reduce the effects of fisheries on corals, sponges, and other sensitive habitats in hard bottom areas where long-lived, fragile benthic epifauna are most likely to occur. Related objectives are to prevent the expansion of bottom trawl effort into unfished areas of the AI and to allow habitat recovery by eliminating bottom trawling that has occurred with low effort outside of the designated open areas in the AI. This alternative would also increase monitoring for enforcement.

Rationale

The rationale for including this alternative for analysis is that it incorporates measures from other alternatives that focus on the habitats that support (or are most likely to support) corals and other fragile sea floor habitats that may be especially slow to recover following disturbance. For the AI, Alternative 5C includes a variation of the open area approach from Alternative 5B, resulting in extensive closures to bottom trawling to protect relatively undisturbed habitats. Additionally, Alternative 5C prohibits all bottom contact fishing within six coral garden areas, providing a higher level of protection for those especially diverse and fragile habitats. For the GOA, Alternative 5C includes closures to bottom trawling in ten areas on the GOA slope to reduce the effects of fisheries with higher scores in the evaluation of the effects of fishing on EFH (Appendix B). Alternative 5C does not include new management measures for the EBS, because available information indicates that the EBS does not support the kind of hard bottom habitats that sustain extensive corals and other particularly sensitive benthic invertebrates. However, under this alternative the Council would initiate a subsequent analysis specifically to consider potential new habitat conservation measures for the EBS, including the management options identified in this EIS and other options.

Alternative 6: Closures to All Bottom Tending Gear in 20 percent of Fishable Waters—This alternative would amend the GOA and BSAI Groundfish FMPs, the Alaska Scallop FMP, the BSAI Crab FMP, and the Pacific Halibut Act regulations to prohibit the use of all bottom tending gear (dredges, bottom trawls, pelagic trawls that contact the bottom, longlines, dinglebars and pots) within approximately 20 percent of the fishable waters (i.e., 20 percent of the waters shallower than 1,000 m) in each of the regions described below.

Gulf of Alaska: The GOA would be subdivided into three regions: Western (corresponding to regulatory area 610), Central (areas 620 and 630), and Eastern (areas 640 and 650).

Aleutian Islands: The AI would be subdivided into four regions: Western (corresponding to regulatory area 543), Central (area 542), Eastern (area 541), and two smaller EBS regulatory areas next to the Aleutians (combination of areas 518 and 519).

<u>Bering Sea</u>: The EBS would be subdivided into three regions south of St. Lawrence Island denoting each of the predominant substrate types (sand, sand/mud, and mud) and taking into consideration the varying depth distribution of each substrate.

The closed areas were identified based on the presence of habitat, such as high relief coral, sponges, and Boltenia, with emphasis on areas with notable benthic structure and/or high concentrations of benthic invertebrates that provide shelter for managed species. The closed areas would include a mix of relatively undisturbed habitats and habitats that are currently fished. Within a given region, existing area closures could comprise all, or a portion of, the closed areas for this alternative.

C.2 DESCRIPTION OF THE FISHERIES

The fisheries off Alaska are an economically important segment of the United States domestic fishing industry. Commercial fishery landings off Alaska totaled approximately 2.28 million metric tons (mmt) in 2001, compared to 2.03 mmt in 2000 (NMFS 2002a). The ex-vessel value of the catch, excluding the value added by processing, was estimated at $974.2 million in 2001, a decrease of $152.2 million from the estimated 2000 ex-vessel value of $1.13 billion. In 2001, domestic landings of seafood products off Alaska represented 53 percent of the United States total landings and 27 percent of the total ex-vessel value. Groundfish accounted for the largest share of the ex-vessel value of all commercial fisheries off Alaska in 2001 at $542.8 million (56 percent), while the Pacific salmon catch was second at $188.5 million (19 percent), shellfish catch was third in value at $123.5 million (13 percent), halibut was fourth in value at $109.0 million (11 percent), and herring accounted for $10.4 million ex-vessel value (1 percent) (Hiatt et al. 2002).

The value of the 2001 catch, after primary processing, was approximately $2.4 billion. This estimate includes the value added by at-sea and shoreside processors, typically characterized as representing the first wholesale gross product value. The following is a brief description of the fisheries off Alaska. A somewhat more detailed description of federal and state managed fisheries off Alaska is provided in EIS Section 3.4.

C.2.1 Harvesting Sector

An extensive description of the North Pacific and EBS harvesting sectors is contained in the Draft Programmatic Groundfish SEIS Chapter 3 (NMFS 2001a) as well as in the Steller Sea Lion Protection Measures SEIS and RIR (NMFS 2001b), and the Annual SAFE documents. These documents contain greater detail on the wide variety of operational modes represented in this sector of the Alaska fishing industry.

C.2.1.1 Groundfish

Groundfish off Alaska are harvested by two main fleet components: 1) catcher vessels that harvest fish for delivery to shoreside or at-sea processors (i.e., motherships, catcher-processors), and 2) factory vessels that catch and process groundfish into value-added products onboard the vessel.

C.2.1.1.1 Catcher Vessels

Groundfish catcher vessels are typically smaller than their catcher-processor counterparts, and they use pelagic and non-pelagic trawl, longline, pot, jig, or dinglebar troll gear to target a wide range of demersal and pelagic species. Catcher vessels operate in both the BSAI and the GOA. They may deliver their catch to on-shore processing plants and in-shore floating processing ships or to motherships and catcher-processors at-sea. Catcher vessels range in size from under 18.3 m (60 feet) to more than 37.8 m (124 feet). Catcher vessels target a number of FMP and state-managed groundfish species, including pollock, Pacific cod, rockfish, flatfish, sablefish, Atka mackerel, and other species. Shorebased and mothership processors depend upon catcher vessels for raw fish for processing.

In 2001, catcher vessels harvested and delivered 932,000 metric tons (mt) of groundfish, representing 47 percent of the total harvest of 1.997 mmt (Table 2.1-1) (Hiatt et al. 2002). The ex-vessel value of groundfish landed by the catcher-vessel fleet in Alaska in 2001 totaled $288.8 million, or 53 percent of the entire ex-vessel value of $542.5 million (Table 2.1-2) (Hiatt et al. 2002; Queirolo, L., June 2003, personal communication). The $288.8 million value includes an implied ex-vessel value from catcher-processors, derived by applying an average reported shoreside processor price, by species, to the retained catch totals for each catcher-processor. Because no actual ex-vessel transaction occurs here, these are only hypothetical values and may not reflect the actual ex-vessel value of these landings.

Catcher vessels reportedly accounted for 789,000 mt or 43 percent of groundfish harvests in the BSAI, and 144,000 mt or 79 percent of the groundfish harvests in the GOA in 2001 (Table 2.1-1). Catcher vessels accounted for an estimated $189 million, or 44 percent of the ex-vessel value of all groundfish harvested in the BSAI in 2001, and $100 million or 85 percent of the ex-vessel value of groundfish harvested in the GOA (Table 2.1-2).

In 2001, catcher vessels using trawl gear accounted for 771,000 mt or 98 percent of the total catcher-vessel harvest of groundfish in the BSAI, followed by vessels using pots that caught 14,000 mt, or less than 2 percent, and vessels using hook and line that caught 2,000 mt, or less than 1 percent. In the GOA, catcher vessels using trawl gear accounted for 119,000 mt, or 82 percent, of the 2001 groundfish catch. They were followed by catcher vessels using hook and line gear that caught 19,000 mt, or 13 percent, and vessels using pots that caught 6,000 mt, or 4 percent, of the total GOA catcher-vessel harvest.

There were 1,285 catcher vessels that caught federally managed groundfish off Alaska during 2001 (Table 2.1-3) (Hiatt et al. 2002). Catcher vessels operating in the GOA totaled 1,115, compared with 308 catcher vessels operating in the BSAI. In 2001, 201 catcher vessels used trawl gear compared with 967 that used hook and line gear and 205 vessels that used pot gear.

C.2.1.1.2 Catcher-Processors

Catcher-processors are vessels that harvest and process seafood and related products at sea. Groundfish catcher-processors include trawlers (both PTR and NPT), hook and line, and pot vessels. Catcher-processor trawlers can be further subdivided as AFA-qualified and non-AFA qualified vessels. The AFA-qualified vessels fish primarily for pollock, Pacific cod, and some flatfish.

Non-AFA qualified vessels fish mainly for flatfish, Pacific cod, rockfish, and Atka mackerel. Catcher-processors range in size from less than 37.8 m (less than 124 feet) to more than 79.2 m (more than 260 feet). Most catcher-processors operate in the BSAI, but other than AFA-qualified vessels, catcher-processors of each gear type also operate in the GOA. Catcher-processors are an important harvesting and processing component of the Alaska groundfish industry.

In 2001, catcher-processors harvested 1.064 mmt of groundfish, or 53 percent of the total groundfish catch of 1.997 mmt (Table 2.1-1). Catcher-processor groundfish harvests of 1.027 mmt occurred in the BSAI, compared with 38,000 mt in the GOA. In 2001, catcher-processors accounted for an estimated total first wholesale product value of $691.6 million for federally managed groundfish species off Alaska, with $664.7 million from the BSAI and $26.9 million from the GOA (Hiatt et al. 2002).

The hypothetical ex-vessel equivalent value of groundfish harvests by catcher-processors totaled $253.7 million, or 47 percent of the total equivalent ex-vessel value of groundfish harvested off Alaska in 2001. Of this total ex-vessel value, $237.1 million or 93 percent occurred in the BSAI and $16.6 million or 7 percent occurred in the GOA (Table 2.1-2). Catcher-processors using trawl gear accounted for $175.8 million of equivalent ex-vessel value or 69 percent of the total catcher-processors groundfish harvest value in 2001, followed by $75.1 million or 30 percent for catcher-processors using hook and line gear, and $2.8 million or 1 percent for catcher-processors using pot gear.

In 2001, 91 catcher-processors caught groundfish off Alaska, with 90 vessels operating in the BSAI and 40 vessels operating in the GOA (Table 2.1-3). Catcher-processors using trawl gear (NPT and PTR) totaled 40 vessels throughout the EEZ off Alaska, with 39 vessels operating in the BSAI and 18 vessels in the GOA. Forty-five catcher-processors used hook and line gear in 2001, with all 45 vessels operating in the BSAI, and 20 of these also fishing in the GOA. Eight catcher-processors used pot gear to harvest groundfish in 2001, with six vessels operating with pot gear in the BSAI and four vessels in the GOA.

In 2001, catcher-processors accounted for an estimated total first wholesale product value of $691.6 million for federally managed groundfish species off Alaska, with $664.7 million from the BSAI and $26.9 million from the GOA (Hiatt et al. 2002).

C.2.1.2 Salmon

The federal government has management responsibility for the salmon troll fishery in the EEZ outside of state waters, but defers management authority over this fishery to the State of Alaska. Most salmon fishing effort and harvest occur within state waters. A variety of harvest methods and gear are employed in the salmon fishery, although only trolling is authorized in federal waters. The major gear groups used include purse seine, drift gillnet, set gillnet, troll, beach seine, and fish wheel. Salmon harvest occurs throughout the State of Alaska, with the most effort and greatest harvest in the state waters adjacent to the GOA and the EBS and considerably less salmon harvest in the AI's state waters. A detailed description of salmon fisheries off Alaska can be found in Sections 3.4.1.5 and 3.4.2.5 of the EIS.

In 2001, 11,160 Alaska Limited Entry salmon permit holders held 11,682 different salmon permits. The number of permit holders making salmon landings totaled 7,306 individuals, fishing 7,372 permits (CFEC Permit Database). A total of 348,740 mt (768.84 million pounds) of salmon were landed, with an ex-vessel value of $229.2 million. Total commercial landings of salmon from state waters adjacent to the EBS totaled 42,180 mt (14 percent), worth $42.2 million (18 percent), and harvested by 4,402 permit holders. Commercial salmon landings from state waters adjacent to the GOA totaled 300,265 mt (86 percent), worth $187.0 million (82 percent), and harvested by 3,050 permit holders. Distribution of catch and value in salmon fisheries changes from year to year, depending on species composition and size of returning runs to individual locations in Alaska, as well as international and domestic market conditions.

C.2.1.3 Crab

The king and Tanner crab fisheries in the BSAI are governed under a federal FMP, but responsibility for management is deferred to the State of Alaska. Crabs are caught by pots and rings in Alaska. Dungeness, king, snow (*Chionoecetes opilio*), Tanner (*Chionoecetes bairdi*), and Korean horsehair crab are the dominant species harvested (not in that order of economic importance). There are 1,622 crab permits issued to 1,236 permit holders (CFEC Permit Database). In 2001, 880 permit holders fished 1,163 permits and caught a total of 20,734 mt (45.71 million pounds) of crab worth approximately $114.5 million at an ex-vessel level (Alaska Department of Fish and Game [ADF&G] 2002).

In 2001, crab catch in the GOA totaled 2,554 mt (5.63 million pounds) with an estimated ex-vessel value of $11.73 million. BSAI crab catches totaled 18,180 mt (40.08 million pounds) with a value of $102.79 million. King crab represented the largest ex-vessel value of crab harvested in Alaska in 2001, at $66.02 million, with $2.37 million (4 percent) harvested from the GOA by 89 permit holders and $63.65 million harvested in the BSAI by 317 permit holders. In 2001, the total ex-vessel value of Tanner crab landings was $43.69 million (including both opilio and bairdi in GOA, opilio only in BSAI). Three hundred and ten permit holders in the GOA accounted for $4.55 million (10 percent) of this total, and $39.14 million (90 percent) was harvested in the BSAI by 220 permit holders.

C.2.1.4 Scallop

The scallop dredge fishery is covered under a federal FMP, but the management of the fishery is the responsibility of the State of Alaska. Scallop fishing occurs in state and federal waters in the GOA and the BSAI. The fishery is managed on a guideline harvest range (GHR) basis, similar to a guideline harvest limit (GHL), by ADF&G registration area. The fishery has 100 percent observer coverage. Scallops are caught by dredge, and shucked onboard the vessel. The fishery evolved from an open access fishery to a limited-entry-permit fishery with nine permitted vessels in 1999. In May 2000, a cooperative was formed among six of the nine scallop vessels. This effectively reduced the number of actively fishing vessels to six, three in the cooperative and three fishing independently. There are three larger vessels greater than 21 m (71 feet) and three smaller vessels less than 21 m (71 feet) operating in the fishery, depending on the year. In the 2001/02 season, four vessels made deliveries of 251.7 mt (554,831 pounds) of shucked scallop meat, worth an estimated $2.91 million at an ex-vessel level. In the 2001/02 season, four vessels made eight landings of scallops totaling 117.8 mt (259,672 pounds) and worth $1.36 million from the Kodiak Registration Area. Catches occurred in both the Northeast and the Shelikof districts. An additional three vessels made five landings of 63.9 mt (140,871 pounds) of scallops worth an estimated $739,572 from the EBS Registration Area.

C.2.1.5 Halibut

Halibut fishing occurs throughout Alaska in the BSAI and GOA. The halibut fishery is primarily managed by the International Pacific Halibut Commission (IPHC). The Council, with approval by the Secretary of Commerce, may develop regulations that are in addition to, and not in conflict with, regulations adopted by IPHC. The halibut fishery off Alaska is a limited-entry fishery, with an individual transferable quota system that allows fishermen to fish a known percentage of the allowable harvest. Halibut are caught mainly with longline gear, but are also taken by hand troll, dinglebar troll, and mechanical jig fisheries. In 2001, there were 3,153 permit holders with 3,288 halibut permits. A total of 2,419 permit holders actively fished 2,461 permits and caught 25,681 mt of halibut, with an ex-vessel value of approximately $110.6 million. Halibut fisheries are important economic, social, and cultural components of many Alaska coastal communities, particularly in the GOA and the Pribilof Islands.

C.2.2 Processing Sector

There are three main components to the seafood processing industry in Alaska: shoreside processors (both onshore and fixed floating), mothership-processors, and catcher-processors. Shoreside processors and mothership-processors depend on catcher vessel deliveries of raw catch. Catcher-processors process the fish they catch themselves and occasionally take deliveries of catch over the side from catcher vessels. Crab and groundfish are processed by all three components of the Alaska processing industry. Salmon and herring typically are processed by shoreside processors. Halibut are processed at shore plants. Scallops are shucked at sea on the catcher vessels, and the meats are delivered ashore. Three motherships operating in the EBS take deliveries of pollock and Pacific cod.

In recent years, ADF&G has reported 364 active processors, composed of 195 catcher-processors, 146 shoreside processors, and 23 floating processors. In 2001, 69 shoreside processors (including non-mothership floating processors), 88 catcher-processors, and 3 motherships participated in groundfish processing. Ten shoreside processors, seven catcher-processors, and three shoreside floating processors participated in crab processing. Within the catcher-processor fleet that targeted groundfish in 2001, 44 vessels used hook and line, producing $126.1 million in products at the first wholesale level; 39 vessels used trawl gear, producing $559.5 million in products; and 6 vessels used pot gear, producing $4.38 million in products (Hiatt et al. 2002).

In 2001, shoreside processors produced a total of $1.376 billion in seafood and related products. In 2001, a total of 69 shoreside processors produced $609.5 million of groundfish products, 115 shoreside processors produced $512.9 million of salmon products, 54 shoreside processors produced $121.3 million of crab products, 73 shoreside processors produced $112.0 million of halibut products, and 48 shoreside processors produced $20.2 million of other seafood and related products (ADF&G Commercial Operators Annual Report, ADF&G Intent to Process) (Table 2.2-1).

C.2.3 Dependent Communities

Analysis of community dependency and impacts is guided by National Standard 8 under the Magnuson-Stevens Act, along with associated guidelines. National Standard 8 states the following:

> Conservation and management measures shall, consistent with the conservation requirements of this [Magnuson-Stevens] Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities and (B) to the extent practicable, minimize adverse economic impacts on such communities (Sec. 301(a)(8)).

The Magnuson-Stevens Act defines a ‘fishing community’ as “...a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and United States fish processors that are based in such community” (Sec. 3 [16]). NMFS further specifies in the National Standard guidelines that a fishing community is “...a social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries dependent services and industries (for example, boatyards, ice suppliers, tackle shops)” (63 FR 24235, May 1, 1998). ‘Sustained participation’ is defined by NMFS as “...continued access to the fishery within the constraints of the condition of the resource” (63 FR 24235, May 1, 1998). Consistent with National Standard 8, this section first identifies affected regions and communities and then describes and assesses the nature and magnitude of their dependence on and engagement in the fisheries relevant to this analysis.

C.2.3.1 Regional Fishery Dependence Profiles

The groundfish catcher-vessel fleet that harvests in areas potentially directly affected by regulations associated with any of the alternatives being considered is large and widely dispersed among many communities. In addition to harvesting groundfish, these vessels also participate in a number of other fisheries, some of which may also be indirectly affected by the various alternatives. Table 2.3-1 provides a count of groundfish catcher vessels harvesting in areas potentially affected by one or more of the alternatives (based on 2001 data) by the community of residence of the vessel owner. This table also contains information on the participation of these vessels in specific groundfish fisheries, as well as in halibut, crab, scallop, salmon, and herring fisheries. As shown, 223 Alaska-owned groundfish vessels from 28 communities participate in the various potentially affected fisheries. Ownership of many vessels is concentrated in relatively few communities. Communities with 5 or more vessels include King Cove (13 vessels), Sand Point (28 vessels), Unalaska (5 vessels), Anchorage (11 vessels), Anchor Point (8 vessels), Homer (51 vessels), Nikolaevsk (5 vessels), Kodiak (53 vessels), Willow (5 vessels), and Cordova (9 vessels). In addition to the Alaska vessels, the affected groundfish catcher-vessel fleet includes 47 vessels from 22 Oregon communities (dominated by Newport, with 19 vessels), 119 vessels from 36 Washington communities (dominated by Seattle with 69 vessels), and 15 vessels from communities in other states. Due to confidentiality restrictions, data for many individual communities cannot be disclosed. Table 2.3-2 provides a distribution of groundfish catcher vessels by aggregated area, and Table 2.3-3 provides value of harvest data by these same regional groupings.

Mobile groundfish processors (motherships and catcher-processors) operating in areas potentially directly affected by one or more of the alternatives (or processing catch from catcher vessels harvesting in those areas) are much fewer in number, and the ownership of these vessels is concentrated in very few communities. Like groundfish catcher vessels, in addition to harvesting groundfish, these vessels also participate in a number of other fisheries, some of which may also be indirectly affected by the various alternatives. Table 2.3-4 provides a count of motherships and catcher-processor vessels potentially affected by one or more of the alternatives (based on 2001 data) by community of residence of the owner of the vessel. This table also contains information on the participation of these vessels in specific groundfish fisheries, as well as in halibut, crab, scallop, salmon, and herring fisheries. As shown, all four motherships potentially affected under any of the alternatives have Seattle-based ownership. Among catcher-processors, 13 Alaska-owned vessels from 8 communities participate in the various potentially affected areas, and 5 of these communities have more than 1 similarly situated vessel (Unlaska, Anchorage, Kodiak, and Sitka each have 2, and Petersburg has 3). In addition to the Alaska vessels, 68 catcher-processors from 9 Washington communities would be affected by one or more of the alternatives. Of the Washington vessels, most (57) are from Seattle. Edmonds and Bellingham have three and two catcher-processors, respectively, and no other Washington community has more than one. Four potentially affected catcher-processors are owned in states other than Alaska and Washington. Due to confidentiality restrictions, regional distribution data must be highly aggregated for the mobile processing sector. Table 2.3-5 provides a distribution of mobile processing vessels by state, and Table 2.3-6 provides value of harvest data by these same groupings.

One change in vessel ownership patterns in recent years has been an increase in direct ownership by CDQ groups. These groups include the Bristol Bay Economic Development Corporation (BBEDC), the Aleutian Pribilof Islands Community Development Association (APICDA), the Central Bering Sea Fisherman's Association (CBSFA), the Coastal Villages Region Fund (CVRF), the Norton Sound

Economic Development Corporation (NSEDC), and the Yukon Delta Fisheries Development Association (YDFDA). These groups have been using their CDQs to leverage capital investment to increase both harvesting and processing capacity. Acquisition of ownership interest in commercial fishing operations and other fisheries-related enterprises is one important means of directly adding to a CDQ group's economic sustainability, consistent with the program's mandate.

CDQ equity acquisitions in vessels through 2000 are presented in Table 2.3-7. As shown, all six CDQ groups have acquired ownership interests in the offshore pollock processing sector, while four of the groups have ownership interest in entities that process groundfish species in addition to pollock. In most of the mobile processing ventures in which CDQ groups have invested, the groups are minority owners; however, the revenues derived from these investments may be substantial. In terms of harvest vessels, as shown in Table 2.3-7, all groups have acquired interests in harvest vessels, and these span a number of vessel size classes, gear types, and target species. Ownership interests in harvest vessels range from minority to exclusive ownership, with the latter being more common in smaller vessel classes. In addition, two groups, APICDA and NSEDC, have invested in inshore processing plants that process a range of species (Table 2.3-8). These inshore plants include both shore-based and floating processing facilities.

Many onshore and inshore floating groundfish processing vessels (that is, floaters) process catch from vessels that obtain at least some of their harvest from areas potentially directly affected by at least one of the alternatives. In addition to processing groundfish, these processors also participate in a number of other fisheries, some of which may be indirectly affected by the various alternatives. Table 2.3-9 provides a count of groundfish processors that receive catch from vessels harvesting in areas potentially affected by one or more of the alternatives (based on 2001 data) by community of operation for the facility. This table also contains information on the participation of these operators in specific groundfish fisheries, as well as in halibut, crab, scallop, salmon, and herring fisheries. As shown, 2 floaters and 71 shore plants in 41 Alaska communities participated in the various potentially affected fisheries, along with 2 floaters and 1 shore plant that are coded in the data as operating in Washington. Due to confidentiality restrictions, processing value data can be disclosed for only a few communities. Table 2.3-10 provides a distribution of groundfish shoreside processors by aggregated area, and Table 2.3-11 provides ex-vessel value of catch delivered to these processors by affected catcher vessels by these same regional groupings.

In addition to the groundfish fishery, entities participating in a number of other fisheries would be potentially affected by at least one of the alternatives (Alternative 6). Predominant among these would be the crab and halibut fisheries. The crab catcher-vessel fleet that harvests in areas potentially affected by any of the alternatives being considered is large, but is less widely dispersed among communities than is the groundfish catcher-vessel fleet. Table 2.3-12 provides a count of crab-catcher vessels harvesting in areas potentially affected by at least one of the alternatives (based on 2001 data) by community of residence of the owner of the vessel. As shown, 50 Alaska-owned crab vessels from 11 communities participate in the potentially affected fisheries. Fully half (25) of the vessels are owned by Kodiak residents. Residents of no other single Alaska community own more than 6 potentially affected vessels. Communities with two or more vessels include King Cove (two vessels), Sand Point (three vessels), Anchorage (five vessels), Homer (six vessels), Sitka (two vessels), and Petersburg (three vessels). In addition to the Alaska vessels, the affected crab catcher-vessel fleet includes 17 vessels from Oregon (including 11 from Newport), 111 vessels from Washington (including 78 from Seattle), and 2 vessels from other states. Due to confidentiality restrictions, data for many individual communities cannot be disclosed. Table 2.3-13 provides a distribution of crab catcher vessels by aggregated area, along with associated ex-vessel harvest values. Only six crab catcher-processors would be affected by any alternative (only Alternative 6). Of these, five are owned by residents of Seattle, and one is owned by a resident of Kodiak.

The halibut catcher-vessel fleet that harvests in areas potentially affected by any of the alternatives being considered is large and widely dispersed among numerous communities. Table 2.3-14 provides a count of halibut catcher vessels harvesting in areas potentially affected by at least one of the alternatives (based on 2001 data) by community of residence of the owner of the vessel. As shown, 358 Alaska-owned halibut vessels from 44 communities participate in the potentially affected fisheries. Communities with 5 or more vessels include Sand Point (13 vessels), Anchorage (12 vessels), Juneau (18 vessels), Homer (44 vessels), Seward (8 vessels), Anchor Point (5 vessels), Ketchikan (14 vessels), Kodiak (90 vessels), St. George (8 vessels), Craig (7 vessels), Sitka (41 vessels), Port Alexander (8 vessels), Cordova (7 vessels) and Petersburg (38 vessels). In addition to the Alaska vessels, the affected halibut catcher-vessel fleet includes 31 vessels from Oregon (with only Woodburn [7] and Newport [6] having 5 or more vessels), 92 vessels from Washington (with only Seattle [25], Anacortes [11], Port Townsend [7], and Edmonds [5] having 5 or more vessels), and 9 vessels from other states (with 1 unknown). Due to confidentiality restrictions, data for many individual communities cannot be disclosed. Table 2.3-15 provides a distribution of halibut catcher vessels by aggregated area, along with associated ex-vessel harvest values. Although some halibut is processed by catcher-processors, there is no specialized halibut catcher-processor fleet similar to that for groundfish and crab.

Existing conditions for the scallop fishery have changed substantially in recent years with the implementation of a license limitation system and the formation of a co-op within the fishery. In at least some recent years (since 1998), multiple vessels from Kodiak, along with single vessels from Kenai, Anchorage, and Ester, Alaska, show harvests in the areas that would be affected by at least one alternative. However, 2001 data show that only three scallop catcher-processors fished in potentially affected areas, none of which was owned in Alaska; two were from Washington, and one was from another state.

C.2.3.2 Regional Socioeconomic Profiles

Regions and communities engaged in and/or dependent upon the fisheries encompassed by this RIR span a large portion of coastal Alaska and include communities in the Pacific Northwest as well. These regions vary considerably in their socioeconomic structure, and include communities of widely varying scales from small, relatively isolated Alaska Native villages to the greater Seattle metropolitan area. The specific geographic footprint of engagement with or dependence upon commercial fishing varies by the specific fishery involved. For example, many communities are engaged in the groundfish fisheries, while the scallop fishery involves few communities in a relatively small area.

With the exception of Alternative 6, impacts on dependent communities from each of the alternatives, where they occur, would result from alternative-driven changes to groundfish fisheries (and associated indirect and induced impacts). Regional socioeconomic profiles specific to the groundfish fisheries are available in a recently prepared summary (Downs 2003), and a more detailed treatment with individual community profiles may be found in the *Sector and Regional Profiles of the North Pacific Groundfish Fisheries* (posting date 01/28/02) available on the Council website (http://www.fakr.noaa.gov/npfmc/). While directed at groundfish fisheries, these profiles also contain a considerable amount of information on harvester and processor diversity on a regional basis with respect to crab, salmon, and halibut fisheries.

In addition to the groundfish fisheries, Alternative 6 also has the potential to result in significant impacts to communities through direct changes in the crab, scallop, and halibut fisheries. A recently prepared summary document (Downs 2003) presents regional and community information on the crab fisheries, and more detailed information on individual crab fishing communities may be found in the BSAI Crab Fisheries SEIS Appendix 3: Social Impact Assessment (draft release in process). Information on the regional distribution of the scallop and halibut fisheries may be found in Sections 3.4.1.4.4 and 3.4.2.1.4, respectively, of the EFH EIS. The scallop fishery has few participating entities, and vessel ownership (and landings) within Alaska are tightly concentrated in the Kodiak and Cook Inlet areas. Socioeconomic profiles of these areas are contained within the groundfish regional information. The halibut fishery spans a wide area and involves dozens of communities. While recent socioeconomic profile information is not available at the same level of detail for the overall area encompassed by the halibut fishery as for the groundfish and crab regions and communities, considerable information on the socioeconomic context of key communities for the analysis of Alternative 6 (e.g., St. Paul) is available in both the groundfish and crab sources noted previously.

Beyond those communities directly engaged in the fishery through local fleets or processing, a number of communities in the community development quotas (CDQ) region could experience impacts as a result of the effect of the alternatives. Socioeconomic profile information specific to the CDQ region may be found in the Steller Sea Lion Protection Measures SEIS (NMFS 2001) and in an updated form in the BSAI Crab Fisheries SEIS Appendix 3: Social Impact Assessment (draft release in process). Regional demographic information relevant to environmental justice considerations may be found in these same sources, as well as in a recently prepared summary specific to EFH considerations (Downs 2003).

C.3 ANALYSIS OF ALTERNATIVES

As previously referenced, NMFS guidance for preparation of RIRs provides that "At a minimum, the RIR . . . should include a good qualitative discussion of the economic effects of the selected alternatives. Quantification of the effects is desirable, but the analyst needs to weigh such quantification against the significance of the issue and available studies and resources" (NMFS 2000(d), page 2).

Data limitations largely preclude a quantitative analysis of the relative economic and socioeconomic impacts of the several proposed actions. Data deficiencies include the following:

1. Cost and operating structure of the groundfish, halibut, salmon, crab, or scallop (i.e., potentially affected) segments of the industry
2. The linkages between changes in fishing behavior and catch per unit of effort, PSC, and bycatch rates
3. Probable operational adjustments and coping strategies (e.g., effort redeployment patterns) that may be adopted by various elements of the industry in response to one or another of the proposed EFH fishing impact minimization alternatives
4. Market demand and price responses to supply shocks (e.g., reduced quantities; changes in timing, quality, or product form; etc.)
5. Affiliation and ownership linkages (both horizontal and vertical), which may influence the economic viability of any given operation following a significant structural change in the fishery that is attributable to adoption of an EFH fishing impact minimization alternative

Therefore, except in the specific case of differential impacts on gross revenues attributable to each of the six primary alternatives (treated in Section 1.4), the ability to quantitatively distinguish between the effects of the suite of fishing impact minimization alternatives (and options) is quite limited within this analysis. With the single exception of gross revenues, the balance of the regulatory impact analysis is primarily limited to characterizing the nature, probable direction, and (in some cases) the likely gross magnitude of attributable economic and operational impacts accruing from these alternatives. Impacts have been monetized wherever possible and appropriate.

C.3.1 Approach in this Analysis

The first section of the analysis of each alternative presents potential benefits attributable to, or deriving from, the alternative fishing impact minimization measures under consideration by NMFS and the Council. The second section of the analysis of each alternative presents the costs associated with the fishing impact minimization measures under consideration. These analyses are conducted from the point of view of all citizens of the United States; that is, they seek to address the question: "What is likely to be the net benefit to the nation?"

The costs and the benefits of the EFH alternatives would not be homogeneously distributed across the population. Many of the costs, in particular, are highly concentrated on particular fishing industry components affected by the different EFH habitat protection alternatives, on fishing communities dependent on that industry component, and on sectors of the economy that supply goods and services to, or otherwise support, that industry component. Therefore, the second part of the analysis (beginning in Section 3.2.3 for Alternative 1) reviews and evaluates, to the extent practicable for each alternative, the distribution issues and the implications of fishing impact minimization measures. Section 3.9 summarizes these benefits, costs, and distribution impacts across all alternatives under consideration for EFH protection.

The fishing impact minimization alternatives discussed in this analysis address concerns that ongoing fishing activity may be adversely modifying habitat, faster than the habitat can renew itself. In economic parlance, one might say that ongoing fishing activity is consuming fish habitat and by implication, potentially depleting its ability to provide a range of ecological services. The EFH fishing impact minimization alternatives are premised on the idea that society can consume the habitat and enjoy its ecological services (including fish production) now, or that it can defer that consumption and enjoy those services in the future. This tradeoff between present and future consumption of EFH reflects the underlying investment nature of the problem the alternatives seek to address. The overarching economic options are to (a) continue (perhaps even increase) current consumption of habitat services, with consequent increased costs and reduced benefits, or (b) invest in long-term resource productivity by deferring consumption of these assets until some future time. The expectation, not yet confirmed, for the proposed EFH action is that by reducing the rate of exploitation of EFH (i.e., net benefits from fishing) in the short term, society will have invested in sustaining (perhaps even enhancing) habitat and will enjoy larger net benefits over the longer term.

The benefits associated with the fishing impact minimization measures are addressed in Section 3.1.1 under two major headings, as follows:

1. Passive-use (or non-use) benefits
2. Use benefits (including non-consumptive use benefits, consumptive use benefits, non-market benefits, and market benefits) and productivity benefits

The results of the analysis of benefits under each alternative are presented in Sections 3.2.1 through 3.9.1 and are compared among alternatives in Section 3.10.

The costs associated with the fishing impact minimization measures are addressed in Section 3.1.2 under eight major headings:

1. Revenue at risk
2. Product quality and revenue impacts
3. Operational costs
4. Safety impacts
5. Impacts on related fisheries
6. Costs to consumers
7. Management and enforcement costs
8. Impacts on dependent communities

Costs associated with each of the alternatives are presented in Sections 3.2.2 through 3.9.2 and compared among alternatives in Section 3.10.

The distributional impacts on revenue at risk are summarized in three subsections under the following headings.

1. Geographic area—EBS, AI, and GOA
2. Fishery—groundfish, salmon, crab, scallop, halibut, and other fisheries
3. Fleet component—catcher vessels and catcher-processors

Distributional impacts are also presented for dependent communities in terms of tax revenues, other community impacts, and CDQ groups.

The distributional impacts associated with each of the alternatives are presented in Sections 3.2.3 through 3.9.3 and compared among alternatives in Section 3.10.

The methodology described below is relevant to the approach taken for each alternative considered and for the comparison of benefits, costs, and impacts among alternatives.

C.3.1.1 Benefits

C.3.1.1.1 Passive-use Benefits

It can be demonstrated that society places economic value on relatively unique environmental assets, whether or not those assets are ever directly exploited. For example, society places real and potentially measurable economic value on simply knowing that a rare or endangered species of animal or plant is protected in the natural environment. The term 'value' is used, in the present context, as it would be in a cost-benefit analysis (i.e., what would people be willing to give up to preserve and/or enhance the asset being assessed?). Because no market, in the traditional economic sense, exists within which EFH (at least in waters of the EEZ off Alaska) is bought, sold, or traded, there is no institutional mechanism wherein a market clearing price may be observed. Such a market clearing price would typically be used to estimate a consumer's willingness-to-pay to obtain the goods or services being traded. Nonetheless, EFH does have economic value, as demonstrated by the current public debate over its preservation and enhancement.

Among those holding these values, there is no expectation of directly using this asset in the normal sense of that term. Whether referred to as passive-use, non-use, or existence value, the underlying premise is that individuals derive real and measurable utility (i.e., benefit) from the knowledge that relatively unique natural assets remain in a comparatively undisturbed state.

Economists define the EFH passive-use value as a public good. A pure public good has the following features: 1) no one can be prevented from enjoying it once it is produced, and 2) one person's enjoyment of the good does not detract from enjoyment of that public good by another person.

Under these conditions, there is a tendency for private sector markets and actions to produce too little of the good. After all, a private firm would have a hard time recovering its costs and realizing a profit if it could not prevent people from consuming (i.e., using or taking enjoyment from) the good once it has been produced. Moreover, from society's point of view, if one person's enjoyment of the good does not reduce another person's opportunity to enjoy it, one might not want to restrict or otherwise ration access, once the good has been produced. For these reasons, private behavior will tend to produce less of a public good than is socially optimal. In other words, private behavior will not sufficiently protect EFH, a public good.

The absence of a traditional economic market for a public good like habitat preservation also makes it hard for economists to place monetary values on the proposed fishing impact minimization measures, whether in the aggregate or with respect to any one of the suite of potential actions under consideration by the Council within the scope of this EIS/RIR.

The concept of passive-use value is well established in economic theory, supported by a growing body of empirical literature, increasingly employed in both public and private valuation analyses, and accepted by most as a legitimate, appropriate, and necessary aspect of natural resource policy and management decision-making. In point of fact, there is no theoretical reason to limit these non-market, passive-use values exclusively to natural assets, although natural assets are the focus of the current analysis. One may reasonably hypothesize that, for example, there exists substantial passive-use value associated with preservation of antiquities, such as the great pyramids of Egypt.

At present, the only widely accepted means of estimating passive-use values is by surveying people to find out what they would be willing to pay (or willing to accept, depending upon with whom the implicit property right resides) for any given action that affects a resource for which non-market values are hypothesized to exist. This approach is termed the 'contingent value' method (CVM). A substantial body of empirical literature has developed, over perhaps the last 25 years, describing the application of this technique to the valuation of natural resource assets. The use of CVM has also been carefully reviewed and accepted (when employed appropriately) by the federal courts (*Ohio v. United States Department of the Interior*, 880 F.2 432 [D.C.Cir. 1989]), as well as by NOAA (58 Federal Register 4601, 4602-14 [1993]).

Empirical research on passive-use value, within the broad context of natural resources, suggests that these economic values may be substantial when they exist. When the public is consciously aware of risks posed to a unique asset (e.g., the Amazon rain forest), they often reveal significant willingness-to-pay values for its protection. In that particular example, there is empirical evidence to support the existence of significant passive-use values (e.g., cash donations to various *Save the Amazon Rain Forest* groups or efforts, celebrity-sponsored fund raisers and large monetary donations to the cause, outright purchase of at-risk land, or acquisition of use-rights to at-risk land, etc.). Closer to home, a USDA Forest Service (Forest Service) study that used contingent valuation to measure the value the public places on the existence of critical habitat for the northern spotted owl indicated that Oregon residents were willing to pay between $49.6 million and $99 million (or $28 per acre) (Loomis et al. 1996).

Notwithstanding the examples referenced above, another issue complicates an assessment of the passive-use value of EFH. Typically, passive-use values have been associated with unique, rare, and widely recognized natural assets (e.g., the Grand Canyon of the Colorado). Indeed, more often than not, CVM analyses of passive-use values involve actions that propose to enhance, protect, or mitigate adverse effects on high profile organisms. In the literature, these are referred to as charismatic mega-fauna, and they include such animals as, the great whales, pandas, lions, tigers, and bears.

With respect to EFH, the values at stake are what economists refer to as marginal values; that is, the values are associated with changes in the characteristics of EFH, not in the presence or absence of EFH itself. Any region of EFH will have a wide range of characteristics. These may include the relative proportions of different sea bed types, locations of corals or other living structures, water temperature, salinity, distribution of vegetation, and so on. Fishing activity may change the nature, productivity, and value of the habitat by altering these characteristics in different ways. For example, unrestricted use of a bottom tending gear type may totally eliminate corals and alter the relative proportions of vegetation types, but leave salinity unchanged. The passive use values that society places on different regions of habitat will depend on these characteristics and can be expected to change as various combinations of characteristics of a particular region change.

It is these changes in the character of the habitat, and the consequent changes in the valuation of that habitat, that are at issue. This has two implications for this discussion: 1) estimates of the total value placed on a 'pristine habitat' do not shed light on the costs and benefits of fishing impact minimization alternatives that make marginal changes in the habitat, and 2) potential valuation methods must go beyond questions that simply elicit valuations of undisturbed habitat from respondents. Most bottom habitat in the Aleutian Islands management area has, it is believed, not been impacted in any way by commercial fishing gear. The methods must yield information on how respondent values will change as the vector of habitat characteristics changes.

In the current context, while EFH is clearly valuable because it contributes to the existence and productivity of many living assets for which both market and non-market values exist (e.g., commercial species of fish and shellfish, Steller sea lions, sea birds, and whales of various species), isolating a passive-use value unique to EFH in the EEZ off Alaska presents conceptual problems. While society's desire to preserve and enhance EFH may be regarded as a derived demand because it provides an ecological service that supplies an input to the production of goods and services from which society derives direct consumptive benefit, passive-use values are in addition to the value obtained from derived goods and services. It seems probable that a portion of the willingness to pay for goods and services obtained from the living marine resources of the BSAI and GOA, whether or not it is revealed in a market, has embedded in it the value of EFH. Few holders of these values would likely be able to either explicitly recognize or express them.

That does not imply, however, that these values do not exist, or that with sufficient time and expertise, they could not be measured. It simply means that, to the best of the analysts' knowledge, there has been no study published to date concerning the passive-use value of EFH. Therefore, at present, it is not possible to provide a specific monetary estimate of the passive-use value that is hypothesized to be associated with one or another of the proposed fishing impact minimization alternatives.

While the absence of empirical treatment of these EFH passive-use values is a limitation of the current benefit/cost analysis, previous passive-use value studies provide some basic guidance to decision-makers and the public in evaluating the benefits of protecting EFH, as summarized by the following three points:

(1) Society places a value on habitat for its own sake (i.e., direct benefit), as well as for its role in the functioning of the ecosystem and production of marketable consumptive-use and non-consumptive-use goods (i.e., indirect benefit). The passive-use value placed on habitat by society may differ with the public's perception of the role of the specific habitat in the ecosystem. For example, wetlands habitat may be perceived by the public to be of greater passive-use value than, say, desert sand habitat or Arctic pack ice habitat.

(2) The public perception of passive-use value for marine habitat may be dependent upon how unique that habitat is believed to be within the ecosystem. For example, a relatively rare, long-lived coral habitat's passive-use value as EFH may be perceived to be higher, by the public, than common mud habitat. Therefore, there may be differences in the value society places on EFH, depending upon its specific characteristic.

(3) The likelihood that any given proposed protection measure (e.g., limits on bottom contacting fishing gear, or spatial or temporal area restrictions) will succeed in protecting the habitat may also influence the public's willingness to pay to support an action.

While it is not possible at this time to provide an empirical estimate of the social value attributable to protection of EFH in the EEZ off Alaska, it is implicit in the fishing impact minimization measures that each of the alternatives to the status quo (i.e., Alternative 1) would be expected to yield an incremental social benefit over the baseline condition. That is, it is assumed that each of the alternatives yields some additional protection for EFH from fishing gear impacts, compared to retention of the status quo.

A non-economic, highly simplified physical measure of the expected reduction of attributable fishery impacts on EFH is provided, by area and type of habitat protected, for each alternative considered in the EIS and RIR. This assessment of the comparative contribution of each alternative to the potential EFH benefit stream to society is by necessity limited to an estimate of the area (i.e., square kilometers) that would be protected by the provisions of each alternative designed to minimize fishing impacts on EFH. They are accompanied by a qualitative description of the associated type(s) of habitat explicitly protected under each alternative.

C.3.1.1.2 Use and Productivity Benefits

As noted above, passive-use value (e.g., existence, bequest value) is often regarded as a non-use value because it does not depend on actual or even potential interaction between the person holding the value and the resource being valued. This section addresses values associated with direct use of the resource. Among these use-benefits are several categories: market and non-market, as well as consumptive and non-consumptive uses. Each is addressed below, within the context of its potential relationship to fishing impact minimization measures.

Non-market/non-consumptive uses are, in general, associated with private recreation or leisure activities. The typical example of such a use is bird watching. The user does not enter into a market transaction to acquire access of the resource (here, wild birds), nor does his or her use consume the resource. In the current context, it seems unlikely that non-market/non-consumptive values represent an important aspect of the aggregate benefit attributable to EFH off the coast of Alaska.

Non-market/consumptive uses may include, within the current context, authorized subsistence use of elements of EFH off the coast of Alaska. Some Alaska Native populations have retained the right to exploit the resources of EFH for customary and traditional subsistence activities. It is reported, for example, that subsistence users actively seek out and harvest black and red deepsea corals for use in the production of Native art. There may be other EFH resources from which subsistence users derive value through direct consumption. These extra-market consumptive uses represent a benefit that would be enhanced by EFH protective measures designed to minimize adverse impacts from commercial fishing gear. They are, therefore, appropriately listed among the gains society may expect from adoption of one or more of the alternatives to the status quo. It is not possible, given currently available information, to estimate the size or distribution of this category of benefits.

Market/non-consumptive uses comprise activities that involve a market transaction to acquire access to the resource, but do not involve consumption of the resource. Within the broader context of EFH located in other parts of the United States, an example of this use would be commercial dive services that take tourists out to scuba dive on coral reef formations. It is unlikely, given the geographic location and depth of most of the EFH identified with the subject action, that market/non-consumptive values represent a significant portion of the benefits deriving from this resource off the coast of Alaska.

Analogous market/consumptive uses are also unlikely to represent a significant element in the overall benefit accruing from protection and enhancement of EFH off Alaska, for many of the reasons just identified for market/non-consumptive uses. However, two associated classes of market/consumptive-use values may be identified in connection with fishing impact minimization measures off Alaska, including opportunity reservation value (future consumptive-use value)[1] and production and yield of FMP and other species (consumptive-use value).

Opportunity reservation value is defined here to mean a societal value distinct from traditional option value, the latter being an individually held form of future use value. In this instance, the value being defined may be regarded as a collective hedge against irreversible loss of some highly valuable good or service, flowing from EFH, that has not yet been recognized. That is, ecosystems such as those that comprise EFH are enormously complex and, as yet, not well understood. EFH may provide some future consumptive use benefit that is not currently used, or even identified. For example, minimizing the adverse effects of fishing practices on EFH may preserve a species of plant or animal or an ecological process that, in the future, may prove to have irreplaceable, tangible value to the world's population. Such examples already exist. Specifically, marine sponges have yielded valuable medicinal compounds for use in anti-malaria and HIV infection suppression drugs (Bishop Museum 2000). At present, it is not known whether or how many of these potentially valuable species or functions exist and, therefore, it is not possible to place a monetary value on their future use. Retention of the option to exploit these public assets in the future clearly has some reservation value, and argues for a precautionary management approach (i.e., erring on the side of preserving these assets).

Production and yield of FMP and other species is another class of market/consumptive-use value considered here. Congress defined EFH as "… those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The EFH regulations further interpret the definition as follows:

> Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to

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[1] See, also, the treatment of "Quasi option value" – the value of preserving a future option given an expectation of the growth of knowledge. In: Pearce, David W. and R. Kerry Turner, *Economics of Natural Resources and the Environment*, Johns Hopkins Press, 1990.

> support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and spawning, breeding, feeding, or growth to maturity covers a species' full life cycle.

The amended Magnuson-Stevens Act requires NMFS to minimize damage to EFH from fishing practices, to the extent practicable. Additionally, the Act requires federal agencies that authorize, fund, or conduct activities that may adversely affect EFH to work with NMFS to develop measures that minimize damage to EFH. While NMFS does not have veto authority over federal projects adversely affecting EFH, this mandate enables NMFS to provide guidance to federal action agencies on ways to tailor their projects to minimize harm to EFH. The amended Magnuson-Stevens Act states that EFH conservation will lead to more robust fisheries, providing benefits to coastal communities and commercial and recreational fisheries alike. This assumes that minimizing damage to EFH from fishing practices will sustain or even increase the production and yield from FMP-managed species and other species important to the fishing industry in Alaska, as well as enhance the contribution of these species to a healthy ecosystem.

Current knowledge permits only a highly conditional evaluation of the effects of fishing on general classes of habitat features and allows only broad connections to be drawn between these features and the life history processes of some managed species. The level of effects on the stocks or potential yields of these species cannot be estimated with current knowledge. An expectation of substantial recoveries, directly attributable to implementation of measures to minimize the effects of fishing on EFH, would require the presence of a species with a clear habitat limitation and consequent poor stock condition. Alaska fisheries include no such clear cases. Therefore, no quantifiable or even qualitative measure of sustained or increased yield in production or biomass of FMP species is available for this analysis. That is, based upon currently available scientific data and understanding of these fishery and habitat resources, it is not possible to measure any economic benefits linked to the biological or ecological changes attributable to the proposed EFH action.

C.3.1.2 Industry Costs

C.3.1.2.1 Revenue at Risk[2]

The economic law of demand (e.g., a downward sloping demand curve) suggests that (assuming all other factors are held constant), if fewer units of a normal good or service are supplied, the individual unit price would be expected to rise. This means that, within the limits of this model, and the context of this action, if fewer fish of a given species are harvested, then fishermen should receive more for each unit of that species they continue to catch and deliver to the market, all else equal. Any increase in price that would actually occur would depend on, among other things, how responsive the price consumers are willing to pay is to changes in the quantity of catch supplied. The consumers' willingness to pay more for these products is dependent upon how unique the products are; that is, whether the consumer can substitute a lower cost alternative product. Very little empirical information is available at this time concerning the responsiveness of price to quantity supplied for the species and product forms potentially affected by the EFH alternatives. (Some preliminary work on this subject, specific to pollock, Pacific cod, and Atka mackerel, was undertaken in connection with the Stellar Sea Lion Reasonable and Prudent

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[2] Revenue at risk should be regarded as an upper-bound estimate. That is, it represents a projection, based upon historical effort and landings data, of the gross value of the catch that would be foregone as a result of one or more provisions of the proposed action, assuming none of that displaced catch could be made up by shifting effort to another area. In many cases, this will not be the case. Therefore, the true impact on gross revenue is likely to be smaller than the estimated revenue at risk, although that is not assured.

Alternative [RPA] RIR Appendix D [NMFS 2001b]. Interested readers may consult that report for additional detail.)[3]

Increased revenue accruing from such a per-unit price rise would be a benefit to primary producers (i.e., fishermen), offsetting an indeterminate amount of the increased operational costs they would be expected to incur through adoption of any one of the proposed fishing impact minimization alternatives to the status quo. However, to the extent that these fishery products are consumed in the United States, this producer benefit would be, to a very large extent, offset by a reduction in consumer welfare from the increase in price. That is, the benefit to the industry would simply be the result of a transfer from consumers. Thus, under these conditions, this hypothesized supply-induced price increase would create no net benefits that could be revealed in a cost-benefit analysis for domestically consumed fish. Quantity changes under some alternatives under consideration in this action (e.g., Alternative 2) may be small enough to have no perceptible impact on prices, while under other alternatives (e.g., Alternative 6) they may. It is not possible, at this time, to estimate the likelihood or magnitude of these price effects.

Alternatively, to the extent that these fish are exported and consumed outside of the United States, any supply-induced price increase would create an attributable net benefit improvement to the nation, from a cost/benefit perspective. This is because the price increase would accrue, in the form of increased gross revenues, to United States producers, while the loss in consumer welfare would be imposed on citizens of other countries. Under OMB guidelines, costs incurred by (and, for that matter, benefits accruing to) foreign producers and consumers are excluded from the net benefit analysis performed in a Regulatory Impact Analysis. Such changes would (all else equal) have no effect on net benefits to the nation.

The remainder of this section examines the expected potential impacts on industry gross revenues attributable to reductions in seafood and other fish-based products being delivered to market (aside from the price effect), including the potential risk of loss of market share.[4] Accurate estimates of the change in gross revenues from reduced production associated with the fishing impact minimization alternatives require information on 1) the volume of production coming from fishing areas that would be affected by each of the fishing impact minimization measures, for each of the fleet sectors; 2) the extent to which each fleet sector would re-deploy displaced fishing effort into other fishing areas in an attempt to mitigate the loss of production from the areas directly affected by the fishing impact minimization measures; and 3) the relative productivity of the fleet sectors in the new areas compared with the EFH-affected areas.

Currently, it is possible to estimate only the first of these (i.e., the volumes of production coming from areas that would no longer be available to fishermen under each of the alternatives). However, estimates of the volumes of production coming from fishing areas restricted by the fishing impact minimization measures, combined with data on historical ex-vessel and/or first wholesale prices, allows estimates of the gross revenues, for each fleet sector, potentially placed at risk under the different alternatives. To better place these impacts in a comparable empirical context, an analytical approach is adopted here, in which the question evaluated is expressed as follows: “What would the effects of these alternatives have

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[3] In an early draft of the cited Stellar Sea Lion (SSL) Appendix D, some very preliminary econometric estimation of seafood demand was attempted. While the effort was commended by reviewers (e.g., SSC), it was deemed to be premature for inclusion in the Final EIS/RIR/IRFA and was eliminated from the document. The Appendix D, referenced here, does not include those empirical modeling sections of concern.

[4] As treated in some detail in *An Analytical Clarification*, above, one would ideally seek to evaluate any attributable effects of these actions in terms of their net results. Because this is not presently possible, for the reasons already discussed, the comparative quantitative assessment presented here focuses on gross measures. The analysts do not assert these measures are close proxies for one another. The analysts do contend that these gross measures can provide useful information to decision-makers, as they consider the expected economic effects of the range of alternatives before them.

been, had each, in turn, been in place (in this example) in 2001?" By posing the analytical question in this way, it is possible to use actual empirical information and official data records on fleet participation, catch composition, production patterns, ex-vessel and first wholesale prices, bycatch quantities, spatial and temporal distribution of effort, and geographical patterns of deliveries to primary processors or transshipping facilities. These estimates can provide a crude measure of the potential economic impact of the alternatives on different fleet sectors. Moreover, if it is assumed that harvest foreclosed to a fleet sector in one area could not have been made up elsewhere by that fleet sector, then the at-risk estimate becomes an approximation of the potential maximum foregone gross revenues directly attributable to the proposed action.

It is also possible to take a further step. Having estimated the maximum gross revenues that might be lost by each fleet segment, on the assumption that the fleet is unable to make up reduced harvests by fishing in other areas, it is possible to gradually relax that analytical constraint by assuming the fleet component would have been able to make up some percentage of the revenue at risk by fishing in other areas not affected by fishing impact minimization measures. This is done without specifying where else the fleet segment might have operated (or at what cost), except to assume that the effort would have been is redistributed to remaining open areas, during remaining open periods, under existing management regulations. With this information available for each fleet segment, readers may apply their own assumptions about the extent to which each fleet segment would be able to make up its catch elsewhere, under the differing temporal and geographic constraints and limitations provided across competing fishing impact minimization alternatives, should these measures be applied to future fishing effort. In this way, individuals may produce their own estimates of the future gross revenues that might be foregone under each.

To be precise, the gross revenues at risk were estimated using information about the following: 1) projected fleet segment harvests for the 2001 fishing year, assuming the provisions of each EFH alternative had been in place in that year; 2) the actual proportions of harvest of different allocations, by different groups of vessels (e.g., vessel length, gear-type, area, processing mode, target species), based upon historical catch patterns in 2001; 3) information about the proportions of the sea surface area closed by the respective fishing impact minimization alternatives, in different management areas; and 4) estimated product mix and ex-vessel (catcher fleet) or first wholesale (catcher-processor fleet) product values for 2001.

The year 2001 was chosen as the base year for the analysis because 1) it was the most recent year for which complete data on catch were available that incorporated retained harvests by all groundfish vessel classes, as well as for crab, halibut, and scallop operations; 2) the BSAI pollock fishery in 2001 reflects the fleet allocations of the AFA, and the BSAI catcher-processors' activity patterns reflect early AFA experience; and 3) Steller sea lion protection measures, consistent with several different EFH scenarios, were in place in that year.

Harvest tonnages were valued using 2001 ex-vessel prices derived from ADF&G fish ticket data for the catcher-vessel components, and first wholesale prices for 2001 for catcher-processor components. The first wholesale prices were estimated by dividing the total wholesale value of production for a species by estimated deliveries of each species of fish, to yield a round weight per ton of catch equivalent value. First wholesale prices are the prices received by the first level of inshore processors, or by catcher-processors and motherships. They reflect the value added by the initial processor of the raw catch. They are not, therefore, equivalent to ex-vessel prices.

The wholesale values were obtained from State of Alaska Commercial Operators' Annual Reports (COAR reports). Implicit in this procedure is the necessary simplifying assumption, likely not correct, that changes in harvest levels would not change the over all product mix composition(fillets, surimi, meal, roe, etc.) at the first wholesale level. Sufficient information is not available to support a more realistic assumption concerning potential changes in product composition. The first wholesale values by species group, fishing gear, and area for the catcher-processor fleet used in this analysis are summarized in Table 3.1-1.

Anecdotal information suggests that the approach used here to estimate prices may tend to understate the revenues generated in the BSAI headed and gutted (H&G) trawl fleet. If this assertion is correct, it would particularly affect the Atka mackerel revenue estimates included in this report. Nonetheless, the analysis reflects the best official data on price and value currently available. The analytical approach adopted here implicitly assumes constant real prices at the ex-vessel and first wholesale levels. To the extent that real prices have risen since 2001, the gross revenues estimated here for the various alternatives likely understate (to an unknown degree) the true gross revenue impacts that may accrue from adoption and implementation of one or another of these fishing impact minimization measures.

The first step in the analysis was to identify the fleet components and target fisheries which would have been likely to be affected by the different fishing impact minimization measures under each of the alternatives proposed for consideration, had each been in place in 2001. The affected fleet components were further subdivided by gear and vessel size categories. These subdivisions were based upon 2001 catch records, by fleet component, area, and target fishery; the analysts' knowledge of the fisheries; and best professional judgment. To estimate the actual harvest by species at risk, it was necessary to determine what proportion of the 2001 harvest (of each target species and retained bycatch) was potentially at risk, based upon geographic displacement attributable to each fishing impact minimization alternative. To do this, landings for each fleet segment were estimated for each State of Alaska statistical area. GIS techniques were then employed to determine what proportion of the physical surface area of each of these statistical areas was specified as restricted or unrestricted under the unique restrictions appropriate to each of the six fishing impact minimization alternatives. The total landings restricted under each of the alternatives could then be estimated by summing restricted landings for each statistical area for each relevant vessel group, gear type, target species, processing mode, and geographic area. This was accomplished for groundfish harvested under federally managed fisheries using the NMFS single vessel database (SVD) and for groundfish, crab, and halibut harvested under State of Alaska managed fisheries using the AKFIN database. Due to the confidential nature of the scallop dredge fishery, the revenue at risk in the scallop fishery was assessed by ADF&G by comparing fishing impact minimization measure impact areas for Alternative 6 with known locations of scallop beds and determining what percentage of recent annual production and value would be placed at risk based on 2001 guideline harvest ranges and the ex-vessel price for shucked scallop meat (Barnhart, J., June 2003, personal communication).

Finally, the harvest tonnages at risk were valued using either ex-vessel (catcher fleet) or first wholesale (catcher-processor fleet) product values, as appropriate, from the 2001 fishing year.

The analysis of revenue impacts of the alternatives was conducted in terms of several gross revenue categories.[5] The first is the potential maximum gross revenues that could have been generated under each respective alternative. This is simply the gross revenue that would have been generated by the TACs and GLHs, associated with a given alternative, if the entire allowable harvest could have been caught, in the 2001 base year. These may differ between the alternatives depending upon the fleet component and affected target species. The second general category is gross revenues at risk under the different alternatives. Various restrictions in the alternatives may have prevented fleets from harvesting fish at accustomed places, times, or with accustomed gear. The affected fishing fleets may or may not have been able to make up the displaced catch and the gross revenues that would have been lost because of these restrictions, by fishing elsewhere. Because different fleets may potentially have been able to recover some or all of these gross revenues, the income from these catches cannot, strictly speaking, be described as lost. Instead, they have been described here as at risk.

Only if it is assumed that harvest foreclosed to a fleet sector in one area by an alternative could not have been made up elsewhere by that fleet sector would at-risk revenues be an estimate of lost gross revenues. Accurate estimates of the abilities of fleets to make up a reduction in harvests in one area by fishing in another require information on the following: 1) the volume of production affected by the various restrictions, 2) the extent to which each fleet sector would have redirect its operations into other fishing areas, and 3) the productivity of the fleet sectors in the new areas. Currently it is possible to estimate only the first of these, i.e., the volumes of production coming from areas that would no longer have been available to fishermen, in 2001, under each of the proposed alternatives. Only for Alternative 5B, which designates actual reductions in TACs for groundfish target species, based on recent catch volumes coming from high-coral/bryzoan and sponge bycatch areas, can the actual reduction in gross revenues be estimated.

Revenues are placed at risk in three ways, corresponding to three different kinds of limitations the alternatives impose on fishing in EFH. An alternative may absolutely prohibit fishing activity by a particular gear (e.g., non-pelagic trawls) and/or target species (e.g., slope rockfish) within a specified area of EFH. In these instances the EFH area is referred to here as closed and the revenues that might have been generated by fishing with that gear, for that target species, in that closed area, are placed at risk. Secondly, Alternatives 5A, 5B, and (the preferred alternative) 5C, each prohibit the use of non-pelagic trawls for all target species in specific areas, spreading the impacts among a number of target species in the EBS, AI, and GOA. Finally, one alternative, Alternative 6, prohibits the use of all bottom-contact gear, including PTR that occasionally touches the seabed, from 20 percent of the fishable waters in all three areas. In this case, the catch and revenues at risk accrue to a potentially much broader segment of the domestic fishing industry, extending to groundfish, crab, halibut, and scallop fishing sectors operating off Alaska. Alternative 6 may affect employers and employees, dependent communities, and families that are, by-and-large, not affected by the somewhat more narrowly focused provisions of the other alternatives (i.e., those that limit regulations to specific gears, target fisheries, or areas).

As noted above, revenues at risk are foregone only if a fishing fleet is unable to modify its operation to accommodate the imposed limits and, thus, cannot make up displaced catches elsewhere (either in remaining open fishing areas or during alternative open fishing periods). Having estimated the maximum

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[5] One would, as previously noted, prefer to base these economic impact evaluations on net, rather than gross, measures. However, insufficient data are available to make this conversion. While the analysts in no way wish to imply that gross and net values are proxies for one another, given the data limitations, gross figures are presented in the expectation that they can provide useful insights into the nature of the impacts which may be expected to accompany adoption of any one of the alternatives under consideration.

revenues that might be lost for each fleet segment, on the assumption that the fleet is unable to make up the affected harvests, it is possible to incrementally relax this assumption and assess the effects. If one assumes that the underlying behavioral model is linear in its parameters, evaluating an alternative assumption about the total foregone catch is straightforward. For example, if one assumes that a given fleet segment is able to make up 10 percent of the harvest elsewhere, the estimated at risk gross revenue impact would be multiplied by 0.90; if the assumption is that, say, 20 percent is made up elsewhere, the total is multiplied by a factor of 0.80, and so forth. This is done without specifying where (or when) the fleet segment might operate, or at what cost. With total revenue at risk information available for each fleet segment, the reader may apply his or her own assumptions about the extent to which each fleet segment would be able to make up its catch elsewhere, thus producing his or her own estimates of the gross revenues that might be foregone under each alternative. Most of the discussion relevant to this approach can be found in this section; Section 3.4, which summarizes the benefits and costs between alternatives; and Section 3.5, which deals with the distribution of impacts among areas, fisheries, fleet components, and dependent communities.

C.3.1.2.2 Product Quality and Revenue Impacts

The fishing impact minimization alternatives considered in lieu of the status quo would impose restrictions on the location of fishing vessel operations that might lead to a decline in product quality and associated reductions in the price the industry receives for fishery products. Changes in product quality may occur for at least two reasons:

- Fishermen may have to fish farther away from processors, requiring them to travel greater distances to deliver their catch.
- Fishermen may be induced to target stocks of sub-optimal sized fish.

C.3.1.2.2.1 Longer Travel to Deliver Fish

The interval between catching and initiating processing groundfish is, reportedly, negatively correlated with product quality (and, thus, value). Some reports suggest that, on a product-for-product basis, the quality of Pacific cod and pollock harvested and processed at-sea is uniformly higher than that of product produced onshore, owing primarily to the significant difference in the interval of time between catching and processing. Inshore processors routinely place limits on the maximum holding time for pollock onboard catcher vessels, and deduct from the price or refuse delivery if the delivery time is exceeded. For those vessels that do not have the capability to process their own catch, given a fixed catch rate and hold capacity, any action that substantially increases the time between catch and delivery imposes costs, both on the harvester and the processor. Beyond some point (which varies by vessel size, configuration, condition of the target fish, and weather/sea conditions) delivery of a usable catch (i.e., one with an economic value to the fisherman and processor) is not feasible.

In this latter connection, a concern common to all operators delivering catch ashore for processing is the effective time limit that exists from first catch onboard until offloading to deliver a salable catch. Informed sources in the industry place the maximum interval at 72 hours (at least in the case of pollock, and perhaps Pacific cod). If fishing grounds that remain open under one or another of the fishing impact minimization alternatives are more remote from sites of inshore processing facilities than the traditional fishing locations, the delivery time for the raw product by the catcher vessel may be lengthened and the value of the delivered product lowered. For smaller vessels with more limited holding capacity and slower running speeds, this limit would impose relatively greater constraints (i.e., operational burdens). The result may be an effective intra-sectoral redistribution of catch share.

Closures (or other operational restrictions) of fishing grounds adjacent to inshore processing facilities may inadvertently redistribute the catch within a sub-sector, from the smaller, least operationally mobile vessels to the larger, faster, more seaworthy elements of the fleet. In the long run, this may have the added (undesirable) effect of inducing further capital stuffing behavior within the industry as those disadvantaged small boat owners perceive the need to invest in added capacity to continue to participate profitably in the fishery.

A number of small catcher vessels participate in bottom contact fishing using non-pelagic trawls, pots, dinglebar troll, and scallop dredge gear, and would be adversely affected by additional running time from remaining areas not restricted or closed by the fishing impact minimization measures to ports with processing and other support facilities. These detailed distributional impacts are discussed further under Section 3.1.2.8, Impacts on Dependent Communities.

C.3.1.2.2.2 Change in Average Size of Fish

A corollary effect of altering the timing and/or location of catch (which each of the five alternatives to the status quo does to one degree or another) might accrue if the average size of fish in the catch falls below the minimum requirement for specific product forms (e.g., deep-skin fillets). These minimums are often dictated by the marketplace, but may also be directly linked to the technical limits of the available processing technology. These impacts could accrue to any or all segments of the fishery. For example, on average, fillet production requires a larger pollock than does, say, surimi production. If spatial displacement (attributable to provisions contained in any specific alternative under review) results in a significant decline in the average size of fish harvested by a given operation, there could be adverse effects on product mix, quality, grade, and value.

For example, IR/IU prohibits the discarding of any pollock or Pacific cod. Product specifications for these species are, as noted above, principally dictated by the marketplace. Therefore, if the average size of fish in the catch declines, perhaps as a result of mandated EFH restriction or closures, increasing amounts of the total catch of these species would be diverted to relatively lower value product forms. For example, if fish are too small for, say, deep-skin fillets, that product form may give way to blocks, IQF shatter pack, etc. Similarly, fillet production could be diverted to surimi and surimi to H&G or mince and meal, etc.

Atka mackerel catch is not governed by IR/IU restrictions. Those close to the industry suggest that there currently exists a marketable minimum size for this species, as well. If the average size fish falls, due to, for example, geographic displacement of fishing effort prescribed by the fishing impact minimization measures, one can anticipate increased discards, with associated higher operating costs per unit of retained catch and product output. Similar outcomes may reasonably be expected in fisheries targeting other species that may be affected by the EFH fishing impact minimization alternative ultimately selected for implementation.

C.3.1.2.3 Operational Costs

Under the five EFH alternatives to the status quo, fishermen would be expected to attempt to minimize losses associated with EFH revenue placed at risk by altering their current operations. These reactions could include the following: 1) redeploying fishing effort, using the same fishing gear and methods, to known adjacent fishing grounds that may be equally or only somewhat less productive (similar CPUE) than the fishing grounds lost to the fishing impact minimization measure; 2) redeploying fishing effort to an area of unknown productivity and operational potential, using the identical fishing gear, in an exploratory mode; 3) switching from a fishing gear that is prohibited to a fishing gear that is allowed within the EFH protection area; and 4) switching to a different target fishery in an area unaffected by fishing impact minimization measures. Each of these strategies may have operational cost implications as described below. While empirical data on operating cost structure at the vessel or plant level are not available, cost trends for key inputs may shed some light on the probable impacts of the fishing impact minimization alternatives on the industry in the aggregate and on average.

Any regulatory action that requires an operator to alter his or her fishing pattern, whether in time or space, is likely to impose additional costs on the operator. The alternative EFH protection actions would almost certainly affect the operating costs of the fishing fleets exploiting most of the marine resources in the federal waters off the coast Alaska, compared to the status quo condition. The following sections address this issue in terms of both fixed and variable costs. Fixed costs tend to arise from investment decisions and variable costs arise from short-run production decisions. As the terms imply, fixed costs are those that do not change in the short run, no matter what the level of activity. Variable costs, on the other hand, are those costs that do change directly with the level of activity, recognizing that variable inputs must be used if production exceeds zero.

As suggested earlier, many costs confronting operators in these fisheries are fixed; that is, they do not change with the level of production. Fixed costs include such expenses as debt payments, the opportunity cost of the investment in the vessel (or plant), the cost of having the vessel or plant ready to participate in the fisheries, some insurance costs, property taxes, and depreciation. Following an action that negatively affects, for example, CPUE, TAC, or catch share, these fixed costs must be distributed across a smaller volume of product output, raising the average fixed cost per unit of production. As previously noted, available information on the cost structure of operations fishing for and processing groundfish, crab, halibut, scallops, etc., is very limited. This is largely so because cost information is often considered highly proprietary by industry members and is, under the best of circumstances, expensive to collect and analyze. Only scattered anecdotal information at the operation level is available on fishing costs (fixed or variable). It is, therefore, impossible to do more than provide a qualitative discussion of the impact of the proposed fishing impact minimization alternatives on operating costs.

Of all the categories of variable factor costs, fuel ranks at or near the top of the list of operating expenses in the fisheries under consideration. Even a qualitative evaluation of the elements of the EFH protection actions (e.g., area closures) suggest that the proposed regulatory changes may likely result in the following 1) longer average trip duration to travel to remaining open fishing grounds; 2) greater total distances traveled per trip [perhaps under more extreme operating conditions]; and 3) longer periods fishing in lower CPUE areas to mitigate the potential loss of catch.

Projecting how changes in running time would affect fuel costs depends on how much fuel must be burned per unit catch. While it is not possible to place a numerical estimate on this factor, it is reasonable to conclude that, on average, total fuel consumption would increase relative to the status quo under each of the proposed alternatives. This increased fuel use would apply except in the case of vessels that cease to fish as a result of EFH restrictions, and perhaps in the case of vessels that switch to a different fishery.

What economists refer to as the opportunity cost of labor is another variable cost that may be increased by various provisions contained within any one of the measures to minimize the adverse effects of fishing on EFH. EFH measures that increase fishing time would reduce the time available for other activities, and in so doing would impose a cost on fishermen. Several of the contemplated measures may increase the time required for fishing in affected fisheries. As noted elsewhere, fishing impact minimization measures may increase transit time to and from fishing grounds; they may force fishermen to fish on grounds with lower CPUE, thus increasing the time required to harvest any given amount of fish; or they may force fishermen to learn new fishing grounds or gear, thus increasing fishing time, at least initially. Because fishing crew members are generally paid with shares of an operation's net (or modified gross) revenues, the additional time spent at sea as a result of these measures may actually decrease crew earnings if the operating expenses of the fishing vessel increase.

This opportunity cost is also reflected in lost time, which reduces the individual's opportunities to engage in other activities and is treated as a cost in economic benefit/cost analysis. The limitations of available models for predicting how fishing operations would behave, given the constraints, and the limited amount of cost information available for fishing operations, makes it impossible to make quantitative estimates of the change in fishing hours or days associated with these alternatives, or to make monetary estimates of the changes in associated opportunity costs.

It has been suggested by some in the industry that fishing costs may increase so much, as a result of the provisions contained in one or another of the EFH alternative actions, that fishermen would not be able to completely harvest the TACs, or GHL, for some target species, at least in some areas. The loss of the revenues in these instances has been discussed above and is detailed in Section 3.5. On the cost side, those revenue losses may be offset, to an unknown extent, by associated reductions in the variable operating costs these operations would otherwise have incurred. From the operator's perspective, for example, fewer days fishing as a result of EFH restrictions would mean reductions in variable costs (e.g., stores, bait, lubricants and fuel expense), reduced wear and tear on vessels and gear, and reduced processing, packaging, and storage expenses for the product. It would also mean reduced payments to labor (although the other side of that coin reflects foregone wages to the skipper and crew, as well as the social value of other goods and services the fishermen might have produced).

On the other hand, the cost of fishing would tend to increase for the fish that continue to be caught. Based on information provided by the industry at public meetings and through individual contacts, as well as the professional judgement of the preparers of this RIR, seven categories of costs were defined for consideration, as follows:

- Increased travel costs
- Costs of learning new grounds or using new gear
- Costs of bycatch avoidance measures, or (if these efforts are unsuccessful) premature closure due to excessive bycatch
- Reduced CPUE due to less concentrated target stocks;
- Potential gear conflicts
- Effects on processors built for higher throughput
- Safety impacts (addressed separately below in Section 3.1.2.4)

<u>Increased Travel Costs</u>: Vessels that had formerly been able to fish areas nearer shore, and in relative proximity to their preferred port of operation, could be pushed farther offshore and/or into more remote fishing areas, as a result of specific provisions contained in EFH alternatives under consideration by the Council. Running to one of the remaining open fishing areas, prospecting for harvestable concentrations of target species, then (depending on operating mode) running back to port with raw catch or product would, as previously noted, require increased expenditures of fuel and other consumable inputs, as well as more time on the water (i.e., trips may be longer, and all variable operating costs and wear and tear on equipment and crew would increase). These changes in fleet operating patterns would likely require a

greater total number of days for a given vessel to take its share of the available TAC or GHL, other things being equal.

How many additional days may be required would vary by stock and ocean conditions, rates of success in locating fishable concentrations of the target species in remaining open areas or time periods, operational mode and capacity, the level of aggregate effort exerted by the fleet or sub-sector in the remaining open areas, etc. But clearly, if catch per unit effort declines, cost per unit of catch would increase. In the limit, smaller vessels may be so disadvantaged by the distances that must be traversed between port and open fishing grounds that they may be unable to operate economically (perhaps, even physically) under these circumstances.

While empirical data on operating costs currently are not available for any of the sectors that may be impacted by the proposed alternatives to the status quo, it appears certain that travel costs would increase due to rules prohibiting transit of specific areas by any vessel (e.g., SSL critical habitat RPAs) or other forms of exclusionary rules that might be attributed to one or another of the EFH action alternatives. In the limit, smaller vessels may be so disadvantaged by the distances that must be traversed between port and open fishing grounds, when intervening areas are closed to transit or otherwise restricted, that they may be unable to operate economically (and perhaps even physically) under these circumstances. These vessels could be effectively closed out of the fishery. The probability of occurrence, resulting magnitude, and distribution of such adverse effects cannot be estimated, based on deductive reasoning.

Even vessels with the physical capacity to circumnavigate no transit and/or restricted access zones to reach open fishing grounds may incur prohibitively high operating costs (e.g., excessive fuel consumption), increased risk (e.g., should sea or weather conditions change unexpectedly), and reduced product quality (i.e., as hold-time increases). Anecdotal reports offered at the December 2000 Council meeting (specific to the SSL EIS RPA open, closed, and no-transit zones) suggested that, in some cases, a vessel wishing to participate in a commercial opening might have to sail from port to one open area, then (depending on success, available quota, etc.) have to retrace its route back to the vicinity of the original point of departure before sailing to an alternative open area, even though a much shorter direct route was available through a designated no-transit zone (SSL EIS RPA). This same outcome could accompany any restricted access provisions associated with EFH closures. In an open access fishery, especially, the old adage “time is money” is fundamentally true; thus, longer distances and increased time in transit mean higher operating costs, less time fishing, and greater exposure to economic and physical risk.

Costs of Learning New Grounds or Using New Gear: It is axiomatic that fishermen fish when and where they believe the fish are most valuable and most readily available. Under provisions of the suite of EFH measures under consideration by the Council, open and closed areas would compel operators to alter the pattern of operations they would voluntarily choose to undertake as profit maximizing entities. That is, in many instances, fishermen would be required to fish on grounds with which they may be unfamiliar. Fishermen would face a learning curve on these new grounds. They would have to become accustomed to a new physical geography underwater and perhaps more extreme and/or exposed sea surface conditions; to new fish locations, behaviors, and habits; and to new patterns of bycatch.

While fishermen learn to operate within these new parameters, they would likely incur increased operating costs. Gear could be more frequently lost or damaged, CPUE would likely be lower, and bycatch of other species could be higher. Higher bycatch could force early closures of fishing grounds, and with fewer optional open areas available, it would be more difficult (and, thus, more costly) for operators to voluntarily move off hot spots to reduce or avoid bycatch.

Even if the bycatch is composed of species for which there is no potential risk of regulatory closure, the additional resources (e.g., time and labor) required to land, sort, and discard unwanted catch would increase operating costs. Because, in many instances, large volumes of fish would have to be taken in places and at times when they have never been taken before, there is little available information for fishermen to use to make inferences about these issues in advance of committing the effort. Thus, they would have very little opportunity to avoid incurring the costs of prospecting new areas (at new times) even if, subsequently, the effort proved uneconomical from the standpoint of catch success.

Under some EFH provisions, vessels would be precluded from fishing an area with the gear they have traditionally used (e.g., NPT GOA slope rockfish). They would, however, be permitted the option under these alternatives of changing over to authorized gear and continuing to participate in the fishery. This opportunity carries with it several implications for the operational and capital cost structure (and, thus, economic viability) of any such operation. The first consideration would be, "Does this provision represent a meaningful opportunity for, and a real accommodation of, the vessels in question?" A cursory examination of the potentially affected fleets suggests that many vessels are too small and/or haven't sufficient horsepower (and likely insufficient revenues from the fishery from which they are being displaced) to make this gear change. For these vessels, the provision does not represent a viable option.

Even for those operations that have the physical and financial capability to undertake the gear changeover, there are several significant economic and logistical barriers to overcome. Perhaps the most obvious would be the potentially significant up-front cost of acquiring the new gear (e.g., longlines, PTR). In addition, there could be (perhaps substantial) costs associated with modifying and adapting the current vessel to efficiently use the gear type (e.g., booms, davits, winches, hydraulics). The conversion costs may include both cash outlays, as well as foreign fishing revenue attributable to down time to complete the transformation. For some operators, obtaining necessary shipyard services could involve the additional time and expense of moving the vessel to a distant port where necessary facilities exist (e.g., Seattle-Tacoma).

Finally, prosecuting a fishery with unfamiliar gear may demand different crew skill-sets, perhaps a different (larger? smaller?) crew. Whether skilled crewmembers can be readily recruited to fill these needs, or whether some or all of the existing crew can be retrained and employed, could be key to a successful, economically viable transition. Recruiting, retaining, and/or retraining a professional fishing crew would impose costs of various types on these operations. While not readily amenable to quantification, these represent very real potential costs.

Costs of Bycatch Avoidance Measures: While the selectivity of the gear fished for these target species varies, groundfish fishermen unavoidably take other species as incidental catch when they fish for most target species. In some instances (e.g., bycatches of halibut, salmon, herring, and some species of crabs), groundfish fishermen are subject to limitations on the amounts of bycatch that they may take. When the bycatch limits (or caps) are reached, the fishery is closed. Fishermen can, to a greater or lesser degree, reduce bycatch by modifying their gear or the way they use it, and by learning the times and places when unacceptably large bycatches might take place (Queirolo et al. 1995). Both bycatches and the avoidance measures that they make necessary impose costs on the operations. Finally, with temporal and geographic dispersion provisions associated with some of the EFH fishing impact minimization measures, there is the potential for increased interactions with protected species (e.g., short-tailed albatross, ESA-listed PNW Chinook salmon), which could require Section 7 consultation (with the potential to trigger further and more extensive fishing closures).

Reduced CPUE Due to Less Concentrated Target Stocks: The economic, operational, and socioeconomic response of individual operators may take several forms following adoption of a specific EFH fishing impact minimization action. For example, anecdotal information supplied by the industry in public meetings and through individual contacts suggests that CPUE may decline, in some cases substantially, as a result of significant fishing effort being forced into unfamiliar or unfavorable areas. The effect of these declines would not likely be uniformly distributed across each management area, gear type, processing mode, or vessel size category and, thus, would carry with them very different implications for profitability, economic viability, and sustained participation in these fisheries.

Potential Gear Conflicts: Concerns have been expressed, from a variety of sources, about the adverse economic effects associated with forcing gear-specific effort out of traditional operating areas and into proximity with other gear groups and/or target fisheries. Trawl gear, pot gear, and longline gear are incompatible when fished simultaneously in a given area. Gear damage or loss is a common outcome when these competing fishing technologies come into contact with one another on the fishing grounds. Each gear group perceives itself as facing unique operating challenges with respect to such conflicts. For example, Pacific cod longline fisheries occur north of the Pribilof Islands at the same time that bottom trawl fisheries target flathead, yellowfin, and rock sole in the same area. By voluntarily isolating themselves in well defined and generally recognized areas, they insulate themselves from the high cost and frustration associated with gear conflicts (loss of longline gear and catch). Bottom trawl fishing area closures being considered under several of the EFH alternatives (Alternatives 4 and 5) would affect significant areas within the accustomed EBS flatfish fishing grounds and could force the bottom trawl effort onto fishing grounds typically used by longline fishermen targeting Pacific cod.

Effects on Processors Built for Higher Throughput: If CPUEs decline and fishing is more geographically dispersed under some alternatives, the aggregate rate of catch could slow. This implies that the rate of delivery to processors would also decline. Because existing processing plant capacity has been built, in many cases, for peak through-put (i.e., to maximize the rate at which catch is received and processed in response to the race-for-fish on the grounds), lower and slower deliveries may not supply sufficient quantities of raw fish for plants to operate profitably. Many plants have been designed, configured, and operated to exploit economies-of-scale in production. They are designed to move an optimal volume of fish through the processing plant at the most efficient, most cost effective rate, given the capacity of the facility and expectations of catch and delivery rates from the catcher-vessel fleet. If operated at rates that significantly deviate from those for which the plant was designed, these economies would be lost, and a plant could become unprofitable to operate.

The nature of these interactive and compounding relationships is important to keep in mind. None of these economic, operational, or logistical elements works in isolation from one another.

C.3.1.2.4 Safety Impacts

Commercial fishing is a dangerous occupation. Lincoln and Conway, of the National Institute of Occupational Safety and Health (NIOSH), estimate that, from 1991 to 1998, the occupational fatality rate in commercial fishing off Alaska was 116 persons per 100,000 full time equivalent jobs, or about 26 times the national average of 4.4/100,000 (Lincoln and Conway 1999). Fatality rates were highest for the EBS crab fisheries. Groundfish fishing fatality rates, at about 46/100,000, were the lowest of the major fisheries identified by Lincoln and Conway. Even this relatively lower rate was about ten times the national average (Lincoln and Conway 1999).

During most of the 1990s, commercial fishing appeared to become relatively safer. While annual vessel accident rates remained comparatively stable, annual fatality per incident rates (case fatality rates) dropped. The result was an apparent decline in the annual occupational fatality rate. From 1991 to 1994, the case fatality rate averaged 17.5 percent per year; from 1995 to 1998 the rate averaged 7.25 percent per year. Lincoln and Conway report that, "The reduction of deaths related to fishing since 1991 has been associated primarily with events that involve a vessel operating in any type of fishery other than crab." (Lincoln and Conway 1999, page 693.) Lincoln and Conway described their view of the source of the improvement in the following quotation. "The impressive progress made during the 1990s, in reducing mortality from incidents related to fishing in Alaska, has occurred largely by reducing deaths after an event has occurred, primarily by keeping fishermen who have evacuated capsized (sic.) or sinking vessels afloat and warm (using immersion suits and life rafts), and by being able to locate them readily, through electronic position indicating radio beacons" (Lincoln and Conway 1999, page 694).

There could be many explanations for this improvement. Lincoln and Conway point to improvements in gear and training, flowing from provisions of the Commercial Fishing Industry Vessel Safety Act of 1988 that were implemented in the early 1990s. Other causes may be improvements in technology and in fisheries management. Technological improvements may include advances in Emergency Position Indicating Radio Beacon (EPIRB, sometimes also called an ELT or Emergency Locator Beacon) technology. Current 406 MHz EPIRBs are more effective as a means of communicating distress than the 121.5 MHz EPIRBs in use in the early 1990s, in that they now transmit a unique identification code in addition to position information, which allows Coast Guard personnel ashore to quickly identify the vessel, use point of contact telephone numbers, and more effectively filter out false alarms.

Fishery management changes have included the introduction of individual quotas for halibut and sablefish, actions that have dramatically slowed the historically frenetic pace of these fisheries. The introduction of co-ops in the pollock fisheries in 1999 and 2000 is not reflected in these statistics. Rationalization of the pollock fishery in the BSAI, however, may have furthered safety improvements. The Lincoln-Conway study implies that safety can be affected by management changes that affect the vulnerability of fishing boats, and thus the number of incidents, and by management changes that affect the case fatality rate. These may include changes that affect the speed of response by other vessels and the Coast Guard. Starting in 1997, the United States Coast Guard's (Coast Guard) Seventeenth District instituted a practice of forward deploying a long range search helicopter to Cold Bay, Alaska, to improve agency response time during the Bristol Bay red king crab fishery. This practice was expanded in 1998 to cover the opilio crab fishery. In 1999, approximately 11 lives were saved, in a 6-day period of extreme weather, when the forward deployed helicopter responded to several vessel sinkings and other marine casualties in short order.

In this RIR, several safety-related issues have been considered with respect to the EFH alternatives. These include the following:

1. Fishing farther offshore
2. Reduced profitability
3. Changes in risk

Fishing Farther Offshore: Changes in fishery management regulations that result in vessels, particularly smaller vessels, operating farther offshore appear likely to increase the risk of property loss, injury to crew members, and loss of life. Fishing impact minimization measures that close nearshore areas to fishing operations, such as closures to bottom contact fishing in Prince William Sound and around the Pribilof Islands (Alternative 6), could compel vessel operators to choose between assuming these increased risks or exiting these fisheries entirely. Weather and ocean conditions, especially in the BSAI, but also in the GOA, are among the most extreme in the world. The region is remote and sparsely populated, with relatively few developed ports. The commercial fisheries are conducted over vast geographic areas. While many vessels in these fisheries are large and technologically sophisticated, many more are relatively small vessels with limited operational ranges.

Several factors associated with fishing farther from shore can reduce the safety of fishing operations by increasing the likelihood of emergency incidents. Vessels would probably have to spend more time at sea in order to take a given amount of fish. It would take more time to travel between port and the remaining open fishing grounds. Operators would also be likely to be fishing in less familiar conditions and on stocks that may be less highly aggregated, thus reducing CPUE. Increases in the time spent at sea increase the length of time fishermen are potentially exposed to accidents. Furthermore, longer trips are likely to increase fatigue and thus the potential for mistakes and accidents.

Other factors may tend to increase the case fatality rate. Fishing vessels may be farther from help if an accident occurs. In many cases, the initial response to trouble comes from other fishermen. If fishing farther offshore, on more extensive fishing grounds, increases the dispersion of the fishing fleet, assistance from other fishermen may not be as readily available. In addition, regulatory actions that force fishing vessels to work farther offshore may turn what would normally have been a request for assistance search and rescue (SAR) case into an emergency or life threatening situation. Many SAR cases involving fatalities start as a casualty to the vessel that degrades its stability or survivability, but does not immediately threaten the vessel or crew. After the initial casualty, other environmental factors (e.g., heavy seas, winds, freezing spray, etc.) may quickly cause the situation to deteriorate. The ability to render assistance early is essential. Vessels fishing farther from shore and/or in more remote and exposed locations may experience additional delays before help can arrive.

In a similar respect, the ability to satisfactorily treat personnel injuries is often determined by the speed with which the injured can receive adequate medical attention. While these factors may affect all operations, they are likely to be most serious for the smaller vessels based in Alaska ports, which have tended to fish relatively close to the shore in the past. For example, it is reported that small vessels operating out of Kodiak or Alaska Peninsula communities typically seek at least 48 hours of stable weather to initiate a typical fishing trip. This 48-hour window of opportunity allows a run from port, time spent fishing, and time for returning to port. The weather window is often attainable between the steady series of low pressure system storms that pass through the region from west to east at all times of the year, although with greater frequency and severity in the winter. With the combined effects of a longer run to fish in more distant waters, plus longer fishing times caused by reduced catch rates, a much longer window of opportunity to conduct a fishing trip would be required. The effect of this new situation could vary. It could result in fewer trips and lowered harvest levels, because there are likely to be fewer relatively good weather periods of sufficient duration. However, as noted below, fishing vessel owners would face economic pressures on their fishing operations due to diminished revenues and increased costs. There is a reasonable likelihood for a tendency to try to squeeze longer trips into marginal weather conditions, with disastrous consequences for some. Fishing impact minimization measures that induce such fishing patterns would almost certainly lead to an increased level of risk to vessels and crews, albeit an increase that cannot be empirically estimated.

Reduced Profitability: As discussed throughout this RIR, proposed restrictions on fishing to protect EFH could reduce the profitability of many operations, especially including many of the smaller operations. Reduced profitability could be an indirect cause of higher accident rates. For example, fishermen facing a profit squeeze could defer needed maintenance on vessels and equipment, reduce operating costs by cutting back on safety expenditures, or scale back the size of their crew in order to reduce crew share expenses. Remaining crew would have expanded responsibilities and could risk greater fatigue, increasing the likelihood of accidents. Finally, these operators could decide to fish more aggressively, even in marginal conditions, in an effort to recoup lost revenues. These factors may affect the incident rate and the case fatality rate, as well.

Changes in Risk: Each of the factors described above increase risk. On the other hand, the potential for increased risk may be offset to some extent by changes in fleet behavior. An increase in risk effectively increases the cost of each additional day of fishing that, in turn, may contribute to reduced levels of participation (e.g., fewer fishing days) by smaller vessels. If this leads to a safety-induced reallocation of harvest from smaller to larger vessels, risk calculations may be affected. Similarly, smaller crew sizes mean that fewer people on a vessel are exposed to danger. Furthermore, skippers who have less invested in safety gear may have an incentive to behave more cautiously or conservatively in other respects in order to offset some of this perceived increased risk. Very little is known about factors that might increase risk, or that might offset risk increases, for fishermen in the North Pacific and EBS. Even the best estimates of statistics as fundamental as the occupational fatality rate are not precise, and are not available at all for recent years. Rough estimates of the relative ranking of occupational fatality rates in different fisheries are known. Little more than qualitative speculation is available concerning the factors that affect the rates in the different fisheries, however. Available information does not permit quantitative modeling of changes in these rates in response to changes in fishery management regulations that could be induced by fishing impact minimization measures. These changes in fishing behavior and patterns could lead to an increased level of risk to vessels and crews, albeit an increase that cannot be empirically estimated.

Specific to the last point, proposed EFH closures (especially when combined with prevailing Steller sea lion closed areas and no-transit zones) that restrict access to nearshore areas could compel vessel operators to choose between assuming increased risks or exiting these fisheries for some or all of the fishing season.

Weather and ocean conditions in the BSAI and the GOA are among the most extreme in the world. The region is remote, sparsely populated, has relatively few developed ports, and the groundfish fisheries are conducted over vast geographic areas. While these factors may affect all operations, they are likely to be most serious for the smaller vessels, based in Alaska ports, that have historically tended to fish relatively close to shore. For example, it is reported that small vessels operating out of Kodiak or Alaska Peninsula communities typically seek at least 48 hours of stable weather to initiate a Pacific cod trip. This 48-hour window of opportunity allows a run from port to the grounds, fishing time, and time for returning to port. The weather window is often attainable between the steady series of low pressure system storms that pass through the region from west to east the entire year. With the combined effects of a longer run to fish in more distant open grounds, perhaps complicated by no transit or other passage restrictions, longer fishing times caused by reduced catch rates, the need to prospect unfamiliar territory, and a run back to port from those more remote grounds (again skirting any restricted transit areas) a much longer window of opportunity may be needed to conduct a fishing trip.

These operational and economic impacts may vary by target, vessel size, port/region, and operational mode. In some instances, the effect may be fewer trips and lower harvest levels for smaller vessel operators because enough periods of good weather are unlikely. Vessel owners may face mounting economic pressures due to diminished revenues and increased costs. There is a reasonable likelihood that some will try to squeeze longer trips into marginal weather conditions. The result of this new fishing pattern will be an increased level of risk to vessels and crews.

Each of the economic and operational factors affecting access to or transit through particular areas, and described here and elsewhere in the RIR, increases risk. If this leads to a safety-induced reallocation of harvest from smaller to larger vessels, fleet-wide risk calculations may be affected. That is, the fewer small, potentially more vulnerable, vessels operating in a given fishery, the less the aggregate risk to the fishing fleet on the grounds. While any such reallocation is primarily distributive in nature (i.e., does not result in a change in net economic benefits or costs), it would have direct implications for many of the other objectives associated with the proposed action alternatives identified by the Council (e.g., equity among historically participating segments of the industry, community stability and welfare concerns, and avoidance of excessive shares by a small number of operators).

C.3.1.2.5 Impacts on Related Fisheries

Direct changes to a fishery, induced by fishing impact minimization measures, could have indirect and unanticipated impacts on other fisheries beyond the gear conflict issue addressed earlier. Some of these impacts could impose (perhaps substantial) costs on these other fisheries. The following costs have been considered in this RIR:

- Displacing capacity and effort
- Compression/overlapping of fishing season
- Increased costs of gearing up and standing down

Displacing Capacity and Effort: While AFA sideboard provisions and LLP constraints seek to manage and control transference of effort and capacity across fisheries, they are not absolute barriers to this phenomenon. Should EFH closures, gear restrictions, TACs (or area apportionments thereof) be too constraining to support existing levels of effort, it is possible that effectively displaced capacity would redistribute to remaining open target fisheries, imposing potentially significant costs on the operations that currently prosecute them.

As previously recognized, operations in any given fishery or sub-sector are not homogeneous in capacity and capability. Therefore, should EFH measures induce movement of capacity and effort from one fishery to others, it is likely that the greatest economic and operational burden would fall upon the smallest, least operationally diversified, and least mobile elements of these fleets. Given these smaller operations' inherent physical limitations (e.g., operational range, catch holding capacity, speed and sea worthiness) it is likely that these would be the first casualties of any effort and capacity transference. Because these operations are most likely to be home ported in small communities along the GOA and BSAI coast, the relative magnitude of such displacement on these local and regional economies would be disproportionately greater, as well.

Compression/Overlapping of Fishing Season: Many of the larger operations in the EBS, and even Aleutians' and Gulf fishing fleets, are highly specialized (e.g., AFA surimi C/Ps). Many others, however, rely upon diversification (i.e., fishing a sequential series of different target fisheries over the course of the year) to sustain an economically viable operation. Communities have developed around, and invested in facilities and infrastructure to support, these fishery participation patterns. The classic Alaska example has come to be the 58-foot Limit Seiner. This class of commercial fishing vessel was specifically designed to meet the State of Alaska's regulatory limit (i.e., maximum 58 feet LOA) for participation in the salmon seine fishery. Over time, these, as well as many other, small boats have evolved patterns of operation that include participation in fisheries for (among others) crab, halibut, and various combinations of groundfish species.

Because these operations are economically dependent on participation in a suite of fisheries, anything that alters their ability to move sequentially from fishery opening to fishery opening places them at economic risk. For example, should the Council select an EFH fishing impact minimization action that results in temporal displacement of fisheries (either directly or indirectly), placing fishery openings in conflict, it could reduce the economic viability of some fishing operations. They could find themselves in the position of choosing to participate in only one fishery, among two or more alternative openings, and foregoing participation in the others. It may not be possible, under these circumstances, for such an operation to remain economically viable in the long run. Besides losing the revenues from participation in fisheries that overlap, these operations could find themselves idled during portions of the year when weather and sea conditions would otherwise permit fishing operations. This could have unintended consequences, such as difficulty retaining a professional crew and smaller gross revenues over which to spread fixed costs. It could also mean lost wages to the community.

The ultimate loss of a significant number of these operations could have profoundly negative economic and social impacts, not only on the EFH-regulated fisheries but also on the commercial sectors of other economically important regional fisheries (e.g., salmon, herring).

There could be an analogous concern about the inshore processing sector. Processing plants often are equally dependent on the predictable sequential prosecution of fisheries during their operating year. Many plants in Alaska are specifically designed and configured to take advantage of efficiencies attributable to a consistent seasonal sequence of species delivered for processing. Crews are hired, maintained, or let go, as needed, based on expected demand for processing services. Likewise, start-up, maintenance, and shut-down costs are predicated on the timing and duration of fishery openings, as are logistical and staging costs to assure production inputs are in place when needed, and outputs reach markets on time.

In connection with the prospect of temporal season changes attributable to Steller sea lion RPA restrictions, some owners of processing capacity have suggested, in testimony before the Council, that they would be forced to consider not opening their plants because of uncertainty about the timing and duration of fisheries. If some plants fail to open on schedule, fishermen who otherwise would have participated in a fishery may have no market for their catch. This may be particularly significant for small catcher boats operating in relatively remote areas of the state. Furthermore, these effects need not necessarily accrue only, nor even substantially, to fisheries for FMP-managed EFH-affected species. In some areas, processors are able to provide markets for, say, salmon, only because they can underwrite some of their fixed staging costs by keeping their operations employed over an extended season with deliveries of crab, halibut, groundfish, etc. (John Garner, NORQUEST Seafoods, per. comm. 2003). The extent to which these potential adverse effects are actually realized cannot be assessed at this time. Nonetheless, they represent potentially significant sources of economic disruption for these sectors of the industry, and the coastal communities dependent upon them.

<u>Increased Costs of Gearing Up and Standing Down</u>: Logistical and staging costs can represent a significant expense for many operations participating in the fisheries of the BSAI and GOA due to the remoteness of the fisheries. Should one or more of the fishing impact minimization measures result in temporal displacement of fisheries (as several have the potential to do), there would be adverse economic and operational impacts on vessels, plants, and crews that could not be readily avoided or compensated for. That is, if an EFH-restriction results in, for example, an accelerated rate of PSC bycatch caused by concentrating effort within the remaining open areas, fisheries could be prematurely closed until additional PSC quota was scheduled to be made available. The immediate result would be an idling of the fleet and associated processing plant capacity. In effect, the fishery would be required to stand-down

until the next scheduled opening. From the perspective of the fishing industry, mandatory idle periods between openings impose direct costs. The longer the duration of imposed idleness and the more numerous these periods, the greater the potential economic and operational burden.

Presumably, some form of step function exists that characterizes these potential adverse impacts. That is, it may be likely that a mandatory stand-down of 24 hours, or 48 hours, or even 72 hours, would impose costs that could be absorbed by most operators participating in the target fishery (although all would likely prefer to avoid them). Indeed, over such a relatively brief interval, an operator might keep the crew productively employed with maintenance and/or other forms of preparation for the anticipated re-opening. Nonetheless, the plant or vessel must continue to pay its variable costs (e.g., wages and salaries, food and housing expenses, fuel and other consumable input costs, etc.) during the stand-down while producing no marketable output, and therefore earning no revenues.

Under such circumstances, each operator could eventually reach a threshold, beyond which the cost of standing-by would become a significant economic burden. Precisely where this threshold lies would likely vary by operation. At present, no empirical information is available with which to predict when these thresholds might be attained by any given plant or vessel. However, if the threshold were reached, the operator would face a series of decisions with potentially significant economic costs and operational consequences.

These costs may be characterized as staging expenses. For example, transporting crews by air to and from remote Alaska locations multiple times in a fishing year (rather than once or twice, as has historically been required) would represent a significant additional operating expense. In association with analysis of the EBS Pollock/Steller RPA analysis undertaken in late 1999 and early 2000, the At-sea Processors Association reported that each C/P that participates in the pollock target fishery carries a crew of 100 to 125. Motherships and inshore plants in that same fishery have at least as many transient employees. The Atka mackerel and Pacific cod target fisheries in both the BSAI and GOA, as well as the GOA pollock fishery, operate at a smaller scale, per operation, and thus have fewer employees per vessel, However, the total number of participating operations is vastly larger than in the aforementioned EBS pollock fishery. Repeated movement of crew to and from staging areas in remote Alaska ports in response to stand-down periods, on the scale suggested by these estimates, would represent a potentially significant economic and logistical burden for these fleets and plants.

Similarly, moving fishing supplies and support materials to and from the vessel's staging port or onshore plant location two or more times each season, as well as providing for secure stand-down status of the vessel or plant and its equipment between openings, could impose considerably higher operating costs, and thus smaller profit margins. Moorage slips, especially for the larger vessels in these fleets, may be in short supply, given the limited physical facilities that currently exist in ports and harbors adjacent to the EFH-affected fishing areas. If entire fleets must lay-up for weeks or even longer periods between openings, existing moorage facilities could be overwhelmed. Even if adequate space could be found, it is probable that rental/leasing costs for that space would be bid up significantly. In the long run, this induced demand could result in investment in additional port and harbor facilities. Should subsequent changes in fishing patterns occur that substantially reduced demand for transient stand-down moorage, some or all of these investments could be stranded (that is, they would become excess capacity).

As suggested above, inshore processors may experience equivalent logistical costs, depending upon their relative level of operational diversification, geographic location, length of current operating season, etc. Presumably, there exists a balance-point between the minimum necessary volume of deliveries of catch to a plant, the duration of idleness between delivery flows, and the ability to operate a processing facility at all. While likely varying from plant to plant, operator to operator, and even species to species delivered, it is clear that if a plant cannot cover its variable operating costs, it is better off (from an economic perspective) to cease operation altogether. As staging costs (e.g., moving crews and supplies to and from the facility) increase, this operating margin shrinks. Data limitations preclude estimating which plants can or would choose to operate under these circumstances. It is apparent, however, that significant temporal changes in fishery openings and/or duration (as implicitly or explicitly provided for under several of the proposed fishing impact minimization alternatives) would increase the likelihood that some may not continue to operate.

C.3.1.2.6 Costs to Consumers

Ultimately, fish are harvested, processed, and delivered to market because consumers place a value on the fish that is over and above what they have to pay to buy them. A person who buys something would often have been willing to pay more than they actually did for the good. The difference between what they would have been willing to pay and what they had to pay is treated, by economists, as an approximation of the value of the good or service to consumers (i.e., consumer's surplus) and as one component of its social value. If the price of the good rises, the size of this benefit will be reduced, all else equal. If the amount of the good available for consumption is reduced, the size of this benefit is also reduced. Provisions of the proposed EFH actions could reduce the value consumers of seafood (and associated fish products) receive from the fisheries for several reasons, including 1) consumers may be supplied fewer fish products; 2) consumers may have to pay a higher price for the products they do consume; and 3) the quality of fish supplied by the fishing industry may be reduced and, thus, the value consumers place on (and receive from) them will decline.

The domestic consumer losses would fall into two parts. One part, corresponding to the loss of benefits from fish products that are no longer produced, would be a total loss to society. This is often referred to as a deadweight loss. The second part, corresponding to a reduction in consumer benefits because consumers have to pay higher prices for the fish they continue to buy, would be offset by a corresponding increase in revenues to industry (i.e., producers' surplus gains). While a loss to consumers, this is not a loss to society. It is a measure of the benefit that consumers used to enjoy, but that now accrues to industry in the form of increased prices and additional revenues.

The actual loss to society cannot be measured with current information about the fisheries. Estimation would require better empirical information about domestic consumption of the different fish species and products, and information about the responsiveness of consumers to the reduction in the supply (e.g., their willingness and ability to substitute other available sources of protein). In addition in the present case, because, under the status quo, society is already in a suboptimal state (i.e., incurring a welfare loss associated with the externalities imposed by destruction and/or degradation of EFH), actions taken to reduce these externalities (i.e., minimizing fishing impacts on EFH) will result in an aggregate welfare improvement to society, offsetting any apparent welfare reduction in the retail/wholesale domestic seafood/fish products commercial marketplace (i.e., no deadweight loss is incurred).

C.3.1.2.7 Management and Enforcement Costs

Management and enforcement considerations, as they pertain to groundfish fisheries in the EEZ off Alaska, are treated at length in Section 4.3. of the EFH SEIS. The reader is referred to that section for detailed discussions. In terms of both management and enforcement costs, NMFS anticipates that all of the EFH protection measure alternatives (with the exception of Alternative 1, Status Quo) would require some level of increase in staff and budget for NMFS Enforcement and the In-Season Management

Branch of the Alaska Regional Office's Sustainable Fisheries Division. The alternatives would all require increased enforcement of complex closed areas, directed fisheries, and gear modification/restrictions.

Although the alternatives would affect fishery monitoring efforts of the Coast Guard, as well, that agency has consistently reported that it considers all activities to support the commercial fisheries off Alaska as part of a national budget and does not estimate additional costs associated with these alternatives. That is to say, the Coast Guard has a long standing commitment to enforce, to the best of its ability, any fishery regulation the Council proposes and NOAA approves and to do so within existing budgetary and resource constraints. Because Coast Guard resource levels can generally be regarded as fixed, within the federal budget cycle, this aspect of the analysis will focus on the type and effectiveness of enforcement support, in lieu of any dollar value, associated with increased enforcement impacts for the various alternatives. With very little likelihood of receiving additional resources to enforce new fishery regulations, resources will be reprioritized to take into account all existing regulations. In the case of EFH fishery impact minimization regulations, this may require resource allocations that would draw enforcement resources away from other areas of Coast Guard responsibility.

This Coast Guard input to the EFH RIR seeks to clarify the expected enforcement costs (i.e., tradeoffs) of the various fishery impact minimization alternatives, found within the proposed EFH action, relative to each other. The criteria used to describe resource allocation requirements and enforcement effectiveness do not allow meaningful comparative analysis of the alternatives without breaking the alternatives into smaller categories, instead of comparing intact alternatives to each other. Therefore, the Coast Guard divided the alternatives into three distinct sub-alternatives, by area, for purpose of the following assessment: AI, EBS, and GOA. This analysis examines the resource requirements as the subalternatives are presented in the EFH EIS. Should VMS or other management measures be added to any of the subalternatives, the resource requirements for those subalternatives could increase or decrease dramatically and the overall ranking of the subalternatives would likely change.

As a general rule of thumb, any regulation that includes a total closure and does not differentiate between gear types is reasonably enforceable using aircraft and, therefore, relatively less resource intensive. Any closure that requires Coast Guard cutters to actively patrol (e.g., bottom trawl or species specific closures), vice aircraft, will require relatively more resources to enforce. The use of the straight-line closures, parallel to latitude and longitude lines, can be more effectively monitored and enforced. This is in contrast to contour line closures that would be impractical to effectively enforce, either from Coast Guard aircraft or cutters and would, therefore, require more patrol time to accurately identify and plot violations of closure areas.

On the basis of the proposed alternatives, as specified in the EFH fishing impact minimization action, the Coast Guard projects the following, with regard to complexity and cost of enforcement:

Alternative 1 (Status Quo/No Action)
No additional reallocation of assets necessary.

Gulf of Alaska subalternatives ranked from least resource intensive, to most resource intensive:

1. Alternative 6

   Alternative 6 for the GOA would be reasonably enforceable with the use of Coast Guard aircraft due to the nature of the closure and the relatively straight lines used to draw the closure areas.

2. Alternatives 2, 4, and 5C (Preferred Alternative)

   Alternatives 2, 4, and 5C for the GOA are nearly identical and are, therefore, considered as one. These alternatives would be more resource-intensive to enforce, due to the type of closure employed. Because the closures would be gear-specific and for Alternatives 2 and 4, species-specific, the use of Coast Guard cutters would be required to conduct at-sea boardings to verify compliance. The use of straight lines to draw the closure areas would, however, allow for more effective monitoring and enforcement than depth contour lines.

3. Alternative 3

   Alternative 3 for the GOA would require more resources to enforce than Alternatives 2, 4, or 6, due to the complexity of the closure lines and the vast linear area included in the closure. This alternative is also based upon gear and target species restrictions, which would require the use of Coast Guard cutters to enforce. Effectiveness of at-sea enforcement of this alternative would be diminished, due to the use of contour lines for the closure boundaries, which adds complexity to the positioning accuracy necessary for compliance and enforcement and may require more patrol time for cutters.

4. Alternative 5A and 5B

   Alternatives 5A and 5B for the GOA would require the most resources to effectively enforce, due to the reasons outlined in describing Alternative 3 above and the fact that there are additional closures to those found in Alternative 3. Because both types of closures found in Alternatives 5A and 5B require gear specific restrictions, at-sea enforcement would require the use of Coast Guard cutters to support boardings to verify compliance.

Bering Sea sub-alternatives ranked from least resource intensive, to most resource intensive:

1. Alternative 5C (Preferred Alternative)

   Alternative 5C would require no additional EFH protection actions beyond the current status quo/ no action condition. Therefore, no additional reallocation of assets would be necessary.

2. Alternative 6

   Alternative 6, for the EBS, would require the least resources to enforce, due to the complete closure of designated areas (not gear- or species-specific), the general use of straight closure lines, and the ability of Coast Guard aircraft to patrol these areas going to and coming from the United States/Russia Maritime Boundary Line.

3. Alternatives 5A and 5B

   Alternatives 5A and 5B, for the EBS, would require more resources to enforce, due to the increased complexity of rotating closures. There would, however, not be a dramatic difference from the enforcement resource requirements of Alternative 6, above. Any illegal fishing within the permanently closed areas would likely be found in the proximity of the open areas.

Therefore, the vast expanse of ocean permanently closed to fishing would not require extensive patrols by Coast Guard cutters or aircraft.

4. Alternative 4

   Alternative 4, for the EBS, would have similar resource requirements as Alternatives 5A or 5B, with the only discernable difference being the smaller size of the rotating closures. Other than that small difference, the resource requirements would be virtually identical to those described in the paragraph above.

Aleutian Islands subalternatives ranked from least resource intensive, to most resource intensive:

1. Alternative 4

   Alternative 4 for the AI would require the least amount of resources of the AI subalternatives to enforce, due to the nature of the closures (complete closures) and the use of straight closure lines. As stated above, these features allow for enforcement using less resource intensive aircraft (instead of cutters), and the effectiveness of the enforcement will be enhanced by the straight lines used to draw the closure areas.

2. Alternative 5A

   Alternative 5A, for the AI, would require slightly more resources to enforce than Alternative 4, due only to the added complexity of having the Yunaska Island closure area and the Seguam Pass closure area close to each other and allowing fishing in the open area between. One larger closure generally requires fewer resources to enforce than two smaller closures.

3. Alternatives 5B, 5C (Preferred Alternative), and 6

   Alternatives 5B, 5C, and 6, for the AI, would require the most resources to enforce, due to the lack of straight line closures in Alternative 6 and the complexity and proximity of the open areas to other open areas in Alternatives 5B and 5C.[6] All of the alternatives would allow for aircraft enforcement, but the effectiveness of that enforcement would be diminished by the factors previously noted. Due to the likelihood that any illegal fishing in a closed area would occur near the edge of an open area, these alternatives have similar resource requirements.

In addition to Coast Guard and NMFS Enforcement, if EFH protection measures imposed in federal waters, were also imposed by the state of Alaska within state waters, there may be additional management and enforcement costs imposed on ADF&G and Alaska State Troopers. There is, at present, no information on the likelihood or the specific form of action the state of Alaska might take in connection with EFH fishing impact minimization. Therefore, no meaningful estimate of cost can be offered.

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[6] Two open areas close to each other with small closed areas between (or two closed areas in close proximity, with an open area between) make monitoring of those small closed areas difficult, because of the ability of violators to quickly enter into one of the open areas. Alternatives 5B and 5C have several such open areas, bordered by small closed areas, creating a patchwork effect that makes enforcement more challenging and, therefore, more resource intensive.

While not specifically contained in the alternatives, VMS or 100 percent onboard observer coverage are minimum requirements to effectively monitor compliance with any of the EFH protection measure alternatives.

Under provisions of the Steller sea lion management actions, VMS are required for trawl and hook and line catcher vessels and catcher-processors participating in the directed pollock, Pacific cod, and Atka mackerel fisheries. VMS provides real-time information on vessel location and can be useful for enforcing area closures and other elements of the fisheries management program. As described in Section 2.3.3 of the SEIS, many of the measures to protect EFH from fishing impacts depend heavily on the strict regulation of the location of fishing activities targeting many of the target fisheries in Alaska. Traditional methods of monitoring compliance with fishing regulations do not fully meet NMFS' need to monitor fishing activities, especially as envisioned under the EFH protection measure actions.

An electronic VMS is generally acknowledged to be an essential component of monitoring and management for complicated, geographically widespread fishing closures. As a result, Alternatives 2 through 6 would require expansion of VMS coverage beyond that currently imposed for Steller sea lion protection. Under these alternatives, additional vessels with a federal groundfish permit (and for some alternatives all groundfish, crab, halibut, and scallop vessels using bottom contact fishing gear) would be required to obtain, install, maintain, and operate an approved VMS at all times while operating in the EEZ off Alaska. This extension of the VMS program would impose additional fishery management costs on NMFS (sustainable fisheries in-season managers, and enforcement), as well as on the fishing industry itself.

VMS data would have to be monitored and interpreted by NMFS Enforcement. Currently, a VMS program manager, a VMS computer specialist, and an enforcement technician are on staff in the Regional Office to implement the existing VMS program. Because followup EFH investigations would be anticipated based on VMS data, the Alaska Enforcement Division (AED) would require two additional enforcement officers, one in Dutch Harbor and one in Kodiak. These officers would conduct dockside boardings and contacts to ensure compliance with EFH and VMS requirements, follow up on suspected violations, patrol with Coast Guard or other patrol units, and respond to observer affidavits, among other EFH-related tasks. One-time costs for training these new officers on the complexities of the VMS database and software would be required. Additional annual costs would also be incurred for office space, vehicles, and related support for these additional staff. Annual salary and personnel costs for these two officers are estimated to be $110,000 each. NMFS Enforcement also anticipates that it would have to add a VMS technician position to support the extension of the VMS requirements to the new classes of vessels considered here. Such a position is likely to be a contract position, costing about $87,000 per year (salary and benefits).

Past experience with VMS regulations promulgated for monitoring of the Stellar sea lion protection areas has demonstrated the need for dockside boardings to ensure understanding and compliance with new VMS requirements among the fleet and provide outreach efforts to VMS retailers and installers to address specific regulatory and implementation concerns. If additional personnel and/or funding for monitoring of EFH protection measures were not provided, any enforcement or compliance monitoring activities in support of EFH protection measures would likely occur at the expense of (i.e., reduction of efforts in) other regulatory areas.

Under existing regulations, a significant component of the groundfish fishery is subject to observer coverage. Observer related response and support are high priorities for NMFS Enforcement. The AED maintains field staff whose primary function is to provide intake and investigative response for complaints and affidavits completed by NMFS-certified observers and compliance-related training and support to observer program personnel. To the extent that any increase in fleet-wide observer coverage were required by EFH protection measures, these increases would be expected to require increased response by AED staff. Absent field staff increases, additional dilution and reprioritization of staff response would be necessary.

Additional Private Sector VMS Costs: As noted, the extension of the VMS program would also impose costs on the fishing industry. These are discussed in more detail in Section C.3.8.4.3. Various VMS packages are available. Operations that must acquire VMS for the first time would have to pay about $1,550 for purchase, installation, and activation of their units. Operations that already have VMS would have to pay $5 per day (or $155 per month) for any new transmissions associated with the EFH or HAPC protection measures.

Operations that must acquire VMS would have to pay $74 per month for transmissions, and $5 per month for a dry dock fee to cover months without transmissions. Repair costs would average about $93 per year for vessels 32 feet and under and $47 per year for larger vessels. VMS equipment failure may also interfere with normal vessel operations until repairs can be made, and this may impose additional costs. NMFS Enforcement treats equipment breakdowns on a case-by-case basis and tries to avoid interrupting a fishing trip already in progress. This is a permanent program, and vessels would incur additional costs as they had to replace VMS units and antennas.

Additional Private Sector Observer Costs: Observer programs are conducted by NMFS in the groundfish fishery and by ADF&G in the crab and scallop fisheries. Under provisions of these management programs, the industry contracts directly with authorized Observer Provider companies. These firms supply observers to fishing vessel operators, as well as to shoreside plants, under contract. The fishing vessel operator pays for the observer services, as required, based upon the coverage level specified in regulation.

If the selected fishing impact minimization alternative results in additional fishing and running time as discussed above under Operating Cost Impacts (RIR Section 3.1.3), the cost of providing observer coverage would increase proportionately.

C.3.1.2.8 Impacts on Dependent Communities

Many of the communities of coastal Alaska that are adjacent to the BSAI and GOA are engaged in, and highly dependent upon, the commercial fisheries in the adjacent EEZ. The nature of engagement varies from community to community and from fishery to fishery. Some communities have fish processing facilities, others are homeport to harvest vessels, and many have both processors and harvesters. Some of the larger communities also have relatively well-developed fishing support sectors. Other communities participate in the fisheries primarily through the BSAI community development quota (CDQ) program. The engagement of CDQ communities occurs in a variety of ways, including receipt of royalties, investment in commercial fishing harvest and/or processing entities, and direct participation in commercial fishing activities through owning/operating vessels. CDQ investments in community fisheries infrastructure, training, and vessels have resulted in additional employment and income for local residents. Sixty-five CDQ communities and numerous Alaska non-CDQ communities (including Unalaska/Dutch Harbor, Sand Point, King Cove, Chignik, Cordova, Seward, Homer, Adak, Sitka, Petersburg, Yakutat, and Kodiak) are most clearly and directly engaged in and dependent upon multiple BSAI and/or GOA fisheries. In addition, Seattle, Washington (and the adjacent Puget Sound area) has a substantial and direct involvement in many of these fisheries. Harvest vessels from Oregon, especially from Newport, also account for a significant portion of the total catch in a number of the larger groundfish and crab fisheries.

Alternative 1 would not provide any additional measures to minimize the effects of fishing on EFH beyond those currently in place or planned as part of other fishery management actions. Therefore, there would be no direct short-term effect on dependent communities. In the long term, it is possible that taking no action under Alternative 1 would adversely affect the fisheries and, in turn, the dependent communities. However, there is no available information to link the effects of fishing on EFH to future production or yield of FMP species; therefore, such potential future effects cannot be demonstrated at this time. Future accumulation of knowledge and improved models should improve our ability to examine the linkages between the effects of fishing on EFH and the future production and yield of FMP species.

For the dependent Alaska communities, there are very few economic opportunities available as an alternative to commercial fishing related activities. For many of these communities (and especially the CDQ communities), unemployment is chronically high, well above the national average, and the potential for economic diversification of these largely remote, isolated, local economies is very limited. Indeed, it is this absence of economic opportunity, combined with the ebb and flow of fishery activity, that has historically resulted in a high level of transient, seasonal labor, and an unstable population base in many of the communities with processing facilities. Closure of portions of EFH areas to fishing, as provided for under virtually all of the proposed fishing impact minimization alternatives except the status quo (Alternative 1), could further reduce employment and business opportunities, especially in communities with significant investment in onshore processing capacity and fleet services, further destabilizing these rural coastal communities. From firms with direct and obvious linkages to the fisheries, such as maritime equipment purveyors, fuel pier operators, cold storage and bulk cargo transshipping firms; to local hotels, restaurants, bars, grocery stores, and commercial air carriers serving these communities, all would be affected by the structural changes in commercial fishing attributable to the fishing impact minimization measure actions. While not readily amenable to quantitative estimation at present, overall, many of these relatively isolated, rural, fishery-dependent communities would likely experience some level of loss in economic and social welfare, as reflected through a general decline in the quality-of-life for their residents. Beyond the private sector effects, local government jurisdictions would likely be adversely affected as well. Most of these coastal fishing communities rely heavily upon tax revenues associated with fishing activities, in all its myriad forms, for operating and capital funds (e.g., fish landings taxes, business and property taxes, sales taxes).

As populations adjust to structural changes associated with some of the alternatives, emigration would likely impose burdens on local social service agencies. For example, school districts depend for economic support upon state and federal revenues based upon per capita enrollment. Because few, if any, viable alternative sources of economic activity exist in most of these rural coastal Alaska communities, the prospects for mitigating any adverse impacts do not appear promising, at least in the foreseeable future.

Fishing is the economic base in many of these communities. Moreover, these communities are generally very fragile, in the sense that they do not have well-developed secondary economic sectors. The cost of doing business in these communities is high and few retail or other firms find it economically advantageous to locate in them. As a result, local residents often have no choice but to spend a large part of their incomes outside their communities. In addition, many who work in the fishing and/or processing sector in these communities are transient laborers who take a large part of their incomes home with them at the end of the season.

Anything that tends to diminish economic activity in such a setting (e.g., reduction in seafood landings, fishing activity, and associated exports) can do disproportionate harm to an already limited infrastructure in these communities. Many of these communities may become vulnerable to loss of transportation service due to disruptions in key fisheries, attributable to EFH-associated regulations. While the relationship is likely not perfectly linear, the more significant the structural change associated with the final alternative adopted (e.g., the greater the increase in revenue at risk, especially adjacent to these communities), the greater will likely be the adverse effects on community stability, social welfare, and quality of life.

Communities that support and depend upon these commercial fisheries may incur substantial adverse economic, socioeconomic, and cultural impacts as they adjust to changes in the total magnitude of fishery related activities, associated with newly imposed requirements of any selected EFH protection management regime. Because much of the economic infrastructure of rural Alaska coastal communities has developed in support of commercial fishing, secondary adverse effects on businesses that supply goods and services to the fleet would also be widespread.

Sixty-five communities in the BSAI region, organized into six non-profit groups, depend upon CDQs of groundfish and crab. These CDQs are either harvested directly by vessels belonging to the communities or contracted out to private companies. If, as expected, the fishing impact minimization alternatives being considered result in lower CPUEs and higher costs in fishing operations, the revenue from the CDQ harvests would be diminished, the value of the CDQ allocations to the member-communities would decrease, and secondary adverse impacts on community businesses would occur.

Alaska non-fishing communities could also have experienced a variety of adverse economic or social impacts related to the different alternatives. These include changes in local public revenues (e.g., where fish taxes collected within organized boroughs directly benefit fishing and non-fishing communities alike), changes in direct employment and income of local residents of non-fishing communities (e.g., where individuals serve as skippers or crew on fishing vessels from other communities), and a loss of indirect benefits derived from nearby fisheries activities (e.g., where the frequency, capacity, and cost of air passenger and cargo service [as well as the cost of surface shipping and, thus, the local cost of a wide range of goods from groceries to fuel] are influenced by the level of local transportation demand created by commercial-fishery-related activity). Whether these types of impacts would actually have been realized in Alaska non-fishing communities varies by alternative.

C.3.2 Alternative 1 (Status Quo)

Under this alternative, no additional measures would be taken at this time to minimize the effects of fishing on EFH.

C.3.2.1 Benefits Associated with Alternative 1

C.3.2.1.1 Passive-use Benefits

Under Alternative 1, fishing activities would continue to affect EFH at current levels (Table 3.2-1).

C.3.2.1.2 Use and Productivity Benefits

Alternative 1 would not provide any additional measures to minimize the effects of fishing on EFH beyond those currently in place or planned as part of other fishery management actions. With current scientific knowledge, it is not possible to predict whether future industry revenue would be placed at risk by taking no action under Alternative 1, because there is no available information to link the effects of fishing on EFH to future production or yield of FMP species. Current information and models provide highly conditional estimates of changes to general components of benthic habitats, and studies to date have identified species that may use the affected features to grow, survive, and reproduce. Even assuming accurate estimates of habitat changes, however, current information and models are insufficient to determine how much such changes detectably affect these processes for FMP fish stocks or to extend such a linkage to estimate changes in their future production or yield. Future accumulation of knowledge and improved models should improve scientists' ability to examine such linkages.

C.3.2.2 Costs Associated with Alternative 1

C.3.2.2.1 Industry Revenue at Risk[7]

There would be no short-term industry revenue at risk under Alternative 1 because there would be no additional fishing impact minimization measures put in place. Potential long-term impacts are unknown, although it is possible that a continuation of current management could lead to a diminishment of EFH, which could in turn lead to a diminished commercial fishery.

C.3.2.2.2 Product Quality and Revenue Impacts

There would be no short-term product quality and revenue impacts from Alternative 1. Potential long-term impacts are unknown, although it is possible that a continuation of current management could lead to a diminishment of EFH, which could in turn lead to a decline in product quality and reduction in fishing revenues.

C.3.2.2.3 Operating Cost Impacts

There would be no short-term operating cost impacts from Alternative 1. Potential long-term impacts are unknown, although it is possible that a continuation of current management could lead to significantly higher operating costs (e.g., continuously declining CPUE).

C.3.2.2.4 Safety Impact

There would be no safety impacts from Alternative 1.

C.3.2.2.5 Impacts on Related Fisheries

There would be no impacts on related fisheries from Alternative 1.

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[7] Revenue at risk represents an upper-bound projection of the gross value of the catch that could be foregone, assuming none of the displaced catch was subsequently made up (see footnote 2).

C.3.2.2.6 Costs to Consumers

There would be no short-term change in costs to consumers for fishery-derived products under Alternative 1. Potential long-term impacts are unknown, although it is possible that a continuation of current management could lead to a diminishment of EFH, which could in turn lead to adverse effects on consumers (e.g., higher prices, reduced availability, lower quality).

C.3.2.2.7 Management and Enforcement Costs

There would be no short-term changes in management or enforcement costs under Alternative 1. Potential long-term impacts are unknown, although it is possible that a continuation of current management could lead to a diminishment of EFH, which could in turn lead to productivity declines in FMP-managed species, a more aggressive and competitive fishing environment, and an increased need for monitoring and enforcement. It may be equally plausible that this would not be the result, if the Council chose to retain the status quo.

C.3.2.3 Distributional Impacts

C.3.2.3.1 Gross Revenue at Risk

No short-term revenue would be placed at risk under Alternative 1. Potential long-term impacts are unknown, although it is possible that a continuation of current management could lead to a diminishment of EFH, which could in turn lead to a diminished fishery and declining revenues.

C.3.2.3.2 Impacts on Dependent Communities

No short-term impacts to dependent communities are foreseen under the Status Quo alternative. Communities currently dependent on the relevant fisheries would continue to engage in fishing and related activities in the same manner as is occurring at present. Potential long-term impacts are unknown.

C.3.3 Alternative 2

This alternative would amend the GOA Groundfish FMP to prohibit the use of bottom trawls targeting rockfish in 11 designated areas of the GOA slope (200 to 1,000 m), but would allow vessels endorsed for trawl gear to fish for rockfish in these areas with fixed gear or pelagic trawl gear. For a more detailed description of the measures imposed by Alternative 2, see EIS Section 2.3.3.

C.3.3.1 Benefits Associated with Alternative 2

C.3.3.1.1 Passive-use Benefits

Under Alternative 2, non-pelagic trawl (NPT) fishing activities targeting slope rockfish in 11 designated areas of the GOA would be eliminated. While it is not possible at this time to provide an empirical estimate of the changes in passive-use value attributable to this protection of EFH, it is assumed that Alternative 2 would yield some incremental increase in the passive-use benefit of EFH over the status quo Alternative 1 (Table 3.3-1). Alternative 2 would eliminate any further impact from NPT fishing for slope rockfish over a total of 10,228 square kilometers (km^2) of GOA shelf and slope edge habitat, or 3.7 percent of the existing fishable area of 279,874 km^2 in the GOA (Table 1.4-1) See EIS Sections 2.3.3 and 4.3 for details on the measures and the environmental consequences of Alternative 2.

C.3.3.1.2 Use and Productivity Benefits

Alternative 2 was designed to reduce the effects of NPT fishing for slope rockfish on EFH in the GOA beyond those measures currently in place or planned as part of other fishery management actions. Current scientific knowledge does not permit either a quantitative or qualitative assessment of the use benefits derived from minimizing the effects of fishing on EFH (Table 3.3-1). However, the assumption implicit in the amendment to the Magnuson-Stevens Act requirement to minimize effects of fishing on EFH is that doing so would result in the sustained or enhanced production from FMP species and contribute to a healthy ecosystem. As such, Alternative 2 would contribute additional measures that would further reduce the impacts of fishing on EFH.

C.3.3.2 Costs Associated with Alternative 2

C.3.3.2.1 Industry Revenue at Risk

Alternative 2, had it been in place in 2001, would have placed a total of $900,000 of gross revenue at risk in the GOA NPT slope rockfish target fisheries (including the value of retained bycatch). The revenue at risk would have been equal to 9.6 percent of the total status quo revenue of $9.36 million (Table 3.3-1).

The 11 designated EFH protection areas described under Alternative 2, are discreet and widely spaced along the GOA outer shelf and slope edge. There is substantial slope rockfish fishing area adjacent to the 11 areas designated for fishing impact minimization measures, where some or all of the revenue at risk could possibly have been mitigated by a redeployment of fishing effort. Additionally, slope rockfish are caught with pelagic trawl gear (PTR), used primarily by the larger catcher-vessel and catcher-processor fleet components (NMFS 2002d). The revenue at risk in the catcher-vessel fleet would have been very small compared with the status quo revenue, and, therefore, the revenue at risk could possibly have been mitigated by redeploying NPT fishing effort into adjacent areas not affected by the fishing impact minimization measures under Alternative 2. Although the revenue at risk in the catcher-processor fleet under Alternative 2 would have been larger than that in the catcher-vessel fleet and representsed more than 12 percent of the total status quo revenue in the catcher-processor fleet component of this fishery, catcher-processor revenue at risk might also have been capable of being mitigated by redeploying NPT fishing effort for slope rockfish to fishing areas adjacent to the areas directly affected by Alternative 2.

It is not possible to estimate the amount of the revenue at risk under Alternative 2 that could have been recovered by redeployment of fishing effort to adjacent areas, or to alternative fishing gears, without a thorough understanding of the fishing strategies that would actually have been employed by fishermen in response to the impacts imposed by Alternative 2. No such information is currently available. Indeed, it is likely that the affected fishermen, themselves, do not yet know how they would adjust to such a new management environment.

C.3.3.2.2 Product Quality and Revenue Impacts

Revenue impacts from changes in product quality could have been minimal under Alternative 2 for both catcher-vessel and catcher-processor fleet components. The small catch and revenue at risk in the catcher-vessel fleet component of the NPT slope rockfish fishery could possibly have been recovered by redeploying fishing effort to areas adjacent to the protected areas with additional time required to attain the necessary catch and deliver it to a shore-based plant for processing. Product quality would not likely have been affected in the catcher-processor fleet component, since these vessels process the catch onboard the vessel (Table 3.3-1).

C.3.3.2.3 Operating Cost Impacts

Operating cost impacts under Alternative 2 could have been minimal for the catcher-vessel fleet given the very small amount of revenue at risk for this fleet component. Operational costs for the catcher-processor fleet component might have increased due to the redeployment of fishing effort necessary to mitigate the 12.3 percent of the status quo revenue at risk for this fleet component. Fishing effort redeployed into areas adjacent to the protected areas might have had lower CPUE of slope rockfish, requiring additional fishing effort to mitigate the catch and revenue at risk. There may have been crowding externalities, as well, as effort became concentrated in remaining open areas (Table 3.3-1).

C.3.3.2.4 Safety Impact

Alternative 2 likely would not have affected safety in the catcher-vessel fleet component, given the unlikelihood of any significant changes in the operational aspects of this fleet. There could potentially have been an increase in adverse the safety impacts of Alternative 2 on the catcher-processor fleet component if additional fishing effort and time had been required to mitigate the revenue at risk for this fleet component (Table 3.3-1).

C.3.3.2.5 Impacts on Related Fisheries

Alternative 2 would have been unlikely to have had significant impacts on related fisheries because NPT fishing effort for slope rockfish would likely have been redeployed into adjacent areas not affected by the fishing impact minimization measures. NPT fishing for slope rockfish currently occurs in those adjacent areas (Table 3.3-1).

C.3.3.2.6 Costs to Consumers

Had it been in place in 2001, Alternative 2 would likely have had some impact on the cost to consumers because, although some or all of the revenue at risk may have been recovered by redeployment of fishing effort, there would likely have been some operational cost increases for the fleet components (Table 3.3-1). These operational cost increases due to Alternative 2 fishing impact minimization measures may have resulted in changes in the product mix, quality, and availability, and, therefore, could under these rules, have resulted in a measurable increase in the cost to consumers of species caught in fisheries directly or indirectly affected by redeployment of the fishing effort. It is not possible, with data and market models currently available, to confirm the existence or size of these potential impacts.

C.3.3.2.7 Management and Enforcement Costs

Management and enforcement costs may have increased under Alternative 2, although it is not possible to estimate by what amount (Table 3.3-1). Under these regulations, additional on-water enforcement could be required to assure compliance with the fishing impact minimization measures applied to the 11 designated areas in the GOA. Although not specifically required by the alternative, a VMS or 100 percent observer coverage could have been needed on all vessels targeting slope rockfish with NPT gear in the GOA to assure compliance with the fishing impact minimization measures under

Alternative 2. Most groundfish vessels operating in the GOA for pollock or Pacific cod fisheries are already equipped with VMS. Vessels not equipped with VMS systems could have been required to install and operate the VMS equipment during the GOA slope rockfish fishery in 2001, and would be in the future, should this alternative be selected by the Council. The GOA slope rockfish fishery occurs primarily 1 to 2 months per year. The number of additional vessels that would have require the VMS system under Alternative 2 is not known. Alternative 2 fishing impact minimization measures are specific to gear (NPT) and target fishery (slope rockfish) and could require additional enforcement measures (boarding and inspection) beyond the typical time/area/fishery management measures currently employed in the GOA.

Although only fishing impact minimization measure Alternative 5B specifically requires the development and implementation of a research and monitoring program, some level of research and monitoring of the effectiveness of the fishing impact minimization measures would likely occur under any alternative adopted. Accomplishing these research and monitoring projects would require significant additional expenditures by the Alaska Region and Alaska Fisheries Science Center over a period of years. Section 3.1.2.7 contains more detail on the NMFS Enforcement and Coast Guard responses to Alternative 2.

C.3.3.3 Distributional Impacts

C.3.3.3.1 Gross Revenue at Risk Effects

C.3.3.3.1.1 Geographic Area Impacts

The impact analysis is presented as if the action in question had, in fact, been adopted and implemented for the 2001 fishing year. Alternative 2 imposes no fishing impact minimization measures in the EBS or AI. Within the GOA, the largest amount of revenue at risk would have been in the Central Gulf of Alaska (CG) with $640,000 at risk, or 8.1 percent of the $7.95 million status quo revenue in the CG (Table 3.3-2). The revenue at risk in the Western Gulf of Alaska (WG) totalsed $230,000, or 28.9 percent of the total status quo revenue of $790,000, reported in 2001. There would have been less revenue at risk in the Eastern Gulf of Alaska (EG), equaling $22,711 or 3.6 percent of the $620,000 status quo revenue, reported in 2001, in the EG.

C.3.3.3.1.2 Fishery Impacts

The only fishery that would have been directly affected by the fishing impact minimization measures, under Alternative 2, is the NPT slope rockfish fishery in the GOA. The total revenue at risk in this fishery would have been $900,000, or 9.6 percent of the 2001 status quo revenue of $9.36 million (Table 3.3-2).

C.3.3.3.1.3 Fleet Component Impacts

The catcher-processor fleet would have had the greatest amount of revenue at risk at $870,000, or 12.3 percent of the status quo total revenue. The catcher-vessel fleet would have had $28,570 of ex-vessel revenue at risk, or 1.2 percent of the 2001 total status quo ex-vessel revenue of $2.33 million. The catcher-vessel fleet would have had revenue at risk only in the CG, whereas the catcher-processor fleet would have had revenue at risk in both the CG and WG. Catcher-processor fleet revenue at risk in the CG would have equal $620,000, or 10.9 percent of 2001 status quo. The catcher-processor fleet would also have had $230,000 of revenue at risk in the WG, or 28.9 percent of the $790,000 status quo

2001 gross revenue in the WG, and nearly all of the $22,711 in revenue at risk in the EG, as well (Table 3.3-2).

C.3.3.3.2 Impacts on Dependent Communities

C.3.3.3.2.1 Overview

Impacts on dependent communities would be expected to be insignificant under Alternative 2, although at least a few individual operations may experience adverse impacts, as detailed below. The only fisheries directly affected by this alternative would be the rockfish fisheries in the GOA, and the only gear group directly affected (for both catcher vessels and catcher-processors) would be non-pelagic trawl. Using 2001 fleet data, 23 vessels (both catcher vessels and catcher-processors) would be affected by this alternative: 3 from Alaska, 4 from Oregon, 15 from Washington, and 1 from another state. Using 2001 processor data, 10 shoreside processors in Alaska would potentially be affected by this alternative.

C.3.3.3.2.2 Catcher Vessels

For catcher vessels, revenue at risk is exclusively concentrated in the CG and represents 1.23 percent of the status quo value (about $29,000 out of $2.33 million) for rockfish fishery harvest of the affected vessels in this area. As noted elsewhere, figures given for catcher vessels represent ex-vessel revenues, which would tend to understate the overall value to associated communities that derive benefits from both harvesting and processing activities if examined alone. Values for first wholesale revenues at risk by shoreside processors from landings of catcher vessels are referenced in the information on shoreside processor locations provided below. As discussed earlier, given the location and size of the closure areas and the small proportion of catch at risk, it is assumed that vessels could recover any potential losses in catch through minimal additional effort. In 2001, the ownership of catcher vessels involved in the at-risk harvest was concentrated in Washington and Oregon communities (with five and four vessels, respectively). Within Alaska, only Kodiak and Anchorage had any vessel ownership, with just one vessel each. No significant impacts are foreseen for these communities as a result of changes associated with catcher vessels under this alternative, due to the low revenues at risk and the small numbers of vessels involved.

C.3.3.3.2.3 Catcher-Processors

For catcher-processors, revenue at risk is concentrated in the CG, but not exclusively so, and represents 12.24 percent of the status quo value (about $860,000 out of $7.04 million) for rockfish fishery harvest of affected vessels in the entire GOA. It is possible that catcher-processors could make up foregone harvests from closed areas by fishing in adjacent open areas, but the costs associated with this increased effort are unknown at this time. The catcher-processors involved in the at-risk harvest generally head, eviscerate, and freeze their catch (and are known as head and gut vessels). Ownership of these vessels is concentrated in Washington with 10 vessels (Kodiak is the only Alaska community with ownership, and then only for 1 vessel; 1 catcher-processor is owned in another state). No significant impacts are foreseen for the community of Kodiak as a result of changes associated with catcher-processors under this alternative, due primarily to having only a single vessel involved. Community level impacts are not anticipated in Washington, even though most vessels with at-risk revenues are concentrated there, due to the large size and diversity of its economy. Individual entities may experience increased costs and/or reductions in harvest.

C.3.3.3.2.4 Shoreside Processors

A summary of the 2001 first wholesale market level impacts of Alternative 2 for shoreside processors (by FMP region of harvest) is presented below. These shoreside processor first wholesale impact estimates are strictly non-additive, with the catcher vessel ex-vessel impact estimates associated with this alternative presented above. Indeed, were the data available to permit a quantitative net impact assessment, the ex-vessel revenues accruing to the catcher vessel operators delivering inshore would appropriately be accounted for as just one of many input costs to the plant's production process (e.g., electricity, water, packaging, labor, etc.). These input costs (e.g., ex-vessel payments to catcher vessels for delivery of raw fish) would be deducted from (rather than summed with) the plant's gross earnings, to arrive at net revenue at this level of the market.

Being unable, due to data limitations, to carry out this final analytical step, the quantitative impact estimates are limited to gross effects. Both market-level impacts (i.e., ex-vessel and first wholesale) are presented to accommodate the specific information needs of each potentially affected sector (e.g., catcher vessels, catcher-processors/motherships, shoreside processors), but their interpretation and application (as noted above) should not be confused. The first wholesale information for shoreside processors may be loosely interpreted for some types of community impacts, but there are four main caveats for the use of this information for these purposes. First, numerous locally important sources of revenue such as fish taxes, which are the cornerstone of municipal revenues in some communities, are more closely tied to the ex-vessel value of landings than to processor first wholesale values. Second, depending on the structure of the individual processors, the individual communities, and the relationships between the two, more or less of the difference between the ex-vessel and first wholesale values may be realized as inputs to the local economy of any particular place. This is due, in part, to the degree to which the individual processing entities are effectively operating as industrial enclaves, the relationship of the workforce to the overall resident labor force (and general population) of the community, the degree of development of local support service industries, local public revenue and service provision structures, and the structure of ownership of the processing entity, among many other factors. Third, the information on first wholesale value for processors is available only on an FMP regional basis and cannot be directly attributed to individual communities, although inferences on general patterns of distribution of impacts may be drawn from the information presented below. Fourth, and perhaps most important, overall harvest levels are unlikely to change substantially as a direct result of this alternative (and a number of other alternatives). While individual entities may be relatively advantaged or disadvantaged, it is likely that these gains and losses will be more or less neutral at the community level, although some cost increases may be anticipated.

For shoreside processors in Alaska, no substantial impacts are foreseen under this alternative because catcher vessel harvest levels are expected to remain constant, and no substantial change in the fishery that would change delivery patterns is forecast (although there may be some relatively minor redistribution of catch among individual vessels). Based on 2001 data, processors involved in the at-risk harvest were concentrated in Kodiak, with eight entities involved. Unalaska/Dutch Harbor and Homer each had one processor that processed at least some volume landed by vessels with some revenue at risk under this alternative. As shown in Table 3.3-3, the total first wholesale value at risk of catch delivered inshore for processing represents approximately 1 percent of the total status quo value (about $149,000 out of $10.78 million) of the relevant fisheries of the CG area, but no breakdown by port of landing is available. Given the very minor potential changes, however, no significant impacts are foreseen for Kodiak or for any other dependent community as a result of changes associated with processors under this alternative.

C.3.3.3.2.5 Multi-Sector Impacts

Multiple sector impacts are unlikely to be significant at the community level under Alternative 2. Among Alaska communities, only Kodiak participates in more that one sector with at-risk revenues and then with only a single locally owned catcher vessel, a single locally owned catcher-processor, and multiple locally operating shoreside processors. As noted, impacts to shoreside processors are anticipated to be insignificant due to the low volumes at risk and the assumption that overall delivery patterns are unlikely to change under this alternative. Some additional Alaska resident crew positions on vessels owned elsewhere may have some compensation at risk, but overall potential for employment and wage or crew share compensation loss is small. Transient vessels owned outside of Alaska typically also make expenditures in ports of landing, which in this case would be concentrated in Kodiak. Given the assumption of general landing patterns remaining consistent, however, any vessel expenditure associated impacts are likely to be minor.

The potential for cumulative impacts is less straightforward. Even if the potential for social impacts under Alternative 2 would not be significant in isolation, this alternative would have the potential, nonetheless, to impose adverse cumulative impacts when evaluated in the context of other factors that currently affect North Pacific and EBS fisheries and fishing communities. Cumulative effects could include interactions with the social impacts of, among others, the near-shore closures put in place in 2001 to protect Steller sea lions, proposed rationalization of the BSAI crab and GOA groundfish fisheries, and the severe decline of salmon prices. These effects would likely be concentrated in communities with (relatively) significant dependence on small boat fleets and those that depend on both salmon harvesting and one or more of the fisheries that would be affected by the alternative.

C.3.4 Alternative 3

This alternative would amend the GOA Groundfish FMP to prohibit the use of bottom trawls targeting rockfish along the GOA slope (200 to 1,000 m), but would allow vessels endorsed for trawl gear to fish for rockfish in these areas with fixed gear or pelagic trawl gear. For a more detailed description of the fishing impact minimization measures imposed by Alternative 3, see EIS Section 2.3.3. For a description of the environmental consequences of Alternative 3, see EIS Section 4.3.

C.3.4.1 Benefits Associated with Alternative 3

C.3.4.1.1 Passive-use Benefits

Under the simplifying analytical convention that Alternative 3 was in effect in 2001, NPT fishing activities targeting rockfish along the slope (200 to 1,000 m) of the GOA would have been eliminated. While it is not possible at this time to provide an empirical estimate of the passive-use value attributable to this protection of EFH, it is assumed that Alternative 3 would yield some incremental increase in the passive-use benefit of EFH over the status quo Alternative 1 (Table 3.4-1). Alternative 3 would minimize the impact of NPT fishing for slope rockfish over a total of 29,059 km^2 of GOA shelf and slope edge habitat, or 10.4 percent of the existing fishable area of 279,874 km^2 (Table 1.4-1). See EIS Section 4.3 for details on the environmental consequences of Alternative 3.

C.3.4.1.2 Use and Productivity Benefits

Alternative 3 is designed to reduce the effects on EFH of NPT fishing for slope rockfish along the slope edge in the GOA beyond measures currently in place or planned as part of other fishery management actions. Current scientific knowledge does not permit either a quantitative or qualitative assessment of the use benefits derived from minimizing the effects of fishing on EFH. However, the assumption implicit in the amendment to the Magnuson-Stevens Act requirement to minimize effects of fishing on EFH is that doing so would result in the sustained or enhanced production from FMP species and contribute to a healthy ecosystem (Table 3.4-1). As such, Alternative 3 would contribute additional measures to further reduce the impacts of fishing on EFH.

C.3.4.2 Costs Associated with Alternative 3

C.3.4.2.1 Industry Revenue at Risk

Had it been implemented in 2001, Alternative 3 would have placed a total of $2.65 million of gross revenue at risk in the GOA NPT slope rockfish target fisheries, including the value of retained bycatch. This was equal to 28.3 percent of the reported 2001 status quo total revenue of $9.36 million (Table 3.4-1).

The fishing impact minimization measure areas described under Alternative 3 would have been imposed upon the GOA shelf and slope edge between 200 and 1,000 m. Although some slope rockfish are caught at depths shallower than 200 m in the GOA with NPT, a majority of the NPT commercial catch of the slope rockfish complex occurs at depths in excess of 150 m (NMFS 2002d). There is limited fishing area for slope rockfish in the 150 to 200 m slope edge adjacent to the 200 to 1,000 m area designated for fishing impact minimization measures. This suggests that there would have been limited areas where the revenue at risk might have been mitigated, in whole or in part, by a redeployment of NPT fishing effort. Approximately 20 percent of the catch of the primary slope rockfish species, Pacific ocean perch, is taken by PTR, fished by larger catcher-vessel and catcher-processor fleet components. Between 30 and 50 percent of the shortraker/rougheye rockfish in the slope rockfish complex are taken incidentally, by HAL gear, in the sablefish and halibut fisheries.

Under Alternative 3, not all revenue at risk could have been recovered by redeployment of fishing effort to adjacent areas or switching to PTR gear by most of the fleet components involved in the fishery in 2001. The smaller catcher-vessel fleet targeting slope rockfish almost exclusively uses NPT gear and has neither sufficient horsepower to fish PTR, nor the revenue from participation in this fishery to warrant the investment needed to use PTR gear. The larger catcher vessels (which also target pollock) and the catcher-processors either already have PTR gear available or have sufficient horsepower to convert to PTR to target slope rockfish. Under Alternative 3, while the revenue at risk might have been recovered by vessels fishing adjacent areas, not affected by the alternative, or by switching to PTR gear within the protected area, there would likely have been a transference of catch share, and thus a transfer of revenue in the fishery from the smaller catcher-vessel fleet component to the larger catcher-vessel and catcher-processor fleet components. The magnitude of this transfer is impossible to estimate without specific knowledge of the redeployment fishing effort strategies that would have been followed by the different fleet components, faced with these fishing rules in 2001. Nor is it possible to estimate the total amount of the revenue at risk under Alternative 3 that could have been recovered by redeployment of fishing effort to adjacent areas or to alternative fishing gears. Such an estimate is not possible without a thorough understanding of the fishing strategies that would have actually been employed by fishermen in response to the impacts of the fishing impact minimization measures imposed by Alternative 3. That information is not available.

C.3.4.2.2 Product Quality and Revenue Impacts

Revenue impacts from changes in product quality would have been possible under Alternative 3, particularly for the smaller catcher-vessel fleet component that could have been required to expend additional fishing effort to recover the catch at risk. This could have lengthened fishing trips and result in diminished product quality. Product quality might not have been affected in the catcher-processor fleet component, since these vessels process the catch onboard the vessel.

C.3.4.2.3 Operating Cost Impacts

Operating costs under Alternative 3 c would likely have been greater overall for both catcher-vessel and catcher-processor fleet components. CPUE of slope rockfish caught with PTR gear and with NPT gear at depths shallower than 200 m along the GOA slope edge is very likely to have been lower than the CPUE of NPT gear in the depth range of 200 m and greater normally fished for these species. If this were not the case, one would expect to observe this behavior in the absence of regulations that make it necessary. This may have resulted in increased fishing effort and associated increased operational costs to make up the catch and revenue at risk.

C.3.4.2.4 Safety Impact

Alternative 3 could have adversely affected safety in all fleet components of the GOA slope rockfish fishery, given the likelihood of significant changes in the operational aspects of these fleets and possible increased fishing effort to mitigate the revenue at risk.

C.3.4.2.5 Impacts on Related Fisheries

There may very well have been an impact on related fisheries from Alternative 3, had it been in place in 2001, because a substantial amount of NPT fishing effort for slope rockfish would likely have been redeployed into adjacent areas shallower than 200 m and not directly affected by Alternative 3. Other fisheries already use these areas, including halibut longline, Pacific cod longline (if open), and other NPT fisheries such as shallow water flatfish. Increased NPT fishing effort at depths less than 200 m along the GOA shelf edge may have imposed substantial economic and operational externalities on these fisheries.

C.3.4.2.6 Costs to Consumers

Alternative 3 would have been likely to have imposed some impact on costs to consumers because, although some or all of the revenue at risk may have been recovered by redeployment of fishing effort, there would likely have been some operational cost increases for the affected fleet components (Table 3.4-1). These operational cost increases, due to Alternative 3 fishing impact minimization measures, may have resulted in a measurable increase in price to consumers of species caught in fisheries directly or indirectly affected by redeployment of the fishing effort, had these measures been in place for the 2001 fisheries. There may also have been welfare costs imposed on consumers from changes in availability of supply, product mix, and/or quality.

C.3.4.2.7 Management and Enforcement Costs

Management and enforcement costs would have been likely to increase under Alternative 3, although it is not possible to estimate by what dollar amount. Section 3.1.2.7 contains some additional detail on the NMFS Enforcement and Coast Guard responses to resource demands connected with monitoring and enforcing provisions of Alternative 3. Although not specifically required by the alternative, a VMS or 100 percent observer coverage could have been needed on all vessels targeting slope rockfish with NPT gear in the GOA to assure compliance with the fishing impact minimization measures under Alternative 3. Most groundfish vessels operating in the GOA for pollock or Pacific cod are already equipped with a VMS. Vessels not equipped with VMS systems might have needed to install and operate the VMS equipment during the 2001 GOA slope rockfish fishery, which traditionally occurs primarily during 1 to 2 months of the year. The number of additional vessels that might have needed to add VMS equipment under Alternative 3 is not known. Alternative 3 fishing impact minimization measures are specific to gear (NPT) and target fishery (slope rockfish) and could, when adopted, require additional enforcement measures (boarding and inspection) beyond the typical time/area/fishery management measures currently employed in the GOA.

Although only fishing impact minimization Alternative 5B specifically requires the development and implementation of a research and monitoring program, some level of research and monitoring of the effectiveness of the fishing impact minimization measures would likely occur under any alternative adopted. Accomplishing these research and monitoring projects would require significant additional expenditures by the Alaska Region and Alaska Fisheries Science Center over a period of years.

C.3.4.3 Distributional Impacts

C.3.4.3.1 Gross Revenue at Risk Effects

C.3.4.3.1.1 Geographic Area Impacts

Assuming, for sake of analysis, that the 2001 fisheries were regulated under Alternative 3, it would have imposeds no fishing impact minimization measures in the EBS or AI. Within the GOA, the largest amount of revenue at risk would have been in the CG, with $2.2 million at risk, or 28.0 percent of the $7.95 million 2001 status quo revenue (Table 3.4-2). The revenue at risk in the WG would have totaled $220,000, or 27.3 percent of the 2001 total status quo revenue of $790,000. The revenue at risk in the EG would have totaleds $210,000, or 33.3 percent of status quo revenue (EG).

C.3.4.3.1.2 Fishery Impacts

The only fishery that would have been directly affected by Alternative 3 is the NPT slope rockfish fishery in the GOA. The total revenue at risk in this fishery was $2.65 million, or 28.3 percent of the status quo revenue of $9.36 million in 2001 (Table 3.4-2).

C.3.4.3.1.3 Fleet Component Impacts

The catcher-processor fleet would have had the greatest amount of revenue at risk, equaling $2.2 million or 31.5 percent of the status quo total revenue of $7.04 million. The catcher-vessel fleet would have had $430,000 of ex-vessel revenue at risk, or 18.6 percent of the total ex-vessel revenue of $2.33 million, recorded in 2001. The catcher-vessel fleet would have had revenue at risk primarily in the CG, whereas the catcher-processor fleet would have revenue at risk in both the CG and WG. Catcher-processor fleet revenue at risk in the CG would have equaled $1.80 million, or 31.9 percent of the 2001status quo in the CG. In the WG, catcher-processor revenue at risk would have equaled $220,000, or 27.3 percent of status quo (Table 3.4-2). In the EG, nearly all of the $210,000 revenue at risk in that region would have been accounted for by catcher-processors.

C.3.4.3.2 Impacts on Dependent Communities

C.3.4.3.2.1 Overview

Impacts on dependent communities would be expected to be insignificant at the community level under Alternative 3, although a number of individual operations may experience adverse impacts. The only fisheries directly affected by this alternative would be GOA slope rockfish species within the overall rockfish category, and the only gear group directly affected (for both catcher vessels and catcher-processors) would be non-pelagic trawl. Using 2001 fleet data, 39 vessels (catcher vessels and catcher-processors) would be affected by this alternative: 12 in Alaska, 8 from Oregon, 18 from Washington, and 1 from another state. Using 2001 processor data, 16 shoreside processors in Alaska potentially would be affected by this alternative.

C.3.4.3.2.2 Catcher Vessels

For catcher vessels, revenue at risk is exclusively concentrated in the CG and represents 18.6 percent of the status quo value (about $430,000 out of $2.33 million) for rockfish fishery harvest of the affected vessels in this area. As discussed earlier, given the location and size of the closure areas and the proportion of catch at risk, it is assumed that as an overall sector, it is possible that vessels could recover any potential losses in catch through additional effort (although the associated costs are unknown) or gear switching (to pelagic trawl gear). As noted earlier, however, the smaller vessels in the fleet targeting rockfish almost exclusively use non-pelagic trawl gear and do not have the same flexibility to switch gear as the larger vessels in the fleet. Therefore, even if there were no large net change in catcher-vessel harvest amounts, the smaller vessel fleet may experience marked adverse impacts (through an effective flow of catch to larger vessels).

Based on 2001 data, Pacific Northwest vessels outnumber Alaska vessels with at-risk revenues, with ownership almost evenly split between Washington (seven vessels) and Oregon (eight vessels). Within Alaska, ownership of relevant vessels is concentrated in Kodiak (nine vessels), with only Anchorage having additional Alaska ownership (one vessel). While all catcher vessels involved in the at-risk harvest are classified as large (over 60 feet), ownership of the vessels at the lower end of the large range is concentrated in Kodiak, so it is likely there would be some net flow away from the community if smaller vessels lose share to larger vessels. For the relevant Kodiak fleet in 2001, the at-risk revenues in the rockfish fishery represent somewhat more than 2 percent of total ex-vessel payments to these vessels for all fisheries in all areas combined. As noted elsewhere, figures given for catcher vessels represent ex-vessel revenues, which would tend to understate the overall value to associated communities that derive benefits from both harvesting and processing activities if examined alone. Values for first wholesale revenues at risk by shoreside processors from landings of catcher vessels are referenced in the discussion of shoreside processor locations provided below. Individual entities within Kodiak may experience adverse impacts under this alternative, particularly smaller vessels, as there may be expected shifts in harvests away from smaller vessels to both larger catcher vessels and catcher-processors, but the magnitude of this potential shift is unknown. Further, as noted elsewhere, the methodology employed to assign distribution of catch within statistical reporting areas may tend to underestimate the actual concentration of catch within the specific closure areas within statistical blocks, particularly for slope rockfish closures and, therefore, to underestimate revenue at risk in a similar manner. It is considered unlikely, however, that the overall loss of revenue and/or the shift from small vessels would result in impacts that would be significant at the community level in Kodiak, due to the relatively small proportion of rockfish value compared to the overall value of the harvest for the involved vessels as a fleet (although some individual vessels may experience increased cost and/or decreased catch). No significant impacts are foreseen for any dependent community outside of Kodiak as a result of changes associated with catcher vessels under this alternative. No significant community level impacts are anticipated for Pacific Northwest communities, due to the size and diversity of the local economic base (although there may be some loss of revenue or catch for a number of involved vessels).

C.3.4.3.2.3 Catcher-Processors

For catcher-processors, revenue at risk is concentrated in the CG, but not exclusively so, and represents 31.53 percent of the status quo value (about $2.22 million out of $7.04 million) for rockfish fishery revenues for the affected vessels in the entire GOA. The revenue at risk represents between 1 and 2 percent of the combined total revenue of the harvest that these vessels take from all the fisheries in which they participate, so the overall impact on the affected fleet would be minimal (although impacts to any particular operation may be greater, depending on specific operational characteristics). Similar to the larger catcher vessels, it is assumed that catcher-processors may be able, with additional effort, to make up foregone harvests from closed areas by changing location or gear strategies, but the costs associated with the extra effort are not known. In this particular case, at-risk harvest could be recovered in part or in whole specifically by effort directed toward shallower areas, or a switch to pelagic trawl gear. The catcher-processors involved in the at-risk harvest are head and gut vessels, and ownership of these vessels is concentrated in the Pacific Northwest, with Washington ownership accounting for 11 out of the 15 vessels with at-risk revenue according to the 2001 data. Kodiak is the only Alaska community with relevant vessel ownership with three catcher-processors with at-risk revenues (and one vessel is owned in another state). The small number of entities precludes disclosure of value data for the Kodiak vessels, but it is assumed that, while there may be hardships for some of the entities involved, no significant impacts are likely for the community of Kodiak as a result of changes associated with catcher-processors under this alternative. For Washington communities, it is unlikely that significant community-level impacts would result from this alternative, given the size and diversity of the local economy, although individual firms may experience adverse impacts under this alternative. Further, while patterns of distribution between Kodiak and Washington vessels cannot be disclosed, the likelihood of significant impacts on either Kodiak or Washington communities is reduced by the small proportion the at-risk revenues comprise of overall catcher-processor harvest revenues for all fisheries in which they participate.

C.3.4.3.2.4 Shoreside Processors

For shore-based processors, in general, no substantial impacts are foreseen under this alternative because catcher-vessel harvest levels are expected to remain at or near status quo levels, and no substantial change in the fishery that would affect delivery patterns is forecast (although there may be some redistribution of catch among individual vessels). There may be some increased costs due to increased catcher vessel effort, but the amount of this increase is unknown. Based on 2001 data, processors involved in the at-risk harvest are concentrated in Kodiak, with nine entities operating. A number of other communities had one or two processors that processed at least some groundfish from vessels with at-risk revenues under this alternative: Akutan and Unalaska/Dutch Harbor (two each), along with King Cove, Seward, and Cordova (one each). As shown in Table 3.3-3, the total first wholesale value at risk of catch delivered inshore for processing represents approximately 16 percent of the total status quo value (about $1.73 million out of $10.79 million) of the relevant fisheries of the CG area, but no breakdown by port of landing is available. Caution must be exercised in the interpretation of these wholesale value data as (1) they are not additive with ex-vessel values presented above, and (2) they cannot be used as a proxy for potential levels of impacts to specific communities without considering the basic caveats laid out in the introductory paragraphs of Section C.3.3.3.2.4 of the Alternative 2 discussion. Given the comparatively modest overall value of the target slope rockfish fishery to shoreside processors and the low level of revenue at risk compared to overall processing in these communities, however, no significant impacts are foreseen for Kodiak or any other dependent community as a result of changes associated with processors under this alternative, although some individual processing entities may experience greater impacts than others.

C.3.4.3.2.5 Multi-Sector Impacts

Multiple sector impacts are unlikely to be significant at the community level under Alternative 3. Among Alaska communities, only Kodiak participates in more that one sector with at-risk revenues, with nine locally owned catcher vessels, three locally owned catcher-processors, and multiple locally operating shoreside processing plants having at least some revenue at risk under this alternative. Revenue at risk for relevant catcher vessels and catcher-processors is roughly 2 percent of total revenues for these vessels, but individual vessels may experience lesser or greater losses. As noted, impacts to shoreside processors are anticipated to be insignificant, due to the low volumes at risk and the assumption that overall delivery patterns are unlikely to change under this alternative. Some additional Alaska (and specifically Kodiak) resident crew positions on vessels owned elsewhere but that spend at least part of the year in Alaska ports may have some compensation at risk, but overall potential for employment and wage or crew share compensation loss is small. Transient vessels owned outside of Alaska typically also make expenditures in ports of landing, which in this case would be concentrated in Kodiak. Given the assumption of general landing patterns remaining consistent, however, any vessel expenditure associated impacts are likely to be minor. Overall, while community impacts in Alaska would be concentrated in Kodiak, it is unlikely that these impacts would rise to the level of significance at the community level, given the relatively few vessels affected by the alternative compared to the overall community fleet, and the relatively low magnitude of the revenue at risk when compared to the overall revenues of the involved vessels, much less those of the local fleet overall.

The potential for cumulative impacts is less straightforward. Even if the potential for social impacts under Alternative 3 would not be significant in isolation, this alternative would have the potential, nonetheless, to impose adverse cumulative impacts when evaluated in the context of other factors that are currently affecting North Pacific and EBS fisheries and fishing communities. Cumulative effects could include interactions with the social impacts of, among others, the near-shore closures put in place in 2001 to protect Steller sea lions, proposed rationalization of the BSAI crab and GOA groundfish fisheries, and the severe decline of salmon prices. These effects would likely be concentrated in communities with (relatively) significant dependence on small boat fleets and communities that depend on both salmon harvesting and one or more of the fisheries that would be affected by the alternative.

C.3.5 Alternative 4

Alternative 4 would amend the GOA Groundfish FMP to prohibit the use of bottom trawls targeting rockfish in 11 designated areas of the GOA slope (200 to 1,000 m), but would allow vessels endorsed for trawl gear to fish for rockfish in these areas with fixed gear or pelagic trawl gear. Alternative 4 would also amend the BSAI Groundfish FMP to establish designated rotating closure areas to the use of NPT gear in the EBS and establish permanent NPT gear closure areas in designated areas of the AI. For a more detailed description of the fishing impact minimization measures imposed by Alternative 4, see EIS Section 2.3.3.

C.3.5.1 Benefits Associated with Alternative 4

C.3.5.1.1 Passive-use Benefits

Had Alternative 4 been in place in 2001, NPT fishing activities targeting slope rockfish in 11 designated areas of the GOA would have been eliminated; use of NPT gear would have been closed in 25 percent of five areas in the EBS on a ten-year rotational basis, with bobbins required on NPT gear fished in other areas; and the use of NPT gear would have been prohibited in designated areas of the AI. While it is not possible at this time to provide an empirical estimate of the passive-use value attributable to this level of protection of EFH, it is assumed that, had it been in place in 2001, Alternative 4 would have yielded some incremental increase in the passive-use benefit of EFH over the status quo Alternative 1 (Table 3.5-1). Each year, Alternative 4 would reduce the impact of NPT fishing for slope rockfish over a total of 10,228 km^2 of GOA shelf and slope edge habitat, NPT fishing for all species over an average of 47,986 km^2 of EBS habitat, and 22,883 km^2 of AI habitat, for a total of 81,097 km^2. This would affect 3.6 percent of the current 279,874 km^2. of GOA shelf and slope edge habitat, 6.0 percent of the current 798,870 km^2. of EBS habitat, and 19.7 percent of the current 105,243 km^2. of AI habitat, for a total of 6.8 percent of the total fishable area in the GOA, EBS, and AI combined (Table 1.4-1). Alternative 4 would have been expected to further reduce NPT fishing impacts in the EBS by requiring disks and bobbins on trawl sweeps and footropes used in open areas (see EIS Sections 2.3.3 and 4.3 for details on the fishing impact minimization measures and the environmental consequences of Alternative 4).

C.3.5.1.2 Use and Productivity Benefits

Alternative 4 is designed to reduce the effects on EFH of NPT fishing in the GOA, EBS, and AI beyond measures currently in place or planned as part of other fishery management actions. Current scientific knowledge does not permit either a quantitative or qualitative assessment of the use benefits derived from minimizing the effects of fishing on EFH. However, the assumption implicit in the amendment to the Magnuson-Stevens Act requirement to minimize effects of fishing on EFH is that doing so would result in the sustained or enhanced production of FMP species and contribute to a healthy ecosystem (Table 3.4-1). As such, Alternative 4 would contribute additional protection measures that could further reduce the impacts of fishing on EFH.

C.3.5.2 Costs Associated with Alternative 4

C.3.5.2.1 Industry Revenue at Risk

Depending upon the EBS rotational areas closed, had Alternative 4 been in place in 2001, this action would have placed a total of $3.53 million to $6.11 million of gross revenue at risk in NPT fisheries in the GOA, EBS, and AI, or 2.2 to 3.8 percent of the status quo total revenue of $156.86 million to $162.79 million (Table 3.5-1).

The 11 designated fishing impact minimization measure areas described under Alternative 4 are discreet and widely spaced along the GOA outer shelf and slope edge. There is substantial slope rockfish fishing area adjacent to the 11 areas designated for fishing impact minimization measures where some or possibly all of the revenue at risk might be mitigated by a redeployment of fishing effort. Additionally, slope rockfish are caught with pelagic trawl gear (PTR) used primarily by the larger catcher-vessel and catcher-processor fleet components (NMFS 2002d). Continuing with the analytical convention adopted above, the revenue at risk in the catcher-vessel fleet would have been very small, compared with the status quo revenue, had Alternative 4 been the rule in 2001. Therefore, the revenue at risk might have been mitigated, in part or in whole, by redeploying NPT fishing effort into adjacent areas not directly affected by Alternative 4. Although the revenue at risk in the catcher-processor fleet under Alternative 4 would have been larger than that in the catcher-vessel fleet, representing more than 12 percent of the total 2001 status quo revenue in the catcher-processor fleet component of this fishery, catcher-processor revenue at risk might also have been partially or completely mitigated by redeploying NPT fishing effort for slope rockfish to fishing areas adjacent to the protected areas.

Alternative 4 would impose a closure to NPT fishing in 25 percent of five areas, with each 25 percent area closure rotating on a 10-year basis. Had these fishing impact minimization measures been in place in 2001, they would have placed approximately 2.9 to 4.8 percent of that year's status quo revenue at risk, depending upon the rotation areas affected. The EBS revenue at risk would have accrued mainly to the catcher-processor fleet component. The revenue at risk in the EBS may have been capable of being mitigated by fishing with NPT gear in adjacent areas, not directly affected by the closures, although crowding externalities, reduced CPUE, bycatch triggered closures, etc., make this uncertain. There may have been additional revenue placed at risk in the EBS under Alternative 4 by the requirement to use bobbins and disks on trawl sweeps for all NPT gear used in open areas; however, the additional adverse economic impact is unknown.

In the 2001 AI fisheries, Alternative 4 would have closed designated areas to fishing for all species, with NPT gear, and would have resulted in placing 1.5 percent of the 2001 status quo revenue in these fisheries at risk. The AI revenue at risk under Alternative 4 would have accrued mainly to the catcher-processor fleet component and might have been mitigated by redeploying NPT fishing effort to adjacent areas, not directly affected by the closures, with the same caveats noted above for EBS NPT.

It is not possible to estimate the amount of the revenue at risk, under Alternative 4, that could have been recovered by redeployment of fishing effort to adjacent areas or to alternative fishing gears without a thorough understanding of the fishing strategies that would actually be employed by fishermen in response to the impacts of the fishing impact minimization measures imposed by Alternative 4.

C.3.5.2.2 Product Quality and Revenue Impacts

Revenue impacts from changes in product quality are possible under Alternative 4, particularly for the smaller catcher-vessel fleet component that may be required to expend additional fishing effort to recover displaced catch, which may lengthen fishing trips and result in diminished product quality (Table 3.5-1). Product quality may not be affected in the catcher-processor fleet component, since these vessels process the catch onboard the vessel, although product mix could be adversely affected (e.g., if the average size of fish declines).

C.3.5.2.3 Operating Cost Impacts

Operating cost impacts under Alternative 4 in the GOA may be minimal for the catcher-vessel fleet, given the small amount of revenue at risk for this fleet component. Operational costs for the catcher-processor fleet component may increase due to the redeployment of fishing effort necessary to mitigate the losses imposed by Alternative 4; in 2001, these would have been 12.3 percent of the status quo revenue estimated to be at risk for this fleet component. Fishing effort redeployed into areas adjacent to the protected areas may have lower CPUE of slope rockfish, requiring additional fishing effort to make up the catch and revenue at risk (Table 3.5-1).

Catcher-processors operating in the EBS NPT flathead sole fishery may have had some increased operational costs, had Alternative 4 been in place in 2001, due to increased running time to reach northern fishing areas when the more southerly areas are closed. They could have also experienced increased operational costs associated with increased fishing effort to mitigate the revenue at risk in these fisheries (Table 3.5-1). It is impossible to estimate the increase in operational costs without fully understanding the fishing effort redeployment strategy that the operators would follow to mitigate revenue placed at risk under Alternative 4; in 2001 these rules would have placed 8.5 to 23.1 percent of the status quo revenues at risk.

Alternative 4 would require the use of bobbins and disks on NPT footropes and trawl sweeps used in open areas. The use of bobbins and disks may reduce the CPUE of some bottom-dwelling species, such as flatfish, resulting in increased fishing time and associated increased operational costs to attain the status quo catch and revenue in these fisheries. This operational impact would occur primarily in the catcher-processor fleet component in the EBS.

In the AI, Alternative 4 would have placed a relatively small amount of the 2001 status quo revenue at risk and may not have resulted in significant increases in operating costs of either the catcher-vessel or catcher-processor fleet components.

C.3.5.2.4 Safety Impact

If implemented for the 2001, Alternative 4 may not have significantly affect the safety of any of the fleet components in the GOA, because fishing effort would likely have been redeployed to adjacent fishing areas with similar CPUE and attributes (e.g., distance from port, distance from safe harbor or shelter, etc.) (Table 3.5-1).

In the EBS, catcher-processors targeting flathead sole, other flatfish, and Pacific cod would have been restricted from fishing some areas closer to their home ports during some time periods, depending upon the area affected by the rotational closures to NPT gear. When more southerly areas are closed, vessels fishing NPT gear would have to travel farther north and farther from ports of call, possibly having an adverse effect on safety.

Alternative 4 may not have significantly affected the safety of any of the fleet components in the AI, because fishing effort would likely have been redeployed to adjacent fishing areas.

C.3.5.2.5 Impacts on Related Fisheries

There may not have been significant impacts on related fisheries from Alternative 4, in 2001, in the GOA, because NPT fishing effort for slope rockfish would likely have been redeployed into adjacent areas where NPT fishing for slope rockfish traditionally occurs (Table 3.5-1).

There may have been impacts on related fisheries in the EBS and AI, if vessels using NPT gear had been displaced into adjacent areas where other gear groups such as HAL and POT vessels were operating.

C.3.5.2.6 Costs to Consumers

Some impact on the cost to consumers from Alternative 4 would have been is likely to occur because, although some of the revenue at risk may have been recovered, in 2001, by redeployment of fishing effort, there would likely have been some operational cost increases for the fleet components

(Table 3.5-1). These operational cost increases due to Alternative 4 fishing impact minimization measures may have resulted in a measurable increase in the price to consumers of species caught in fisheries directly or indirectly affected by redeployment of fishing effort, depending on specific market conditions (e.g., demand elasticities and availability of substitute supplies). There may also have been costs imposed on consumers from changes in availability of supply, product mix, and/or product quality.

C.3.5.2.7 Management and Enforcement Costs

Management and enforcement costs may increase under Alternative 4, although it is not possible to estimate by what amount. Additional on-water enforcement may be required to assure compliance with the fishing impact minimization measures applied in the GOA, EBS, and AI (Table 3.5-1). Section 3.1.2.7 contains some additional detail on the NMFS Enforcement and Coast Guard responses to resource demands connected with monitoring and enforcing provisions of Alternative 4.

Although not specifically required by the alternative, a VMS or 100 percent observer coverage might be needed on all vessels targeting slope rockfish with NPT gear in the GOA and all vessels using NPT gear in the EBS and AI to assure compliance with the fishing impact minimization measures under Alternative 4. Most groundfish vessels operating in the GOA, EBS, and AI for pollock or Pacific cod fishery are already equipped with a VMS. Vessels not equipped with VMS systems might need to install and operate the VMS equipment during NPT fisheries in the GOA, EBS and AI. The number of additional vessels that might need to add VMS equipment under Alternative 4 is not known. Alternative 4 fishing impact minimization measures are specific to gear (NPT) and may require additional enforcement measures (boarding and inspection) beyond the typical time/area/fishery management measures currently employed in the GOA.

Although only fishing impact minimization measure Alternative 5B specifically requires the development and implementation of a research and monitoring program, some level of research and monitoring of the effectiveness of the alternative would likely occur under any alternative adopted. Accomplishing these research and monitoring projects would require significant additional expenditures by the Alaska Region and Alaska Fisheries Science Center over time.

C.3.5.3 Distributional Impacts

C.3.5.3.1 Gross Revenue at Risk Effects

C.3.5.3.1.1 Geographic Area Impacts

If implemented, Alternative 4 would impose s fishing impact minimization measures in the GOA, EBS, and AI. Within the GOA, had this alternative been in place in 2001, the largest amount of revenue at risk would have been in the CG, with $640,000 at risk, or 8.1 percent of the $7.95 million status quo revenue in the CG (Table 3.5-2). The revenue at risk in the WG would have totaled $230,000, or 28.9 percent of the 2001 total status quo revenue of $790,000. There would have been very little revenue at risk in the EG, equaling $22,711 or 3.6 percent of the $620,000 total status quo revenue for that area in 2001.

In the EBS, Alternative 4 would have placed between $1.82 million and $4.40 million in revenue at risk, or 2.0 to 4.5 percent of the $90.92 million to $96.74 million in 2001 status quo revenue in the affected fisheries.

In the AI, had this alternative been in place, $820,000 of revenue would be placed at risk, or 1.4 percent of the $56.70 million status quo revenue in the affected fisheries, in 2001.

C.3.5.3.1.2 Fishery Impacts

In the GOA, the only fishery that would have been directly affected by Alternative 4, had it been in place in 2001, is the NPT slope rockfish fishery. The total revenue at risk in this fishery would have been $900,000, or 9.6 percent of the status quo revenue of $9.36 million in 2001 (Table 3.5-2).

Alternative 4 would place revenues at risk in a number of NPT target fisheries in the EBS, including flathead sole, yellowfin sole, rock sole, other flatfish, Pacific cod, among others. However, the largest revenue at risk would occur in the flathead sole fishery, where, had Alternative 4 been the rule in 2001, $1.23 million to $3.34 million of revenue would have been placed at risk, equaling 8.5 to 23.1 percent of the $14.46 million status quo revenue, depending upon the rotational area affected.

In the AI, under the same assumption, Alternative 4 would have placed revenue at risk in NPT fisheries for Atka mackerel, flatfish, Pacific cod, and rockfish. The largest revenue at risk in the AI would have been in the NPT rockfish fishery, where $460,000 or 8.6 percent of the total status quo revenue value of $5.4 million would have been placed at risk. The impact on the Atka mackerel fishery would have placed $80,000 at risk, or 0.2 percent of the $41.16 million 2001 status quo value in this fishery.

C.3.5.3.1.3 Fleet Component Impacts

In the GOA, the catcher-processor fleet would have had the greatest amount of revenue at risk, in 2001 equaling $870,000, or 12.3 percent of the status quo total revenue. The catcher-vessel fleet would have had $28,570 of ex-vessel revenue at risk, or 1.2 percent of the total ex-vessel revenue of $2.33 million. The catcher-vessel fleet would have had revenue at risk only in the CG. The catcher-processor fleet would have had 2001 revenue at risk mainly in the CG ($620,000, or 10.9 percent of status quo), but also in the WG ($230,000, or 28.9 percent of the $790,000 status quo gross revenue), and nearly all of the $22,711 revenue at risk in the EG, had Alternative 4 been in place that year (Table 3.5-2).

In the EBS, substantially all of the revenue at risk would occurs in the catcher-processor fleet component. Assuming this rule had been in place in 2001, a total of $1.82 million to $4.40 million of revenue would have been placed at risk, equaling 2.0 to 4.8 percent of the $90.34 million to $90.92 million of status quo revenue, depending upon the rotational areas affected.

In the AI, the catcher-processor NPT fleet would have accounted for substantially all of the $820,000 revenue at risk, or 1.4 percent of the 2001 total status quo revenue of $56.7 million.

C.3.5.3.2 Impacts on Dependent Communities

C.3.5.3.2.1 Overview

Impacts on dependent communities would not be significant at the community level under Alternative 4, although a number of individual operations may experience adverse impacts. The only fisheries directly affected by this alternative would be groundfish fisheries. Unlike Alternatives 2 and 3, however, groundfish fisheries would be affected by this alternative in addition to the targeted rockfish fishery. Further, this alternative would have impacts on GOA, EBS, and AI fisheries, but the only gear group directly affected for both catcher vessels and catcher-processors would be non-pelagic trawl. Using 2001 fleet data, 43 vessels (both catcher vessels and catcher-processors) would be affected by this alternative: 4 in Alaska, 3 from Oregon, 31 from Washington, and 5 from other states. Using 2001 processor data, between 11 and 19 shoreside processors in Alaska would potentially be affected by this alternative, depending on specific closure configurations.

For the GOA, impacts to catcher vessels, catcher-processors, and processors would be identical to those seen under Alternative 2. As a result, as in Alternative 2, no significant impacts to dependent communities in the GOA are anticipated under this alternative. Potential impacts to EBS fishery associated communities are described in the following subsections.

C.3.5.3.2.2 Catcher Vessels

Based on 2001 data, Alaska-owned catcher vessels that would be affected by this alternative are associated with Kodiak (two vessels) and Anchorage (one vessel). Overall ownership is dominated by the Pacific Northwest, with 13 to 16 vessels from Washington and 3 to 4 vessels from Oregon (and one vessel from another state). For catcher vessels in the EBS, the only potentially affected fisheries are Pacific cod and pollock. The revenue at risk under any of the rotational area closure scenarios represents a negligible portion (less than 0.03 percent) of the total status quo revenues (less than $2,000 out of $5.85 million) for these species for relevant catcher vessels in this area ($5.85 million). For catcher vessels in the AI, the only potentially affected fishery is for Pacific cod, and the potential revenue at risk represents a negligible portion (0.12 percent or less) of the total status quo revenues for this species for relevant catcher vessels in this area (less than $2,000 out of $1.21 million to $1.32 million). As noted elsewhere, figures given for catcher vessels represent ex-vessel revenues, which would tend to understate the overall value to associated communities that derive benefits from both harvesting and processing activities if examined alone. Values for first wholesale revenues at risk by shoreside processors from landings of catcher vessels are referenced in the discussion of shoreside processor locations provided below. As a result of the negligible at-risk portion of the total groundfish fishery in either the EBS or AI, no significant impacts to dependent communities related to catcher vessels are anticipated for any area.

C.3.5.3.2.3 Catcher-Processors

Based on 2001 data, 24 catcher-processors would have revenue at risk under Alternative 4. Ownership of these vessels is concentrated in Washington (18 vessels), while Alaska-based ownership is exclusively in Kodiak (2 vessels). Vessels from other states account for the remaining four entities. For catcher-processors in the EBS, there is a wide range of potentially affected groundfish species. The catcher-processors involved in the at-risk harvest are generally head and gut vessels. The revenue at risk under any of the rotational area closure scenarios represents a small portion (2.11 to 4.94 percent) of the total status quo revenues for the relevant species for the affected catcher-processors in this area ($2.10 million to $4.94 million out of $99.42 million to $100 million), and it is assumed that at least some portion of this already minimal at-risk revenue could be made up by fishing in other areas with very little increase in effort. For catcher-processors in the AI, there is a range of potentially affected groundfish species, but fewer than seen in the EBS. The revenue at risk represents a small portion (1.48 percent) of the total status quo revenues for the relevant species for the catcher-processors in this area ($820,000 out of $55.38 million). As a result of the small at-risk portion of the total groundfish fishery in either the EBS or AI, no significant impacts to dependent communities related to catcher- processors are anticipated for any area.

C.3.5.3.2.4 Shoreside Processors

For shoreside processors, no substantial impacts are foreseen under this alternative because catcher vessel harvest levels are expected to remain constant, and no substantial change that would affect inshore delivery patterns in the fishery is forecast (although there may be some relatively minor redistribution of catch among individual vessels). Based on 2001 data, processors involved in the at-risk harvest are concentrated in Kodiak (with five to eight entities, depending on closure configurations), with a secondary concentration in Unalaska/Dutch Harbor (with one to five entities, depending on closure configurations). Four other communities each had a single processor that processed at least some groundfish from vessels with at-risk revenues under this alternative (Sand Point, King Cove, Homer, and Seward), while Akutan would have one or two entities, depending on closure configurations. As shown in Table 3.3-3, the total first wholesale value at risk of catch delivered inshore for processing represents approximately 1 percent of the total status quo value (about $149,000 out of $10.78 million) of the relevant fisheries of the CG area and far less than 1 percent in the AI and EBS areas, but no breakdown by port of landing is available. Caution must be exercised in the interpretation of these wholesale value data as (1) they are not additive with ex-vessel values presented above, and (2) they cannot be used as a proxy for potential levels of impacts to specific communities without considering the basic caveats laid out in the introductory paragraphs of Section C.3.3.3.2.4 of the Alternative 2 discussion. Given the very minor potential changes, however, no significant impacts are foreseen for any dependent community as a result of changes associated with processors under this alternative.

C.3.5.3.2.5 Multi-Sector Impacts

Multiple sector impacts are unlikely to be significant at the community level under Alternative 4. Among Alaska communities, only Kodiak participates in more that one sector with at-risk revenues and then with only two to three catcher vessels or catcher-processors and multiple locally operating shoreside processors. As noted, impacts to shoreside processors are anticipated to be insignificant, due to the low volumes at risk and the assumption that overall delivery patterns are unlikely to change under this alternative. Some additional Alaska resident crew positions on vessels owned elsewhere may have some compensation at risk, but overall potential for employment and wage or crew share compensation loss are small. Transient vessels owned outside of Alaska typically also make expenditures in ports of landing, which in this case would be concentrated in Kodiak (and, perhaps, Dutch Harbor). Given the assumption of general landing patterns remaining consistent, however, any vessel expenditure associated impacts are likely to be minor.

The potential for cumulative impacts is less straightforward. Even if the potential for social impacts under Alternative 4 would not be significant in isolation, this alternative would have the potential, nonetheless, to impose adverse cumulative impacts when evaluated in the context of other factors that are currently affecting North Pacific and EBS fisheries and fishing communities. Cumulative effects could include interactions with the social impacts of, among others, the near-shore closures put in place in 2001 to protect Steller sea lions, proposed rationalization of the BSAI crab and GOA groundfish fisheries, and the severe decline of salmon prices. These effects would likely be concentrated in communities with (relatively) significant dependence on small boat fleets and in communities that depend on both salmon harvesting and one or more of the fisheries that would be affected by the alternative.

C.3.6 Alternative 5A

Alternative 5A would amend the GOA and BSAI Groundfish FMPs to prohibit the use of NPT gear in designated areas of the EBS, AI, and GOA. In the GOA, NPT gear would be prohibited for all species in ten designated sites and for slope rockfish on the GOA slope between 200 and 1,000 m. In the EBS, the use of NPT gear would be prohibited for all species in 33.3 percent of five areas on a 5-year rotational basis. NPT gear used in other open areas of the EBS would require disks/bobbins on trawl sweeps and footropes. In the AI, NPT gear would be prohibited for all species in designated areas. For a more detailed description of the fishing impact minimization measures imposed by Alternative 5A, see EIS Section 2.3.3.

C.3.6.1 Benefits Associated with Alternative 5A

C.3.6.1.1 Passive-use Benefits

Under Alternative 5A, NPT fishing activities for all species in ten designated areas and for slope rockfish along the entire slope (200 to 1,000 m) in the GOA would be eliminated. Use of NPT gear would be closed over 33.3 percent of five areas in the EBS on a 5-year rotational basis, with bobbins required on NPT gear fished in other areas. The use of NPT gear would be prohibited for all species in designated areas of the AI. While it is not possible at this time to provide an empirical estimate of the passive-use value attributable to this level of protection of EFH, it is assumed that Alternative 5A would yield some incremental increase in the passive-use benefit of EFH over the status quo Alternative 1 (Table 3.6-1).

Alternative 5A would minimize the impact of NPT fishing over a total of 31,904 km^2 of GOA shelf and slope edge habitat (11.4 percent of the current 279,874 km^2 of habitat), an average 63,975 km^2 of EBS habitat (8.0 percent of the current 798,870 km^2 of habitat), and 32,235 km^2 of AI habitat (30.6 percent of the current 105,243 km^2 of habitat), for a total of 128,114 km^2, or 10.8 percent of the combined fishable area of 1,183,987 km^2 (Table 1.4-1). Alternative 5A would further reduce NPT fishing impacts in the EBS by requiring disks and bobbins on trawl sweeps and footropes used in open areas. EIS Sections 2.3.3 and 4.3 details on the fishing impact minimization measures and the environmental consequences of Alternative 5A.

C.3.6.1.2 Use and Productivity Benefits

Alternative 5A would reduce the effects on EFH of NPT fishing in the GOA, EBS, and AI beyond measures currently in place or planned as part of other fishery management actions. Current scientific knowledge does not permit either a quantitative or qualitative assessment of the use benefits derived from minimizing the effects of fishing on EFH. However, the assumption implicit in the amendment to the Magnuson-Stevens Act requirement to minimize effects of fishing on EFH is that doing so would result in the sustained or enhanced production from FMP species and contribute to a healthy ecosystem (Table 3.6-1). As such, Alternative 5A would contribute additional measures that would further reduce the impacts of fishing on EFH.

C.3.6.2 Costs Associated with Alternative 5A

C.3.6.2.1 Industry Revenue at Risk

As above, assuming for sake of analysis that Alternative 5A had been implemented for the 2001 fishing year, it would have placed a total of $7.92 million to $10.90 million of gross revenue at risk in NPT fisheries in the GOA, EBS, and AI, or 4.4 to 6.0 percent of the status quo total revenue of $180.66 million to $181.30 million, depending upon which rotational areas are affected in the EBS (Table 3.6-1).

The ten designated areas described under Alternative 5A in the GOA are discreet and widely spaced along the outer shelf and slope edge. Within the entire GOA there is substantial NPT fishing area adjacent to the 10 areas designated for protection where some of the revenue at risk might have been mitigated by a redeployment of fishing effort. However, Alternative 5A would have placed 31.8 percent of the 2001 status quo revenue at risk in the EG, an amount that would likely have been difficult to make up elsewhere. Amendment 58 to the GOA FMP, which took effect in 1998, prohibits trawling in the EG east of latitude 140º W. This leaves a very limited area within the EG where the revenue at risk for the NPT fisheries could be mitigated. There would likely have been some portion of the EG revenue at risk in 2001 that would not have been recovered under Alternative 5A rules.

Although some slope rockfish are caught with NPT gear at depths shallower than 200 m in the GOA, a majority of the NPT commercial catch of the slope rockfish complex occurs at depths in excess of 150 m (NMFS 2002d). There is limited fishing area for slope rockfish in the 150 to 200 m slope edge adjacent to the 200 to 1,000 m area designated for protection where revenue at risk might be mitigated, in whole or in part, by a redeployment of NPT fishing effort under Alternative 5A. Approximately 20 percent of the catch of the primary slope rockfish species, Pacific ocean perch, is historically taken by PTR gear fished by larger catcher-vessel and catcher-processor fleet components. Between 30 and 50 percent of the shortraker/rougheye rockfish in the slope rockfish complex is traditionally taken as incidental catch, with HAL gear, in the sablefish and halibut fisheries.

Under Alternative 5A, most, if not all, of the revenue at risk in the GOA might have been recovered by redeployment of fishing effort to adjacent areas or switching to PTR gear by most of the fleet components involved in the fishery. The smaller catcher-vessel fleet targeting slope rockfish almost exclusively uses NPT gear and has neither sufficient horsepower to fish PTR, nor the revenue from participation in this fishery to warrant the investment necessary to utilize PTR gear. The larger catcher vessels (vessels that also target pollock) and the catcher-processors either already have PTR gear available or have sufficient horsepower to convert to PTR to target slope rockfish. Under Alternative 5A, while the revenue at risk may be recovered by vessels fishing adjacent areas of the GOA not directly affected by the alternative or by switching to PTR gear within the protected areas, there would likely be a transference of catch share, and thus a transfer of revenue in the fishery from the smaller catcher-vessel fleet component to the larger catcher-vessel and catcher-processor fleet components. The magnitude of this transfer is impossible to estimate without specific knowledge of the fishing effort redeployment strategies that would actually be followed by the different fleet components.

Alternative 5A imposes a closure of NPT fishing in 33.3 percent of five areas, with each area rotating on a 5-year basis. These fishing impact minimization measures would, had they been implemented for the 2001 fishing year, have placed approximately 2.7 to 5.8 percent of the 2001 status quo revenue at risk, depending upon the rotation areas affected. The EBS revenue at risk would occur mainly in the catcher-processor fleet component. Some or all of the revenue at risk in the EBS might be capable of being mitigated by fishing with NPT gear in adjacent areas not affected by fishing impact minimization measures. However, there could be additional revenue placed at risk in the EBS under Alternative 5A by the requirement to use bobbins and disks on trawl sweeps for all NPT gear used in open areas. The amount of this additional revenue at risk is unknown.

In the AI, Alternative 5A would close designated areas to all species with NPT gear. Had it been the rule in 2001, it would have resulted in placing 3.0 percent of the status quo revenue in these fisheries at risk. The AI revenue at risk impacts under Alternative 5A would occur mainly in the catcher-processor fleet component and could potentially be mitigated, in whole or in part, by redeploying NPT fishing effort to adjacent areas not directly affected by the alternative.

C.3.6.2.2 Product Quality and Revenue Impacts

Revenue impacts from changes in product quality would be possible under Alternative 5A, particularly for the smaller catcher-vessel fleet component operating with NPT gear in the GOA. These vessels may be required to expend additional fishing effort in an attempt to recover the revenue at risk, which could lengthen fishing trips and result in diminished product quality. Product quality may not be affected in the catcher-processor fleet component, since these vessels process the catch onboard the vessel, unless, for example, the average size fish in the catch changed substantially.

C.3.6.2.3 Operating Cost Impacts

Operating cost impacts under Alternative 5A may likely be greater overall for both the GOA catcher-vessel component and catcher-processor fleet components in all areas. CPUE of slope rockfish caught with PTR gear and with NPT gear at depths shallower than 200 m along the GOA slope edge may be lower than the CPUE of NPT gear in the depth range of 200 m and greater where these species are normally fished. This may result in increased fishing effort and associated increased operational costs to mitigate the catch and revenue at risk.

Larger catcher vessels and catcher-processors in the GOA have the option of changing to PTR gear for targeting slope rockfish. However, the smaller catcher vessels, particularly the 18.3 m (60 feet) and smaller vessels, do not have sufficient horsepower to effectively switch to PTR fisheries, and the equipment costs would likely be prohibitive, given the annual revenue of these vessels. Operational costs for the catcher-processor fleet component may increase due to the redeployment of fishing effort necessary to mitigate the 17.6 percent of the status quo revenue placed at risk for this fleet component.

Catcher-processors operating in the EBS NPT flathead sole fishery could have increased operational costs under Alternative 5A due to increased running time to reach northern fishing areas when the more southerly areas are closed, and possibly due to increased fishing effort to make up the revenue at risk in these fisheries (Table 3.6-1). It is impossible to estimate the increase in operational costs without fully understanding the fishing effort redeployment strategy that the operators would actually follow. Undoubtedly, had Alternative 5A been in place in 2001, there would have been efforts to mitigate the 11.8 to 29.3 percent of the status quo revenue placed at risk in the NPT fishery for flathead sole in that year. Alternative 5A would require the use of bobbins and disks on NPT footropes and trawl sweeps used in open areas. The use of bobbins and disks may reduce the CPUE of some bottom-dwelling species such as flatfish, resulting in increased fishing time and associated increased operational costs to attain the status quo catch and revenue in these fisheries. This operational impact would occur primarily in the catcher-processor fleet component in the EBS.

In the AI, Alternative 5A would have placed a relatively small amount, 3.0 percent, of the 2001 status quo revenue at risk and may not have resulted in any significant increases in operating costs for either catcher-vessel or catcher-processor fleet components.

C.3.6.2.4 Safety Impact

Alternative 5A may not significantly affect the safety of any of the fleet components in the GOA, because fishing effort would likely be redeployed to adjacent fishing areas (Table 3.6-1).

In the EBS, catcher-processors targeting flathead sole, other flatfish, and Pacific cod would be restricted from fishing some areas closer to their home ports during some time periods, depending upon the area affected by the rotational closures to NPT gear. When more southerly areas are closed, vessels fishing NPT gear would have to travel farther north and farther from ports of call, possibly increasing safety impacts.

Alternative 5A may not significantly affect the safety of any of the fleet components in the AI, because fishing effort would likely be redeployed to adjacent fishing areas within similar distance of their home port.

C.3.6.2.5 Impacts on Related Fisheries

There may be an impact on related fisheries in the GOA from Alternative 5A, because a substantial amount of NPT fishing effort for slope rockfish would likely be redeployed into adjacent areas shallower than 200 m that would not be directly affected by the alternative. Other fisheries occur in these areas, including halibut longline, Pacific cod longline (if open), and other NPT fisheries such as shallow water flatfish. Increased NPT fishing effort at depths less than 200 m along the GOA shelf edge could have negative indirect economic impacts on these fisheries (Table 3.6-1).

There may be impacts on related fisheries from Alternative 5A in the EBS and AI as vessels using NPT gear are displaced into adjacent areas where other gear groups such as HAL and POT vessels may be operating.

C.3.6.2.6 Costs to Consumers

Some impact on consumers from Alternative 5A may occur because although some or all of the revenue at risk may be recovered by redeployment of fishing efforts, there would likely be some operational cost increases for the fleet components (Table 3.6-1). Operational cost increases may result in a measurable increase in the price to consumers of species caught in fisheries directly or indirectly affected by the redeployment of fishing effort. There may also be attributable costs imposed on consumers from changes in availability of supply, product mix, and/or product quality.

C.3.6.2.7 Management and Enforcement Costs

Management and enforcement costs may increase under Alternative 5A, although it is not possible to estimate by what amount. Additional on-water enforcement could be required to assure compliance with the fishing impact minimization measures applied in the GOA, EBS, and AI (Table 3.6-1). Section 3.1.2.7 contains some additional discussion of the NMFS Enforcement and Coast Guard responses to resource demands connected with monitoring and enforcing provisions of Alternative 5A.

Although not specifically required by the alternative, VMS equipment or 100 percent observer coverage might be needed on all vessels using NPT gear in the GOA, EBS, and AI to assure compliance with Alternative 5A. Most groundfish vessels operating in the GOA, EBS, and AI for pollock or Pacific cod fishery are already equipped with VMS. Vessels not equipped with VMS systems might need to install and operate the VMS equipment during NPT fisheries in all areas. The number of additional vessels that might need to add VMS equipment under Alternative 5A is not known. Alternative 5A fishing impact minimization measures are specific to gear (NPT) and may require additional enforcement measures (boarding and inspection) beyond the typical time/area/fishery management measures currently employed in the GOA.

Although only fishing impact minimization measure Alternative 5B specifically requires the development and implementation of a research and monitoring program, some level of research and monitoring of the effectiveness of the alternative would likely occur under any alternative adopted. Accomplishing these research and monitoring projects would require significant additional expenditures by the Alaska Region and Alaska Fisheries Science Center over a period of years.

C.3.6.3 Distributional Impacts

C.3.6.3.1 Gross Revenue at Risk Effects

C.3.6.3.1.1 Geographic Area Impacts

Alternative 5A imposes fishing impact minimization measures in the GOA, EBS, and AI. Adopting the analytical convention that Alternative 5A was in place for the 2001 fishing year, within the GOA, the largest amount of revenue at risk would have been in the CG, with $2.55 million in revenue at risk, equaling 12.3 percent of the $20.69 million 2001 status quo revenue in the CG (Table 3.6-2). The revenue at risk in WG would have equaled $810,000, or 13.0 percent of the 2001 total status quo revenue of $6.25 million. There would have been $240,000 in revenue at risk in the EG, or 31.8 percent of the $760,000 status quo revenue.

In the EBS, Alternative 5A would have placed between $2.63 million and $5.61 million of revenue at risk, or 2.7 to 5.8 percent of the $96.27 million to $96.91 million status quo revenue in the fisheries affected, had this rule been in effect that year.

In the AI, $1.69 million of revenue would have been placed at risk, or 3.0 percent of the $56.70 million status quo revenue in the affected fisheries, in 2001.

C.3.6.3.1.2 Fishery Impacts

In the GOA, Alternative 5A would have affected a number of NPT fisheries, but primarily fisheries targeting rockfish and Pacific cod. The total revenue at risk in the NPT rockfish fishery would have been $2.82 million, or 30.1 percent of the status quo revenue of $9.36 million in 2001 (Table 3.6-2). The total revenue at risk in the GOA NPT Pacific cod fishery (mainly from the catcher-vessel fleet component) would have been $380,000 or 4.9 percent of the status quo revenue of $7.66 million.

Alternative 5A would have placed revenues at risk in a number of NPT target fisheries in the EBS, including flathead sole, yellowfin sole, rock sole, other flatfish, Pacific cod, and others. However, the largest revenue at risk would have occurred in the flathead sole fishery, where $1.70 million to $4.23 million of revenue would have been at risk, or 11.8 to 29.3 percent of the $14.46 million 2001 status quo revenue, depending upon the rotational area affected. The total revenue that would have been at risk in the EBS NPT Pacific cod fishery ranges from $190,000 to $980,000, or 1.3 to 6.8 percent of the 2001 status quo revenue of $14.33 million.

In the AI, Alternative 5A would have placed revenue at risk in NPT fisheries for Atka mackerel, flatfish, Pacific cod, and rockfish. The largest revenue at risk in the AI would have been in the NPT rockfish fishery, where $1.09 million, or 20.2 percent of that year's total status quo revenue value of $5.4 million, would have been placed at risk. The impact on the Atka mackerel fishery would have put $200,000 at risk, or 0.5 percent of the $41.16 million status quo value in this fishery in 2001.

C.3.6.3.1.3 Fleet Component Impacts

In the GOA, the catcher-processor fleet would have had the greatest amount of revenue at risk, equaling $2.70 million, or 17.6 percent of the status quo total revenue. The catcher-vessel fleet would have had $900,000 of ex-vessel revenue at risk, or 7.3 percent of the total ex-vessel revenue of $12.31 million (Table 3.6-2). Under Alternative 5A, had it been in place in 2001, the catcher-vessel fleet would have had revenue at risk in the EG of $60,000, or 20.8 percent of status quo; in the CG, $470,000, or 4.9 percent of status quo; and in the WG, $360,000, or 16.0 percent of status quo. The GOA catcher-processor fleet would have had revenue at risk mainly in the CG ($2.07 million, or 18.9 percent of status quo), but also in the WG ($450,000, or 11.3 percent of the $4 million status quo gross revenue) and the EG ($180,000 or 39.3 percent of the $450,000 status quo revenue).

In the EBS, substantially all of the revenue at risk would have occurred in the catcher-processor fleet component. A total of $2.63 million to $5.61 million of revenue would have been at risk in the 2001 fishery, or 2.9 to 6.2 percent of the $90.45 million to $91.08 million status quo revenue, depending upon the rotational areas affected.

In the AI, the catcher-processor NPT fleet would have accounted for substantially all of the $1.69 million revenue at risk, or 3.1 percent of the 2001 total status quo revenue of $55.38 million.

C.3.6.3.2 Impacts on Dependent Communities

C.3.6.3.2.1 Overview

Unlike the previous alternatives, impacts to dependent communities may be significant at the community level, at least for a couple of communities (King Cove and Sand Point), under Alternative 5A. Adverse impacts to individual operations may occur in other communities (especially Kodiak), but these impacts are considered unlikely to be significant at the community level, due to the low magnitude of the impacts relative to the overall operations of the affected fleet and processing entities (as well as the overall community fishing sectors).

The only fisheries directly affected by Alternative 5A would be groundfish fisheries. Similar to Alternative 4 (but unlike Alternatives 2 and 3), groundfish species in addition to rockfish would be affected by this alternative. Like Alternative 4, this alternative would have impacts on GOA, EBS, and AI fisheries. Like Alternatives 2, 3, and 4, the only gear group directly affected for both catcher vessels and catcher-processors would be non-pelagic trawl. Using 2001 fleet data, 82 to 89 vessels (catcher vessels and catcher-processors combined) would be affected by this alternative: 25 to 32 in Alaska, 12 to 13 from Oregon, 38 to 40 from Washington, and 6 from other states. Using 2001 processor data, between 16 and 21 shoreside processors in Alaska would potentially be affected by this alternative, depending on specific closure configurations.

C.3.6.3.2.2 Catcher Vessels

Based on 2001 data, within Alaska, ownership of catcher vessels harvesting relevant groundfish species with at-risk revenue is concentrated in the Aleutians East Borough (AEB) with 17 vessels (King Cove with 8 vessels and Sand Point with 9), and Kodiak with 6 to 13 vessels. (Anchorage and Girdwood ownership accounted for an additional vessel each.) Unlike other alternatives, which featured only large (over 60 feet) vessels with revenue at risk, this alternative has both large and small vessels with revenue at risk. All but two of the AEB vessels with at-risk revenues are under 60 feet, while none of the Kodiak vessels is a small vessel. The two other Alaska-owned vessels include one large and one small vessel. Ownership in the Pacific Northwest is largely confined to large vessels, with 17 to 30 vessels from Washington (including two small vessels) and 12 to 13 vessels from Oregon (with no small vessels).

Under Alternatives 2, 3, and 4, GOA impacts to catcher vessels were confined to the CG area. Under Alternative 5A, catcher vessels would have had at-risk catch in the EG, the CG, and the WG. At-risk harvest would not have been evenly distributed among the GOA areas, ranging from 20.85 percent in the EG, to 4.86 percent in the CG, to 16.04 percent in the WG, based upon 2001 fishery performance. However, since the CG accounts for 79 percent of harvest among relevant catcher vessels in the entire GOA under status quo conditions, the at-risk percentage of total catch for the entire GOA is only 7.30 percent for all affected catcher vessels. Total status quo harvest in the EG is $310,000 and the WG is $2.24 million, compared to $9.76 million in the CG. At-risk revenue is about $900,000. Fisheries with greater than negligible (0.1 percent in this case) at-risk amounts in the GOA include deep water flatfish (3.4 percent), Pacific cod (5.1 percent), pollock-bottom trawl (9.1 percent), and rockfish (18.8 percent). For the affected catcher fleet as a whole, the revenue at risk represents about 2 percent of the ex-vessel value of their total harvest from all fisheries in which they participate (and about 3 percent of total groundfish ex-vessel value in particular). As noted elsewhere, figures given for catcher vessels represent ex-vessel revenues, which would tend to understate the overall value to associated communities that derive benefits from both harvesting and processing activities if examined alone. Values for first wholesale revenues at risk by shoreside processors from landings of catcher vessels are referenced in the discussion of shoreside processor locations provided below. There are, however, variations within the fleet in terms of the community distribution of effort among fisheries. Almost twice as many catcher vessels participate in the pollock and cod fisheries as participate in the rockfish fisheries, and the smaller catcher vessels that are concentrated in King Cove and Sand Point do not participate in the rockfish fisheries. King Cove vessels affected by this alternative have 5.4 percent of the value of their total harvest at risk, almost all of it pollock. Sand Point vessels affected by this alternative have 3.3 percent of their revenue at risk, about three-fourths of which is Pacific cod and one-fourth pollock. Affected Kodiak boats have only 2 percent of their revenue at risk under this alternative, primarily from Pacific cod.

The amount of revenue at risk that would likely be lost under actual conditions varies considerably by community. The smaller catcher boats of King Cove and Sand Point would be placed more at risk by any restrictions on their fishing activity than larger catcher vessels of other communities. Larger vessels from Kodiak and the Pacific Northwest communities can generally fish the EBS and the AI waters more easily than boats from King Cove and Sand Point. As discussed in the sector and regional groundfish profiles for King Cove and Sand Point (http://www.fakr.noaa.gov/npfmc/), many fishing operations are organized around a fleet of 58-foot salmon boats with multi-gear capability. This fleet historically has made a living through diversification, participating in a combination of groundfish (Pacific cod, pollock, other), halibut, crab, and salmon fisheries – with each comprising no more than 30 or 40 percent of total earnings. With the recent decline in the crab and salmon fisheries, groundfish have assumed great importance for these vessels – up to 75 percent of a vessel's ex-vessel income in recent years. Whereas salmon used to account for a third of a vessel's income, it now produces perhaps a tenth of the boat's ex-vessel returns. Crab returns have declined from up to 14 percent of a boat's earnings to 4 or 5 percent – if the boat continues to take crab at all. Halibut is an important but variable component of a vessel's suite of fisheries. Since halibut is now an IFQ fishery, it is relatively expensive to buy into participation, especially for fishermen experiencing declining crab and salmon fisheries. The King Cove and Sand Point vessels fishing halibut are essentially those that qualified for the initial allocation of IFQs.

Boats from King Cove and Sand Point differ in their groundfish emphasis. King Cove boats catch a lot of Pacific cod and very little pollock. Sand Point boats have (through 2001, the most recent statistical year for which complete data are available) harvested more pollock than Pacific cod. Both fleets depend on closer and more protected fishing waters. They are less able, compared to larger vessels, to travel longer distances to find alternative fishing areas. These vessels face an inherent competitive disadvantage, compared to larger vessels, because they must stay tied up during heavy weather, when larger boats can fish. Closures of relatively close fishing grounds would impose additional costs on these vessels compared to vessels from Kodiak and the Pacific Northwest. In conjunction with the decline of other fisheries, the effects on vessels from these communities could be significant. Each community has essentially only one processor, and this restricted local market also places constraints on the local fleet. As a result of all of these factors, the communities of King Cove and Sand Point may experience significant impacts under this alternative, depending on the success of strategies to replace at-risk revenues.

Affected catcher vessels from Washington and Oregon closely resemble those from Kodiak, but with an even higher dependence on Pacific cod and pollock. Together, Pacific cod and pollock account for over 80 percent of ex-vessel payments to the boats, with Pacific cod again predominating. Based on 2001 data, Oregon-based boats operating in the EEZ off Alaska harvest proportionally more of their total FMP catch from the areas that would be closed by this alternative than is the case for vessels from other regions, but little more can be gleaned from the available information. The revenue at risk represents about 3 percent of the total ex- vessel payments paid to boats from Oregon, and less than 1 percent of those paid to Washington boats. Assuming that at least some at-risk revenue can be made up with minimal costs by altering fishing areas or approaches, it is not likely that these operations would experience significant impacts under this alternative.

For catcher vessels operating in the EBS and AI, the only affected species is Pacific cod. For both the EBS and AI, revenue at risk under this alternative is 0.1 percent or less of the total status quo revenues of the affected vessels for each area (less than $2,000 out of $5.82 million and $1.32 million, respectively). As a result of the negligible at-risk portion of the catcher-vessel harvest of any groundfish fishery in either the EBS or AI, no significant impacts to dependent communities related to catcher vessels in these areas are anticipated.

C.3.6.3.2.3 Catcher-Processors

Based on 2001 data, ownership of catcher-processors with at-risk revenue is concentrated in Washington (with 15 to 19 vessels). Alaska ownership is exclusive to Kodiak (two to three vessels). Four vessels are owned in other states.

For catcher-processors, revenue at risk in the GOA is 17.6 percent under this alternative, and this is not evenly distributed among the various areas within the GOA. Revenue at risk in the EG is relatively modest in terms of total value ($180,000 out of a status quo revenue for affected vessels of $450,000), but this is relatively large in percentage terms (39.3 percent). For the CG, revenue at risk is 18.9 percent of the total ($2.07 million out of $10.93 million), while the analogous figure for the WG is 11.3 percent ($450,000 out of $4 million). The GOA total revenue associated with a number of species is potentially at risk, but only for a few species in greater than negligible (0.3 percent in this case) amounts. These are deep water flatfish (2.2 percent), flathead sole (1.1 percent), rex sole (7.3 percent), and rockfish (33.8 percent). Except for rockfish, it is assumed that all at-risk revenues for all species could easily be recovered with minimal efforts in other areas, due to the very low at-risk percentages involved. The catcher-processors involved in the at-risk rockfish harvest are head and gut vessels.

For the EBS, catcher-processors under Alternative 5A would experience revenue at risk associated with a number of different groundfish species (risk would vary by the specific rotational closure in place at any given time). The fisheries that have a revenue at risk greater than 1 percent include arrowtooth flounder (0.5 to 2.8 percent of a status quo value of $3.38 million), flathead sole (11.8 to 29.3 percent of $14.46 million), Greenland turbot (0.5 to 11.2 percent of $500,000 to $1.12 million), Pacific cod (2.2 to 11.5 percent of $8.50 million), rockfish (7.2 to 27.2 percent of $160,000 and other (11.6 to 27.9 percent of $170,000 to $180,000). Many of these species, however, have a relatively low overall value to the catcher-processor sector. As a result, relatively large percentage declines may have minimal impacts on the sector (and associated communities). Of all of the species with at-risk revenues greater than 1 percent of total value, the only species with at-risk revenues greater than $100,000 are flathead sole ($1.70 million to $4.23 million), Pacific cod ($190,000 to $980,000), and Greenland turbot ($120,000 to $130,000). The catcher-processors harvesting and processing these species include head and gut vessels, as well as some pollock vessels that fill in with these fisheries.

For the AI, catcher-processors under Alternative 5A would experience revenue at risk associated with a number of different groundfish species. While many of these species have a relatively high percentage of revenue at risk, the overall value at risk is comparatively low. Revenue of $10,000 or greater is at risk for only five species: Atka mackerel ($200,000 at risk, which is 0.5 percent of status quo revenue of affected vessels), Greenland turbot ($190,000, 51.0 percent of status quo revenue), Pacific cod ($130,000, 1.6 percent of status quo revenue), rock sole ($60,000, 42.8 percent of the status quo revenue) and rockfish ($1.09 million, 20.2 percent of status quo revenue). It is assumed that, given the small percentage of total catch at risk, catcher-processors could make up for revenue at risk for the Atka mackerel and Pacific cod fisheries. Further, the absolute value of the rock sole revenue at risk ($60,000) is low enough that community level impacts are unlikely. This leaves the Greenland turbot and rockfish revenue shortfalls as being somewhat more problematic. Similar to the pattern seen in the EBS, the AI catcher-processors harvesting and processing the at-risk harvest for these species are head and gut boats along with some pollock-oriented vessels filling in during non-pollock periods.

The information available indicates that most of the revenue at risk is borne by affected Washington area catcher-processors (80 percent) and that this represents about 3 percent of their combined total catch valuation from all fisheries in which they participate. Affected catcher-processors from non-Washington locations bear about 20 percent of the revenue at risk, which is about 6 percent of their total catch valuation (double the proportion of the Washington vessels), and this may be a low estimate. Catcher-processors affected by this alternative and owned by residents of Washington harvest pollock extensively (about 75 percent of total catch valuation), while catcher-processors from other regions focus more on cod (66 percent of total catch valuation).

Due to confidentiality restrictions based on a small number of participating entities, revenue information for Alaska-based catcher-processors with revenue at risk cannot be disclosed for this alternative. It is known, however, that impacts accruing in Alaska would be concentrated in Kodiak. Given the small number of entities involved, the relative size of the local fishery-based economy, and what is known about the relative order of magnitude of overall impacts to the fleet, it is assumed that community level impacts associated with catcher-processors would not be significant. In the case of Washington communities, while individual Washington-owned entities may experience adverse impacts under this alternative, it is assumed that community level impacts would be significant under this alternative due to the scale of the local economy in those communities.

C.3.6.3.2.4 Shoreside Processors

For shoreside processors, no substantial impacts are foreseen under this alternative for EBS and AI fisheries because catcher-vessel harvest levels are expected to remain constant, and no substantial change in the fishery is forecast. In the GOA, with processor dependence on a wider variety of fisheries, potential interactive impacts are more complex. Based on 2001 data, processors involved in the at-risk harvest are concentrated in Kodiak (with six to eight entities, depending on closure configurations), although a number of other communities had processed at least some groundfish from vessels with at-risk revenues under this alternative (including some communities in Southeast Alaska, unlike Alternatives 2, 3, and 4). These were Unalaska/Dutch Harbor (two to four processors) and King Cove (one to two processors), along with seven others with one processor each (Akutan, Sand Point, Moser Bay [Kodiak Island Borough], Chignik, Sitka, Cordova, and Petersburg). As shown in Table 3.3-3, the total first wholesale value at risk of catch delivered inshore for processing represents approximately 8 percent of the total status quo value ($3.28 million out of $42.25 million) of the relevant fisheries of the GOA area, well below 1 percent for the AI and EBS areas, and about 6 percent for all areas combined (about $3.28 million out of $58.59 million), but no breakdown by port of landing is available. Caution must be exercised in the interpretation of these wholesale value data as (1) they are not additive with ex-vessel values presented above, and (2) they cannot be used as a proxy for potential levels of impacts to specific communities without considering the basic caveats laid out in the introductory paragraphs of Section C.3.3.3.2.4 of the Alternative 2 discussion. Processor-associated impacts to dependent communities could be significant in some of the smaller communities in the WG area, due primarily to potential impacts to local catcher-vessel fleets. However, as discussed earlier, the magnitude of these impacts would depend on the success of local fleet mitigation strategies that are not known at this time. Further, data to quantify the potential magnitude of these impacts on shore processors in the individual communities are confidential. No significant community impacts are anticipated for any other dependent communities.

C.3.6.3.2.5 Multi-Sector Impacts

Multiple sector impacts may be significant at the community level under Alternative 5A. Among Alaska communities, Kodiak, King Cove, and Sand Point participate in more that one sector with at-risk revenues. Kodiak is home to 6 to 13 locally owned catcher vessels, 2 to 3 locally owned catcher-processors, and some 6 to 8 locally operating shoreside processing entities with at least some revenue at risk, depending on closure configurations. Neither King Cove nor Sand Point is home to locally owned catcher-processors, but both have multiple locally owned catcher vessels (eight and nine vessels, respectively) and have at least one dominant local processor with at least some revenue at risk under this alternative. Revenue at risk for King Cove and Sand Point catcher vessels is a higher percentage of total overall ex- vessel revenues (at 5.4 and 3.3 percent, respectively) than is the case in Kodiak (about 2 percent), and these vessels represent a much larger proportion of the total community fleet in King

Cove and Sand Point than do the affected vessels in Kodiak. Given the smaller vessels in King Cove and Sand Point (with less flexibility of response), the higher proportion of revenue at risk, the higher proportion of the fleet with revenue at risk, and the known challenges that these fleets (and communities) are facing with other fisheries, the WG communities of King Cove and Sand Point may have experienced social impacts from this alternative that would be significant at the community level. Other Aleutians East Borough communities that derive benefits from revenues generated through borough raw fish taxes on landings in King Cove and Sand Point may experience impacts. These impacts to other borough communities would, however, probably not have been significant as the overall quota would have been unchanged, and no changes in landing patterns would have been expected at the regional level. Individual Kodiak entities may experience adverse impacts under this alternative, but impacts at the community level are considered unlikely to rise to a level of significance given the small proportion of revenue at risk for the affected catcher vessels, the low volumes at risk, and the assumption that overall delivery patterns are unlikely to change for Kodiak based shoreside processors under this alternative. Some additional Alaska resident crew positions on vessels owned elsewhere, but that spend at least part of the year in Alaska ports, may have some compensation at risk. Transient vessels owned outside of Alaska typically also make expenditures in ports of landing, which in this case would be concentrated in Kodiak (and, perhaps, Dutch Harbor). Given the assumption that overall delivery patterns for the community are unlikely to change, however, any vessel expenditure associated impacts are likely to be minor.

The potential for cumulative impacts is less straightforward. Even if the potential for social impacts under Alternative 5A would not be significant in isolation, this alternative would have the potential, nonetheless, to impose adverse cumulative impacts when evaluated in the context of other factors that are currently affecting North Pacific and EBS fisheries and fishing communities. Cumulative effects could include interactions with the social impacts of, among others, the near-shore closures put in place in 2001 to protect Steller sea lions, proposed rationalization of the BSAI crab and GOA groundfish fisheries, and the severe decline of salmon prices. These effects would likely be concentrated in communities with (relatively) significant dependence on small boat fleets and communities that depend on both salmon harvesting and one or more of the fisheries that would be affected by the alternative.

C.3.7 Alternative 5B

Alternative 5B would amend the GOA and BSAI Groundfish FMPs to prohibit the use of NPT gear in designated areas of the EBS, AI, and GOA. In the GOA, use of NPT gear would be prohibited for all species in ten designated sites and for slope rockfish on the GOA slope between 200 and 1,000 m. In the EBS, the use of NPT gear would be prohibited for all species in 33.3 percent of five areas on a 5-year rotational basis. NPT gear used in other open areas of the EBS would require disk/bobbins on trawl sweeps and footropes. In the AI, use of NPT gear would be prohibited for all species in designated areas extending to the limits of the EEZ. Under Option 2, six coral garden areas would be established in the AI where all bottom contact fishing would be prohibited.

Different areas would be closed to NPT gear in the AI under three different Alterantive 5B options. Under Option 1, additional closures would occur in areas of high coral and sponge bycatch. TACs for Pacific cod, Atka mackerel and rockfish NPT fisheries would be reduced by the 1998 to 2002 average annual historical weights of target species caught in the designated closure areas and in the coral and sponge closure areas. Under Option 2, additional closures to use of all bottom-contact gear would occur in six designated coral gardens, additional closures would occur in areas of high coral and sponge bycatch as in Option 1, and TACs for Atka mackerel and rockfish NPT fisheries would be reduced by the 1998 to 2002 average annual historical weights of target species caught in the designated closure areas and in the coral and sponge closure areas. Under Option 3, NPT gear would be prohibited for all species in designated areas extending to the limits of EEZ, but no TAC reductions or additional closures would be imposed due to high coral and sponge bycatch. Additional measures imposed by Alternative 5B in the AI include 100 percent observer coverage and VMS on all groundfish vessels using NPT gear and the development of a comprehensive research and monitoring system. For a more detailed description of the fishing impact minimization measures imposed by Alternative 5B, see EIS Section 2.3.3.

C.3.7.1 Benefits Associated with Alternative 5B

C.3.7.1.1 Passive-use Benefits

Under Alternative 5B, NPT fishing activities for all species in ten designated areas, and for slope rockfish along the entire slope (200 to 1,000 m) in the GOA, would be eliminated. Use of NPT gear would be closed over 33.3 percent of five areas in the EBS on a 5-year rotational basis, with bobbins required on NPT gear fished in other areas. The use of NPT gear would be prohibited for all species in designated areas of the AI. Under Option 2, all bottom-contact gear would be prohibited in six designated coral garden areas off Semisopochnoi Island, Bobrof Island, Cape Moffet, Great Siskin Island, Ulak Island, and Adak Canyon. While it is not possible to provide an empirical point estimate of the passive-use value attributable to this protection of EFH at this time, it is assumed that Alternative 5B would yield some incremental increase in the passive-use benefit of EFH over the no action Alternative 1 (Table 3.7-1).

Alternative 5B would reduce the impact of NPT fishing over a large area of habitat in the GOA, EBS, and AI. However, the current distribution of fishing effort does not extend to the edge of the EEZ. Thus, fishing impacts on EFH would actually be minimized over 31,904 km^2 of GOA shelf and slope edge habitat (11.4 percent of the current 279,874 km^2 of habitat) and an average 63,975 km^2 of EBS habitat (8.0 percent of the current 798,870 km^2 of habitat), as in Alternative 5A. Alternative 5B would further reduce NPT fishing impacts in the EBS by requiring disks and bobbins on trawl sweeps and footropes used in open areas. In the AI, Alternative 5B, Option 1, would reduce the impact of NPT fishing over 74,443 km^2 of AI habitat, or 68.5 percent of the current fishable area of 108,243 km^2 in the AI. Under Alternative 5B, Option 2, the impact of NPT fishing would be reduced by 76,689 km^2, or 70.7 percent of the current fishable area. Use of bottom-contact gear would be prohibited in 380 km^2 of six coral garden areas. Under Alternative 5B, Option 3, the impact of NPT fishing would be reduced by 64,986 km^2, or 59.9 percent of the current fishable area. Overall, Alternative 5B would affect between 160,865 and 172,568 km^2, or 13.5 to 14.5 percent of the combined fishable area of 1,187,287 km^2 in the GOA, EBS, and AI. [See EIS sections 2.3.3 and 4.3 for details on fishing impact minimization measures and the environmental consequences of Alternative 5.]

C.3.7.1.2 Use and Productivity Benefits

Alternative 5B is designed to reduce the effects on EFH of NPT fishing in the GOA, EBS, and AI. These fishing impact reductions would extend beyond measures currently in place or planned as part of other fishery management actions. Current scientific knowledge does not permit either a quantitative or qualitative assessment of the use benefits that would be derived from minimizing the effects of fishing on EFH. However, the assumption implicit in the amendment to the Magnuson-Stevens Act requirement to minimize effects of fishing on EFH is that doing so would result in the sustained or enhanced production from FMP species and contribute to a healthy ecosystem (Table 3.7-2). As such, Alternative 5B would contribute additional measures that would further reduce the impacts of fishing on EFH.

C.3.7.2 Costs Associated with Alternative 5B

C.3.7.2.1 Industry Revenue at Risk

Alternative 5B, Option 1, had it been in place for the 2001 fishing year, would have placed a total of $12.94 million to $15.93 million of gross revenue at risk in NPT fisheries in the GOA, EBS, and AI, or 7.2 to 8.8 percent of the status quo total revenue of $179.77 million to $180.41 million, depending upon which rotational areas are affected in the EBS (Table 3.7-1). Alternative 5B, Option 2, had it been in place for the 2001 fishing year, would have placed $9.22 million to $12.20 million of gross revenue at risk in NPT fisheries in the GOA, EBS, and AI, or 5.1 to 6.8 percent of the status quo total revenue of $179.77 million to $180.41 million, depending upon which rotational areas are affected in the EBS (Table 3.7-1). Under Option 2, the prohibition on bottom contact fisheries in the six designated coral gardens in the AI would have placed an additional $234,000 of revenue at risk in NPT and HAL groundfish fisheries, up to 4.4 percent of the HAL halibut catch in IPHC Area 4B (Tom Kong, IPHC staff, personal communication, March 10, 2005), and 0.3 percent of the POT fishery catch of king and Tanner crab in the AI. Alternative 5B, Option 3, had it been in place for the 2001 fishing year, would have placed $7.46 million to $10.44 million of gross revenue at risk in NPT fisheries in the GOA, EBS, and AI, or 4.1 to 56.8 percent of the status quo total revenue of $179.77 million to $180.41 million, depending upon which rotational areas are assumed affected in the EBS (Table 3.7-1). In the AI, under Options 1 or 2, there would have been reductions in TACs for NPT target species that would reduce gross revenue in the catcher-vessel and catcher-processor fleet components.

Based on recent harvests from within the fishing impact minimization areas in the AI, the 2003 Atka mackerel trawl TAC of 45,649 mt would have been reduced under Alternative 5B, Options 1 and 2, by 6 percent, or 2,739 mt, resulting in the a complete loss of $2.73 million in first wholesale revenue. Under Alternative 5B, Options 1 and 2, the 2003 trawl caught rockfish TAC in the AI of 18,254 mt would have been reduced by 12 percent, or 2,190 mt, resulting in a complete loss of $1.10 million in first wholesale gross revenue. Since the Pacific cod TAC is allocated for both the AI and EBS combined, it is assumed that the combined area TAC for trawl-caught Pacific cod would be reduced by 10 percent, or 9,021 mt, from the 90,210 mt 2003 TAC, under Alternative 5B, Option 1, rules. Using the recent historical Pacific cod catch rates of 25 percent in the AI and 75 percent in the EBS, this would have resulted in a total loss in first wholesale revenue of $8.50 million in the EBS and $2.83 million in the AI, for a total of $11.34 million, in the 2001 fishery. The reduction in revenue from the EBS and AI from TAC reductions, under Alternative 5B, Option 1, would have totaled $15.16 million, with an $8.50 million reduction in revenue in the EBS and a $6.66 million reduction in the AI. Under Alternative 5B, Option 2, the reduction in first wholesale revenue in the AI from TAC reductions would have totaled $3.83 million. There would be no reduction in first wholesale revenue under Alternative 5B, Option 3.

The ten designated areas described under Alternative 5B in the GOA are discreet and widely spaced along the outer shelf and slope edge. Within the entire GOA, there is substantial NPT fishing area adjacent to the ten designated areas where the revenue at risk might be mitigated by a redeployment of fishing effort. However, had Alternative 5B been in effect in 2001, it would have placed 31.8 percent of the status quo revenue at risk in the EG. That large a revenue at risk would have been difficult to fully make up. Amendment 58 to the GOA FMP, which took effect in 1998, prohibits trawling in the EG, east of latitude 140º W. This leaves a very limited area within the EG where the revenue at risk for the NPT fisheries could be mitigated. It is likely that some portion of the EG revenue at risk would not have been recovered under Alternative 5B.

Although some slope rockfish are caught with NPT gear at depths shallower than 200 m in the GOA, a majority of the NPT commercial catch of the slope rockfish complex occurs at depths in excess of 150 m (NMFS 2002d). There is limited fishing area for slope rockfish in the 150 to 200 m slope edge adjacent to the 200 to 1,000 m area, designated for protection, where the revenue at risk might be mitigated by a redeployment of NPT fishing effort under Alternative 5B. Approximately 20 percent of the catch of the primary slope rockfish species, (i.e., Pacific ocean perch,) is taken by PTR fished by larger catcher-vessel and catcher-processor fleet components. Between 30 and 50 percent of the shortraker/rougheye rockfish in the slope rockfish complex is taken incidentally, by HAL gear, in the sablefish and halibut fisheries.

Under Alternative 5B, most, if not all, of the revenue at risk in the GOA might be recovered by redeployment of fishing effort to adjacent areas, or by switching to PTR gear by most of the fleet components involved in the fishery. The smaller catcher-vessel fleet targeting slope rockfish almost exclusively uses NPT gear and has neither sufficient horsepower to fish PTR, nor the revenue from participation in this fishery to warrant the investment necessary to utilize PTR gear. The larger catcher vessels (vessels that also target pollock) and the catcher-processors either already have PTR gear available or have sufficient horsepower to convert to PTR to target slope rockfish. Under Alternative 5B, while the revenue at risk might be recovered by vessels fishing adjacent areas in the GOA, or by switching to PTR gear within the protected areas, there could be a transfer of catch share and, thus, a transfer of revenue in the fishery, from the smaller catcher-vessel fleet component to the larger catcher-vessel and catcher-processor fleet components. The magnitude of this transfer is impossible to estimate without specific knowledge of the redeployment fishing effort strategies that would actually be followed by the different fleet components.

Alternative 5B imposes a closure of NPT fishing in 33.3 percent of five areas, with each area rotating on a 5-year basis. These fishing impact minimization measures would, had they been in place in 2001, have placed approximately 2.7 to 5.8 percent of the status quo revenue at risk, depending upon the rotation areas affected. The EBS revenue at risk would occur mainly in the catcher-processor fleet component. Some portion or all of the revenue at risk in the EBS might be made up by fishing with NPT gear in adjacent areas not directly affected by Alternative 5B. However, there could be additional revenue placed at risk in the EBS under Alternative 5B by the requirement to use bobbins and disks on trawl sweeps for all NPT gear used in open areas. The amount of increased revenue that could be placed at risk is unknown.

In the AI, under all three options of Alternative 5B, NPT gear would be prohibited for all species in designated areas within the EEZ, and additional closures would occur in areas of high coral and sponge bycatch under Options 1 or 2. Under Alternative 5B, Option 2, bottom-contact gear would be prohibited in additional designated coral garden areas. Under Alternative 5B, Options 1 and 2, TACs in NPT fisheries would be reduced by the 1998 to 2002 average historical amounts of target species caught in the designated closure areas and in coral and sponge closure areas. Under all three options of Alternative 5B, revenue would be placed at risk in both catcher-vessel and catcher-processor fleet components for NPT fisheries in the AI.

C.3.7.2.2 Product Quality and Revenue Impacts

Revenue impacts from changes in product quality would be possible under Alternative 5B, particularly for the smaller catcher-vessel fleet component operating with NPT gear in the GOA. These vessels may have to expend additional fishing effort in their attempt to recover a portion of the revenue at risk, which may lengthen fishing trips and result in diminished product quality. Product quality may not be affected in the catcher-processor fleet component, since these vessels process the catch onboard the vessel.

Product quality could be affected, however, if the average size or condition of the fish changes significantly.

C.3.7.2.3 Operating Cost Impacts

Operating cost impacts under Alternative 5B may be greater overall for both the GOA catcher-vessel component and catcher-processor fleet components in all areas. CPUE of slope rockfish caught with PTR gear and with NPT gear at depths shallower than 200 m along the GOA slope edge could be lower than the CPUE of NPT gear in the depth range of 200 m and greater where these species are normally fished. This would likely result in increased fishing effort and associated operational costs to make up the catch and revenue at risk.

Larger catcher vessels and catcher-processors in the GOA have the option of changing to PTR gear for targeting slope rockfish. However, the smaller catcher vessels, particularly the 18.3 m (60 feet) and smaller vessels, do not have sufficient horsepower to switch to PTR fisheries, and the equipment costs would likely be prohibitive, given the annual revenue of these vessels. Had 5B been implemented in 2001, operational costs for the catcher-processor fleet component might have increased due to the redeployment of fishing effort made necessary to make up a portion or all of the 17.6 percent of the status quo revenue at risk for this fleet component.

Catcher-processors operating in the EBS NPT flathead sole fishery would likely have increased operational costs under Alternative 5B due to increased running time to reach northern fishing areas when the more southerly areas are closed, and possibly due to increased fishing effort to mitigate the revenue at risk in these fisheries (Table 3.7-1). It is impossible to estimate the increase in operational costs without fully understanding the fishing effort redeployment strategy that the operators would follow in their attempt to mitigate these 5B attributable losses. Assuming 5B had been the rule in 2001, this would have meant that 11.8 to 29.3 percent of status quo revenue would have been placed at risk in the NPT fishery for flathead sole that year. Alternative 5B would require the use of bobbins and disks on NPT footropes and trawl sweeps used in open areas. The use of bobbins and disks may reduce the CPUE of some bottom-dwelling species such as flatfish, resulting in increased fishing time and associated operational costs to attain the status quo catch and revenue in these fisheries. This operational impact would occur primarily in the catcher-processor fleet component in the EBS.

In the AI, all three options of Alternative 5B would likely result in increased operational costs for both the catcher-vessel and catcher-processor fleets. Alternative 5B would require any vessel using NPT gear to have a VMS system. Although all of the vessels fishing the area probably have such a system now, Alternative 5B may require additional VMS operation time on these vessels due to SSL regulations. Alternative 5B also requires 100 percent observer coverage for vessels targeting groundfish, which would increase observer costs on the catcher vessels that are currently required to have only 30 percent observer coverage. All three options of Alternative 5B would produce a complicated patchwork of open and closed areas. Under Alternative 5B, Options 1 and 2, additional areas would likely be closed to NPT gear, depending on coral/sponge bycatch rates that may change from year to year. This may require fishermen to alter their normal fishing areas and possibly explore for new fishing grounds within the designed option NPT area, increasing fishing effort to mitigate catch and revenue at risk. All of these fishing strategies would likely result in increased operational costs in the AI catcher vessel and catcher-processor NPT groundfish fleets (Table 3.7-1).

C.3.7.2.4 Safety Impact

Alternative 5B may not significantly affect the safety of any of the fleet components in the GOA, because fishing effort would likely be redeployed to immediately adjacent fishing areas (Table 3.7-1).

In the EBS, catcher-processors targeting flathead sole, other flatfish, and Pacific cod would be restricted from fishing some areas closer to their home ports during some periods, depending on the fishing impact minimization measure area affected by the rotational closures to NPT gear. When more southerly areas are closed, vessels fishing NPT gear would have to travel farther north and farther from safe harbor and ports of call.

Alternative 5B would likely affect the safety of the catcher-vessel and catcher-processor fleet components in the AI, because fishing effort would likely be redeployed to new fishing areas, possibly farther from the vessels' home ports.

C.3.7.2.5 Impacts on Related Fisheries

There would likely be an impact on related fisheries in the GOA from Alternative 5B, because a substantial amount of NPT fishing effort for slope rockfish would likely be redeployed into adjacent areas shallower than 200 m that would not be directly affected by the alternative. Other fisheries occur in these areas, including halibut longline, Pacific cod longline (when open), and other NPT fisheries such as shallow water flatfish. Increased NPT fishing effort at depths of less than 200 m along the GOA shelf edge may have negative (and potentially substantial) indirect economic impacts on these fisheries (Table 3.7-1).

There may be impacts on related fisheries from Alternative 5B in the EBS and AI, as vessels using NPT gear are displaced into adjacent areas where other gear groups such as HAL and POT vessels may be operating.

C.3.7.2.6 Costs to Consumers

There may be an increase in costs to consumers from Alternative 5B, because the total revenue at risk could not be recovered in the AI, due to the reduction in TACs (Table 3.7-1). There may be some increases in operational costs for certain fleet components that may be passed on to consumers from harvesters and processors (depending on market conditions, such as available close substitutes in supply, demand elasticities, vertical integration, etc.). There may also be attributable welfare costs imposed on consumers from changes in availability of supply, product mix, and/or product quality.

C.3.7.2.7 Management and Enforcement Costs

Management and enforcement costs may increase under Alternative 5B, although it is not possible to estimate by what numerical amount. Additional on-water enforcement may be required to ensure compliance with the fishing impact minimization measures applied in the GOA, EBS, and AI (Table 3.7-1). Section 3.1.2.7 contains some additional discussion of NMFS Enforcement and Coast Guard responses to resource demands connected with monitoring and enforcing provisions of Alternative 5B.

VMS equipment or 100 percent observer coverage might be needed on all vessels using NPT gear in the GOA and EBS, and both VMS and 100 percent observer coverage would be required in the AI to ensure compliance with all three options of Alternative 5B. Most groundfish vessels operating in the GOA, EBS, and AI for pollock or Pacific cod fishery are already equipped with VMS. Vessels not equipped with VMS systems may be required to install and operate the VMS equipment during NPT fisheries in all areas. The number of additional vessels that would have to add VMS equipment under Alternative 5B is not known. Alternative 5B fishing impact minimization measures are specific to gear (NPT) and may require additional enforcement measures (boarding and inspection) beyond the typical time/area/fishery management measures currently employed in the GOA.

Alternative 5B specifically requires the development and implementation of a research and monitoring program to assess the effectiveness of the fishing impact minimization measures. Accomplishing these research and monitoring projects would require significant additional expenditures by the Alaska Region and Alaska Fisheries Science Center over a period of years.

C.3.7.3 Distributional Impacts

C.3.7.3.1 Gross Revenue at Risk Effects

C.3.7.3.1.1 Geographic Area Impacts

Alternative 5B, had it been the rule in 2001, would have imposed fishing impact minimization measures in the GOA, EBS, and AI. Within the GOA, the largest amount of revenue at risk would have been in the CG, with $2.55 million at risk, or 12.3 percent of the $20.69 million 2001 status quo revenue in the CG (Table 3.7-2). The revenue at risk in the WG totals $810,000, or 13.0 percent of the 2001 status quo revenue of $6.25 million. There would have been $240,000 revenue at risk in the EG, or 31.8 percent of the $760,000 status quo revenue that year.

In the EBS, Alternative 5B would have placed between $2.63 million and $5.61 million of revenue at risk, or 2.7 to 5.8 percent of the $96.27 million to $96.91 million of status quo revenue in the fisheries affected, had it been in place in 2001. However, the reduction in the combined BSAI trawl TAC for Pacific cod, required by Alternative 5B, Option 1, would have reduced the revenue from NPT fisheries for Pacific cod in the EBS by $8.50 million, or more than the total of the combined species revenue at risk for EBS fishing impact minimization measures. These represent pure losses for the sector, because the forgone catch may not be made up by redeployment.

In the 2001 AI fisheries, under Alternative 5B, Option 1, $6.71 million in revenue would have been placed at risk, or 12.0 percent of the $55.81 million of status quo revenue in the affected fisheries. Additionally, under Alternative 5B, Option 1, TAC reductions would have reduced the revenue in the AI NPT fisheries for Atka mackerel, Pacific cod, and rockfish by $6.66 million, or nearly all of the revenue at risk in the AI in 2001 under Alternative 5B, Option 1. Under Alternative 5B, Option 2, $2.99 million in revenue would have been placed at risk, or 5.4 percent of the 2001 status quo revenue in the affected fisheries. Additionally, under Alternative 5B, Option 2, TAC reductions for Atka mackerel and rockfish would have reduced the revenue in AI NPT fisheries by $3.83 million. Under Alternative 5B, Option 2, the prohibition on bottom-contact gear in the six AI coral garden areas would place an additional $234,000 of revenue at risk in the NPT and HAL groundfish fisheries, up to 4.4 percent of the IPHC Area 4B HAL halibut catch, and 0.3 percent of the POT fishery catch of king and Tanner crab in the AI. Under Option 3 of Alternative 5B, $1.23 million in revenue would have been placed at risk, or 2.2 percent of the $55.81 million of status quo revenue in affected fisheries.

C.3.7.3.1.2 Fishery Impacts

In the GOA, Alternative 5B would affect a number of NPT fisheries, but primarily fisheries targeting rockfish and Pacific cod. The total revenue at risk in the NPT rockfish fishery under these rules would have equaled $2.82 million, or 30.1 percent of the status quo revenue of $9.36 million in 2001 (Table 3.7-2). The total revenue at risk in the GOA NPT Pacific cod fishery (mainly from the catcher-vessel fleet component) would have been $380,000, or 4.9 percent of the status quo revenue of $7.66 million.

Alternative 5B would place revenues at risk in a number of NPT target fisheries in the EBS, including flathead sole, yellowfin sole, rock sole, other flatfish, and Pacific cod, among others. However, the largest revenue at risk would occur in the flathead sole fishery, where, had this rule been in place in 2001, $1.70 million to $4.23 million of revenue would have been at risk, equaling 11.8 to 29.3 percent of the $14.46 million status quo revenue, depending upon the rotational area affected. The total revenue at risk in the EBS NPT Pacific cod fishery would have ranged from $190,000 to $980,000, or 1.3 to 6.8 percent of the 2001 status quo revenue of $14.33 million. However, the reduction in the combined BSAI trawl TAC for Pacific cod, required by Alternative 5B, would have reduced the revenue from NPT fisheries for Pacific cod in the EBS by $8.50 million or, over $7.0 million more than the Pacific cod revenue at risk and more than the total of the combined species revenue at risk from EBS fishing impact minimization measures.

In the AI, all three options of Alternative 5B would place revenue at risk in NPT fisheries for Atka mackerel, flatfish, Pacific cod, and rockfish. The largest revenue at risk in the AI would be in the NPT Atka mackerel fishery, where, had Alternative 5B, Option 1, been in place in 2001, $3.61 million or 8.8 percent of the status quo revenue of $41.01 million would have been placed at risk (Table 3.7-2). If Alternative 5B, Option 2, had been in place, $1.59 million, or 3.9 percent of the status quo revenue, would have been placed at risk (Table 3.7-3). If Alternative 5B, Option 3, had been in place, $0.62 million, or 1.5 percent of the status quo revenue in the AI NPT Atka mackerel fishery would have been placed at risk (Table 3.7-4). The TAC reduction requirement under Alternative 5B, Options 1 and 2, would have reduced the trawl-caught Atka mackerel revenue in the AI by $2.73 million or 75.6 percent of the revenue at risk in this 2001 fishery, leaving $880,000 of revenue at risk that could potentially have been recovered, in whole or in part, with redeployment of fishing effort. In addition to the impacts on the Atka mackerel fishery, Alternative 5B, Option 1, would have placed $1.64 million of Pacific cod at risk, or 17.1 percent of the status quo revenue of $9.61 million, in this 2001 fishery. However, the TAC reduction in AI trawl-caught Pacific cod would have reduced the revenue in this fishery by $2.83 million, or more than the revenue at risk that was estimated based on 2001 harvest data. Under Alternative 5B, Options 1 and 2, $1.45 million of revenue would have been placed at risk in the NPT rockfish fishery, or 28.5 percent of the status quo revenue value of $5.08 million. Of this amount, $1.10 million would not have been recoverable, due to the TAC reduction. Some or all of the remaining $350,000 revenue at risk in the rockfish NPT fishery could potentially have been recovered by redeploying fishing effort to adjacent open areas or switching to PTR gear. Under Alternative 5B, Option 2, the prohibition of bottom-contact gear in the six designated AI coral garden areas would place $234,000 of revenue at risk in the Pacific cod NPT and HAL fisheries, up to 4.4 percent of the IPHC Area 4B HAL halibut catch, and 0.3 percent of POT fishery for mainly king crab in the AI.

C.3.7.3.1.3 Fleet Component Impacts

In the GOA, had this rule prevailed in 2001, the catcher-processor fleet would have had the greatest amount of revenue at risk, $2.70 million, or 17.6 percent of the status quo total revenue. The catcher-vessel fleet would have had $900,000 of ex-vessel revenue at risk, or 7.3 percent of the total ex-vessel revenue of $12.31 million (Table 3.7-2). Under Alternative 5B, the catcher-vessel fleet would have had revenue at risk in the EG of $60,000, or 20.8 percent of status quo; in the CG, $470,000, or 4.9 percent of status quo; and in the WG, $360,000, or 16.0 percent of status quo. The GOA catcher-processor fleet would have had revenue at risk mainly in the CG ($2.07 million or 18.9 percent of status quo), but also in the WG ($450,000, or 11.3 percent of the $4 million status quo gross revenue) and the EG ($180,000, or 39.3 percent of the $450,000 status quo).

In the EBS, substantially all of the revenue at risk would have occurred in the catcher-processor fleet component. A total of $2.63 million to $5.61 million of revenue is at risk or 2.9 to 6.2 percent of $90.45 million to $91.08 million of status quo revenue, depending upon the rotational area closures, had 5B been in place that year. However, the reduction in the combined BSAI trawl TAC for Pacific cod, required by Alternative 5B, Option 1, would have reduced the catcher-processor revenue from NPT fisheries for Pacific cod in the EBS by $8.50 million, or over $7.0 million more than the Pacific cod revenue at risk and more than the total of the catcher-processor combined species revenue at risk from EBS fishing impact minimization measures, based on the 2001 fisheries.

In the AI, the catcher-processor NPT fleet would have accounted for $6.40 million at risk under Alternative 5B, Option 1, $2.94 million at risk under Option 2, and $1.20 million at risk under Option 3, or more than 95 percent of the total 2001 revenue at risk under all three options. The catcher-processor revenue at risk under Alternative 5B, Option 1, is 11.7 percent of the total 2001 status quo revenue of $54.49 million, 5.4 percent under Option 2, and 2.2 percent under Option 3. The catcher-vessel fleets would have had $310,000 of revenue at risk, or 23.6 percent of the total status quo revenue of $1.32 million under Alternative 5B, Option 1. Under Alternative 5B, Option 2, the total catcher-vessel fleets would have had $50,000 of revenue at risk, or 3.9 percent of the total status quo revenue. Under Alternative 5B, Option 3, the total catcher-vessel fleets would have had $30,000 at risk, or 2.2 percent of the status quo revenue. All of the catcher-vessel fleet impact on revenue at risk in the AI is in the NPT fishery for Pacific cod, whereas the catcher-processor fleet impacts on revenue at risk are mainly in the Atka mackerel, rockfish, and Pacific cod fisheries. The TAC reductions, required by Alternative 5B, would have reduced the revenue in the catcher-processor fleet for Atka mackerel and rockfish and for the catcher-processor and catcher-vessel fleet for Pacific cod by a total of $6.66 million, or nearly all of the revenue at risk in the AI under Alternative 5B, Option 1, had it been the rule in 2001. The TAC reductions, required under Alternative 5B, Option 2, would have reduced the revenue in the catcher-processor fleet for Atka mackerel and rockfish by $3.83 million, or more than all of the revenue at risk due to fishery impact minimization measures in the AI under Alternative 5B, Option 2. Under Alternative 5B, Option 2, the prohibition of bottom-contact gear in the six AI coral garden areas would place $164,000 of revenue at risk in the catcher-processor fleet targeting Pacific cod, $69,000 of revenue at risk in the catcher vessel fleet targeting Pacific cod, up to 4.4 percent of the HAL catcher vessel fleet harvesting halibut in IPHC Area 4B, and 0.3 percent of the primarily king crab catch by the POT catcher vessel fleet in the AI.

C.3.7.3.2 Impacts on Dependent Communities

C.3.7.3.2.1 Overview

Like Alternative 5A, impacts to dependent communities may be significant at the community level, at least for a few communities (King Cove and Sand Point) under each of the Alternative 5B options. Adverse impacts to individual operations may occur in other communities (especially Kodiak), but these impacts are considered to be unlikely to be significant at the community level, due to magnitude of the impacts relative to the overall operations of the affected fleet and processing entities (as well as the overall community fishing sectors).

The only fisheries directly affected by any of the Alternative 5B options would be groundfish fisheries. Similar to Alternative 4 (but unlike Alternatives 2 and 3), groundfish fisheries in addition to rockfish would be affected by this alternative. Like Alternative 4, this alternative would have impacts on GOA, EBS, and AI fisheries. Like Alternatives 2, 3, and 4, the only gear group directly affected for both catcher vessels and catcher-processors would be non-pelagic trawl. Using 2001 fleet data, 93 vessels (catcher vessels plus catcher-processors) would be affected by this alternative: 28 in Alaska, 12 from Oregon, 47 from Washington, and 6 from other states. Washington and Oregon communities, though significantly engaged in the fishery, are not considered dependent communities, based on the overall economic structure of those communities and the relatively small role the Alaska groundfish fishery plays in the local economy. Using 2001 processor data, 19 shoreside processors in Alaska would potentially be affected by this alternative.

C.3.7.3.2.2 Catcher Vessels

Based on 2001 data (within Alaska), ownership of catcher vessels harvesting relevant groundfish species with at-risk revenue under any of the Alternative 5B options is concentrated in the AEB with 19 vessels (King Cove has 8 and Sand Point 11) and Kodiak with 7 vessels. All but two of the AEB vessels are classified as small (less than 60 feet) vessels, while none of the Kodiak vessels are so classified. Anchorage and Girdwood account for the remaining two Alaska-owned vessels; one of these is a small vessel, and one is a large vessel. Ownership in the Pacific Northwest accounts for 44 vessels with at-risk revenues under this alternative (32 from Washington, all but 2 of them large vessels, and 12 vessels, all large, from Oregon). Four vessels (three large and one small) are owned in other states.

Catcher vessel-associated community impacts in the GOA under any of the Alternative 5B options would be the same as those seen under Alternative 5A. As noted under that alternative, significant impacts associated with local catcher fleets could accrue to the communities of King Cove and Sand Point. Catcher vessel-associated community impacts in the EBS under any of the Alternative 5B options would be the same as those seen under Alternative 5A (not significant).

For catcher vessels operating in the AI, the only affected fishery would be Pacific cod under any of the options, but the amount of revenue at risk would vary by option. Under Option 1, the revenue at risk under this alternative ($310,000) is 23.6 percent of the status quo total ($1.32 million) for affected vessels for the area. As noted elsewhere, figures given for catcher vessels represent ex-vessel revenues, which would tend to understate the overall value to associated communities that derive benefits from both harvesting and processing activities if examined alone. Values for first wholesale revenues at risk by shoreside processors from landings of catcher vessels are referenced in the discussion of shoreside processor locations provided below. Based on known characteristics of the different fleet segments, the ownership of these vessels with at-risk AI revenues would primarily be concentrated in Pacific Northwest communities, and any impacts seen in Alaska would be concentrated in Kodiak. No significant community level impacts associated with this catcher fleet are anticipated, due to the amount of revenue at risk and the relative size and diversity of the economies of these communities (although some vessels would likely experience increased costs and/or decreased harvests).

Under Alternative 5B, Option 2, the revenue at risk ($50,000) is 3.9 percent of the status quo total ($1.32 million) of affected vessels for the AI area. The additional prohibition on bottom-contact gear in the six AI coral garden areas would place an additional $69,000 in revenue at risk to the NPT groundfish trawl fleet, up to 4.4 percent of IPHC Area 4B HAL halibut catch (affecting 33 or 156 catcher vessels), and 0.3 percent of the king and Tanner crab POT catch by catcher vessels in the AI (affecting 5 to 10 of 17 catcher vessels). The vessels with revenues at risk under Option 2 would be the same vessels as those with revenue at risk under Option 1; therefore, effects on communities would be expected to be similar to those seen under Option 1 (but of a lower intensity due to less revenue at risk). Impacts would be concentrated in Pacific Northwest communities and Kodiak, and no significant community level impacts are anticipated associated with this catcher fleet, due to the size and diversity of the economies of these communities and the relatively minor level of revenue at risk (although some vessels would likely experience increased costs and/or decreased harvests).

Under Alternative 5B, Option 3, the revenue at risk ($30,000) is 2.3 percent of the status quo total ($1.32 million) of affected vessels for the AI area. The vessels with revenues at risk under Option 3 would be the same vessels as those with revenue at risk under Option 1; therefore, effects on communities would be expected to be similar to those seen under Option 1 (but of a lower intensity due to less revenue at risk). Impacts would be concentrated in Pacific Northwest communities and Kodiak, and no significant community level impacts are anticipated associated with this catcher fleet, due to the size and diversity of the economies of these communities and the relatively minor level of revenue at risk (although some vessels would likely experience increased costs and/or decreased harvests).

C.3.7.3.2.3 Catcher-Processors

Based on 2001 data, Alaska ownership of catcher-processors with revenue at risk is exclusive to Kodiak (three vessels). Ownership in the Pacific Northwest is exclusive to Washington (15 vessels). Because of the small number of entities, information on harvest value cannot be disclosed for Alaska catcher-processors at risk under this alternative. For catcher-processors, impacts under any of the Alternative 5B options would be the same for the GOA as seen under Alternative 5A. Catcher-processor-related impacts under any of the Alternative 5B options in the EBS would also be the same as those seen under Alternative 5A.

For the AI, affected catcher-processors under Alternative 5B, Option 1, would experience revenue at risk of $6.40 million, or approximately 11.7 percent of the status quo revenue total ($54.49 million). (This is approximately 3.8 times the analogous revenue at risk under Alternative 5A.) Catcher-processors would experience revenue at risk associated with a number of different groundfish species. While some of these species have a relatively high percentage of revenue at risk, the overall value at risk is comparatively low for a number of these species. Only three species have revenue greater than $10,000 at risk. These are Atka mackerel ($3.61 million at risk, which is 8.8 percent of status quo value), Pacific cod ($1.33 million, 16.1 percent of status quo value), and rockfish ($1.45 million, 28.5 percent of status quo value). The catcher-processors harvesting and processing these species are primarily head and gut vessels.

Due to confidentiality restrictions based on a small number of participating entities, value information for Alaska-based catcher-processors with revenue at risk cannot be disclosed for this alternative. Impacts experienced in Alaska would, however, be concentrated in Kodiak. Given the small number of entities involved, and the relative size of the local fishery-based economy, it is assumed that community level impacts associated with catcher-processors would not be significant, although some individual entities may have experienced adverse impacts due to increased costs and/or decreased harvests. While individual Washington-owned entities may experience adverse impacts under Alternative 5B, Option 1, it is assumed that community level impacts would not be significant under this alternative due to the scale of the local economy in those communities.

Under Alternative 5B, Option 2, affected catcher-processors in the AI would experience revenue at risk of $2.94 million, or approximately 5.4 percent of the status quo revenue total ($54.49 million). Revenues at risk would be associated with the same groundfish species as under Option 1, but the amount of revenue at risk would be different for Atka mackerel, Greenland turbot, Pacific cod, and rockfish. Greenland turbot revenues at risk, however, as under Option 1, would be less than $10,000. For the other three species, revenue at risk would be less than that seen under Option 1: Atka mackerel ($1.59 million at risk, which is 3.9 percent of the status quo value), Pacific cod ($430,000 at risk, 5.2 percent of the status quo value), and rockfish ($1.19 million at risk, 23.5 percent of the status quo value). Under Option 2, the six designated coral garden areas would place an additional $164,000 of revenue at risk in the catcher-processor NPT Pacific cod fishery. The same vessels would be affected as those under the larger NPT restriction in the AI. The vessels with revenues at risk under Option 2 would be the same vessels as those with revenue at risk under Option 1; therefore, effects on communities would be similar to those seen under Option 1 (but of a lower intensity due to less revenue at risk). Specific information on Alaska-based catcher processors cannot be disclosed, but impacts experienced in Alaska would be concentrated in Kodiak. Given the small number of entities involved, the small amount of revenue at risk, and the relative size of the local fishery-based economy, it is assumed that community level impacts associated with catcher-processors would not be significant, although some vessels may experience increased costs and/or decreased harvests. While individual Washington-owned entities may experience adverse impacts under this Alternative 5B option, it is assumed that community level impacts would not be significant due to the amount of revenue at risk and the scale of the local economy in those communities.

Under Alternative 5B, Option 3, affected catcher-processors in the AI would experience revenue at risk of $1.20 million, or approximately 2.2 percent of the status quo revenue total ($54.49 million). Revenues at risk would be associated the same groundfish species as under Option 1, but the amount of revenue at risk would be different for Atka mackerel, Greenland turbot, Pacific cod, and rockfish. Greenland turbot revenues at risk, however, as under Option 1, would be less than $10,000. For the other three species, revenue at risk would be less than that seen under Option 1: Atka mackerel ($620,000 at risk, which is 1.5 percent of the status quo value), Pacific cod ($320,000 at risk, 3.9 percent of the status quo value), and rockfish ($260,000 at risk, 5.1 percent of the status quo value). The vessels with revenues at risk under Option 2 would be the same vessels as those with revenue at risk under Option 1; therefore, effects on communities would have be similar to those seen under Option 1 (but of a lower intensity due to less revenue at risk). Specific information on Alaska-based catcher processors cannot be disclosed, but impacts experienced in Alaska would be concentrated in Kodiak. Given the small number of entities involved, the small amount of revenue at risk, and the relative size of the local fishery-based economy, it is assumed that community level impacts associated with catcher-processors would not have been significant, although some vessels may experience increased costs and/or decreased harvests. While individual Washington-owned entities may experience adverse impacts under this Alternative 5B option, it is assumed that community level impacts would not be significant, due to the amount of revenue at risk and the scale of the local economy in those communities.

C.3.7.3.2.4 Shoreside Processors

Shoreside processors involved in the at-risk harvest (using 2001 data) under any of the Alternative 5B options are concentrated in Kodiak (with nine entities). Akutan had two entities, and a number of other communities each had a single processor that processed at least some groundfish from vessels with at-risk revenues under this alternative (King Cove, Sand Point, Unalaska/Dutch Harbor, Ketchikan, Moser Bay [Kodiak Island Borough], Chignik, Sitka, and Cordova).

Under Alternative 5B, Option 1, the total first wholesale value at risk of catch delivered inshore for processing represents approximately 8 percent of the total status quo value (about $3.28 million out of $42.45 million) of the relevant fisheries of the GOA area, about 24 percent of the AI status quo value (about $726,000 out of $3.08 million), well below 1 percent for the EBS area, and about 7 percent for all areas combined (about $4.01 million out of $58.84 million), but no breakdown by port of landing is available. Caution must be exercised in the interpretation of these wholesale value data as (1) they are not additive with ex-vessel values presented above, and (2) they cannot be used as a proxy for potential levels of impacts to specific communities without considering the basic caveats laid out in the introductory paragraphs of Section C.3.3.3.2.4 of the Alternative 2 discussion. Similar to Alternative 5A, processor-associated impacts to dependent communities may be significant in some of the smaller communities in the WG area (for the reasons discussed under Alternative 5A), but data that would be needed to quantify these impacts are confidential. Based on 2001 processor location data, it is assumed that most of the additional AI Pacific cod catch at-risk under this alternative (compared to Alternative 5A) would be processed in Unalaska/Dutch Harbor. In terms of the scale of potential impacts, the $310,000 at risk (using 2001 data) is equivalent to 2 percent of the total Pacific cod value ($15 million) processed in the community in 2000, or about 0.2 percent of the total value ($144 million) for all species processed in the community in 2000, the most recent year for which complete community level data are available. Given that at least some of this catch would likely be made up by redeployment of catcher vessel effort in other areas, along with the low overall proportion of the at-risk totals compared to overall local processing, no significant community impacts associated with processing are likely for Unalaska/Dutch Harbor, although some individual entities may experience a loss of processing volume and/or revenues. No significant community impacts are anticipated for any other dependent communities.

Under Alternative 5B, Option 2, revenue at risk for the relevant fisheries of the GOA area and the EBS area would be the same as under Option 1. For the AI fisheries, revenue at risk for all fished species would remain the same for relevant fisheries with one exception: Pacific cod deliveries to shoreline processors would have less revenue at risk under Alternative 5B, Option 2, than under Option 1. It is assumed that most of AI Pacific cod catch at-risk under this option would be processed in Unalaska/Dutch Harbor. The $50,000 at risk is approximately 0.3 percent of the total Pacific cod value ($15 million) processed in the community in 2000 (the most recent year for which complete community-level data for Unalaska/Dutch Harbor are available), or about 0.03 percent of the total processing value ($144 million) for the community in 2000. The catch and revenue at risk from the prohibition on use of all bottom-contact gear in the six designated coral gardens in the AI under Option 2 would affect catch that otherwise would have been processed in Unalaska/Dutch Harbor. Given the low overall proportion of the at-risk totals compared to overall local processing, no significant community impacts associated with processing would be likely for Unalaska/Dutch Harbor, although some individual entities may experience a loss of processing volume and/or revenues. No significant community impacts would be likely for any other dependent communities.

Under Alternative 5B, Option 3, revenue at risk for the relevant fisheries of the GOA area and the EBS area would be the same as under Option 1. For the AI fisheries, revenue at risk for all fished species would remain the same for relevant fisheries with one exception: Pacific cod deliveries to shoreline processors would have less revenue at risk under Alternative 5B, Option 3, than under Option 1. It is assumed that most of AI Pacific cod catch at-risk under this option would be processed in Unalaska/Dutch Harbor. The $30,000 at risk is approximately 0.2 percent of the total Pacific cod value ($15 million) processed in the community in 2000 (the most recent year for which complete community-level data for Unalaska/Dutch Harbor are available), or about 0.02 percent of the total processing value ($144 million) for the community in 2000. Given the low overall proportion of the at-risk totals compared to overall local processing, no significant community impacts associated with processing would be likely for Unalaska/Dutch Harbor, although some individual entities may experience a loss of processing volume and/or revenues. No significant community impacts would be likely for any other dependent communities.

C.3.7.3.2.5 Multi-Sector Impacts

Multiple sector impacts may be significant at the community level under Alternative 5B, Option 1. Among Alaska communities, Kodiak, King Cove, and Sand Point participate in more that one sector with at-risk revenues. Kodiak is home to seven locally owned catcher vessels, three locally owned catcher-processors, and some nine locally operating shoreside processing entities with at least some revenue at risk, depending on closure configurations. Neither King Cove nor Sand Point is home to locally owned catcher-processors, but both have multiple locally owned catcher vessels (8 and 11 vessels, respectively) and have at least one dominant local processor with at least some revenue at risk under this alternative. Alaska fleet related community impacts would be similar to those seen under Alternative 5A, with revenue at risk for King Cove and Sand Point catcher vessels comprising a higher percentage of total overall ex-vessel revenues than is the case in Kodiak, and these vessels represent a much larger proportion of the total community fleet in King Cove and Sand Point than do the affected vessels in Kodiak. Given the smaller vessels in King Cove and Sand Point (with less flexibility of response), the higher proportion of revenue at risk, the higher proportion of the fleet with revenue at risk, and the known challenges that these fleets (and communities) are facing with other fisheries, the WG communities of King Cove and Sand Point may experience social impacts from this alternative that would be significant at the community level. Other Aleutians East Borough communities that derive benefits from revenues generated through borough raw fish taxes on landings in King Cove and Sand Point may have experienced impacts. These impacts to other borough communities would, however, probably not have been significant as the overall quota would have been unchanged, and no changes would have been expected in landing patterns at the regional level. Individual Kodiak entities may experience adverse impacts under this alternative, but impacts at the community level are considered unlikely to rise to the level of significance given the small proportion of revenue at risk for the affected catcher vessels, the low volumes at risk, and the assumption that overall delivery patterns are unlikely to change for Kodiak based shoreside processors under this alternative. Kodiak may experience additional catcher-processor related impacts over and above those seen in Alternative 5A, but the information that would permit such an analysis is confidential. Some additional Alaska resident crew positions on vessels owned elsewhere, but that spend at least part of the year in Alaska ports, may have some compensation at risk. Transient vessels owned outside of Alaska typically also make expenditures in ports of landing, which, in this case, would be concentrated in Kodiak. Given the assumption that overall delivery patterns for the community are unlikely to change, however, any vessel expenditure associated impacts are likely to be minor.

Multiple sector community impacts under Alternative 5B, Option 2, would be the same as those identified under Alternative 5B, Option 1, because the same fleets and processors would be affected, and most multiple sector impacts to communities would be driven largely by GOA impacts that would not differ between the options under this alternative. As under Alternative 5B, Option 1, these impacts may be significant at the community level in King Cove and/or Sand Point for the reasons identified in the Alternative 5B, Option 1, discussion. Additional impacts would be concentrated in Kodiak, but it is not likely that they would be significant at the community level for the reasons outlined in the Alternative 5B, Option 1, discussion.

Multiple sector community impacts under Alternative 5B, Option 3, would also be the same as those identified under Alternative 5B, Option 1, because the same fleets and processors would be affected, and most multiple sector impacts to communities would be driven largely by GOA impacts that would not differ between the options under this alternative. As under Alternative 5B, Option 1, these impacts may be significant at the community level in King Cove and/or Sand Point for the reasons identified in the Alternative 5B, Option 1, discussion. Additional impacts would be concentrated in Kodiak but it is not likely that they would be significant at the community level for the reasons outlined in the Alternative 5B, Option 1, discussion.

The potential for cumulative impacts is less straightforward. Even if the potential for social impacts under Alternative 5B would not be significant in isolation, this alternative would have the potential, nonetheless, to impose adverse cumulative impacts when evaluated in the context of other factors that are currently affecting North Pacific and EBS fisheries and fishing communities. Cumulative effects could include interactions with the social impacts of, among others, the near-shore closures put in place in 2001 to protect Steller sea lions, proposed rationalization of the BSAI crab and GOA groundfish fisheries, and the severe decline in salmon prices. These effects would likely be concentrated in communities with (relatively) significant dependence on small boat fleets and communities that are dependent on both salmon harvesting and one or more of the fisheries that would be affected by the alternative.

C.3.8 Alternative 5C (Preferred Alternative)

Alternative 5C would amend the GOA and BSAI Groundfish FMPs to prohibit the use of specific bottom contact fishing gear in designated areas of the AI and GOA. In the GOA, use of NPT gear would be prohibited for all species in ten designated sites of the GOA upper to intermediate slope between 200 and 1,000 m. In the AI, use of NPT gear would be prohibited for all species in designated areas extending to the limits of the EEZ, and use of all bottom-contact gear would be prohibited for all species in six designated coral garden sites off Semisopochnoi Island, Bobrof Island, Cape Moffet, Great Siskin Island, Ulak Island, and Adak Canyon.

Additional measures imposed by Alternative 5C in the AI would include 100 percent observer coverage and VMS on all commercial fishing vessels using bottom-contact gear. Fishery monitoring measures in the GOA would include existing levels of observer coverage, but significantly expanded VMS requirements. The proposed extension of VMS in the GOA is analyzed in detail in Section C.3.8.4, below. For a more detailed description of the fishing impact minimization measures imposed by Alternative 5C, see EIS Section 2.3.3.

C.3.8.1 Benefits Associated with Alternative 5C

C.3.8.1.1 Passive-use Benefits

Under Alternative 5C, NPT fishing activities for all species in ten designated areas along the upper and intermediate slope (200 to 1,000 m) in the GOA would be eliminated. The use of NPT gear would be prohibited for all species in designated areas of the AI, and six coral garden areas would be established in which use of all bottom contact commercial fishing gear would be prohibited. While it is not possible to provide an empirical estimate of the passive-use value attributable to this protection of EFH at this time, it is assumed that Alternative 5C would yield some incremental increase in the passive-use benefit of EFH over status quo Alternative 1 (Table 3.8-1).

Alternative 5C would reduce the impact of NPT fishing on specific areas of habitat in the GOA, as well as over large areas of the AI. It would also eliminate use of all bottom contact fishing in six specific known coral garden areas in the AI. Current distribution of fishing effort does not extend to the edge of the EEZ. As a result, fishing impacts on EFH would actually be minimized over 7,157 km^2 of GOA shelf and slope edge habitat (2.6 percent of the current 279,874 km^2 of habitat). In the AI, Alternative 5C would reduce the impact of NPT fishing over 66,713 km^2 of AI habitat, or 61.6 percent of the current fishable area of 108,243 km^2 in the AI. Additionally, Alternative 5C would reduce the impact of all commercial bottom contact fishing gear over 380 km^2 in the AI, or 0.35 percent of current fishable area. Overall, Alternative 5C would affect 74,250 km^2, or 19.1 percent of the combined fishable area of 388,117 km^2 in the GOA and AI. See EIS sections 2.3.3 and 4.3 for details on fishing impact minimization measures and the environmental consequences of Alternative 5C.

C.3.8.1.2 Use and Productivity Benefits

Alternative 5C is designed to reduce the effects on EFH of NPT fishing in the GOA and AI. These fishing impact reductions would extend beyond measures currently in place or planned as part of other fishery management actions. Current scientific knowledge does not permit either a quantitative or qualitative assessment of the use benefits that would be derived from minimizing the effects of fishing on EFH. However, the assumption implicit in the amendment to the Magnuson-Stevens Act requirement to minimize effects of fishing on EFH is that doing so would result in the sustained or enhanced production from FMP species and contribute to a healthy ecosystem (Table 3.7-2). As such, Alternative 5C would contribute additional measures that would further reduce the impacts of fishing on EFH.

C.3.8.2 Costs Associated with Alternative 5C

C.3.8.2.1 Industry Revenue at Risk

Alternative 5C, had it been in place for the 2001 fishing year, would have placed \$2.39 million of gross revenue at risk (excluding revenue at risk from AI coral gardens) in NPT fisheries in the GOA and AI, or 1.3 percent of the status quo total revenue of \$180.41 million from groundfish in Alaska (Table 3.8-1).

The ten designated areas where NPT gear would be prohibited, described under Alternative 5C, in the GOA are discreet and widely spaced along the outer shelf and slope edge. Substantial NPT fishing areas remain within the entire GOA, adjacent to the ten designated areas, where the revenue at risk might be mitigated by a redeployment of fishing effort. However, had Alternative 5C been in effect in 2001, it would have placed 9.1 percent of the status quo revenue at risk in the WG, 4.6 percent of the status quo revenue at risk in the EG, and 2.7 percent of the status quo revenue at risk in the WG. Overall, Alternative 5C would have placed \$1.17 million of revenue at risk, or 4.2 percent of the total status quo revenue of \$27.69 million in NPT groundfish fisheries in 2001.

Under Alternative 5C, most, if not all, of the revenue at risk in the GOA might be recovered by redeployment of fishing effort to adjacent areas, or by switching to PTR gear by most of the fleet components involved in the fishery. The smaller catcher-vessel fleet targeting slope rockfish almost exclusively uses NPT gear and has neither sufficient horsepower to fish PTR, nor the revenue from participation in this fishery to warrant the investment necessary to utilize PTR gear. The larger catcher vessels (vessels that also target pollock) and the catcher-processors either already have PTR gear available or have enough horsepower to convert to PTR to target slope rockfish. Under Alternative 5C, while the revenue at risk might be recovered by vessels fishing adjacent areas in the GOA or by switching to PTR gear within the protected areas, there could be a transfer of catch share, and, thus, a transfer of revenue in the fishery, from the smaller catcher-vessel fleet component to the larger catcher-vessel and catcher-processor fleet components. The magnitude of this transfer is impossible to estimate without specific knowledge of the effort redeployment fishing strategies that would actually be followed by the different fleet components.

In the AI, Alternative 5C would prohibit the use of NPT gear for all species in designated areas within the EEZ. All bottom-contact gear would be prohibited in additional designated coral garden areas. Under Alternative 5C, the area within the EEZ closed to NPT would place $1.23 million of revenue at risk or 2.2 percent of the $55.81 million status quo revenue in both catcher-vessel and catcher-processor fleet components in the AI. It is likely, however, that most, if not all, of the revenue at risk could be mitigated by fishing in adjacent areas that would remain open to NPT fisheries.

Alternative 5C would further prohibit the use of all commercial bottom contact fishing gear is six coral garden areas in the AI. Bottom contact gear in use in these areas includes NPT, HAL, and POT. Impacted fisheries include NPT fisheries for groundfish, HAL fisheries for groundfish and halibut, and POT fisheries for king and Tanner crab. Given the relatively small, discreet areas encompassed by the designated AI coral gardens, it was difficult to obtain precise estimates of catch and revenue placed at risk by proposed restrictions in these areas. Had Alternative 5C been in place during 2001, groundfish revenue at risk from NPT and HAL fisheries in the coral garden areas would have been $234,575, or less than 0.5 percent of the status quo groundfish revenue in the AI. The IPHC estimated that, had Alternative 5C been in place from 1995 through 2002, a combined total of 1.1 to 1.15 million pounds of halibut catch could have been placed at risk, or approximately 4.4 percent of the total harvest in IPHC area 4B in the AI (Tom Kong, IPHC staff, personal communication, March, 10, 2005). Had Alternative 5C been in place from 1995 through 2003, restrictions on crab pot fisheries could have placed a combined total of 171,876 pounds of catch at risk, or 0.3 percent of the total harvest of 53.25 million pounds during this period. Ex-vessel revenue at risk in crab fisheries in the coral gardens would have totaled $313,000, or less than 0.1 percent of the status quo revenue of $121.9 million over the 9-year period. Catch and revenue placed at risk in the AI due to the prohibiting of bottom-contact gear in the six coral garden areas would likely have been mitigated by transferring fishing effort to adjacent areas open to bottom contact fishing.

C.3.8.2.2 Product Quality and Revenue Impacts

Revenue impacts from changes in product quality would be possible under Alternative 5C, particularly for the smaller catcher-vessel fleet component operating with NPT gear in the GOA. These vessels might have to expend additional fishing effort in their attempt to recover a portion of the revenue placed at risk, which could lengthen fishing trips and result in diminished product quality. Product quality might not be affected in the catcher-processor fleet component, since these vessels process the catch onboard the vessel. Product quality could be affected, however, if the average size or condition of the fish changes significantly.

C.3.8.2.3 Operating Cost Impacts

Operating cost impacts under Alternative 5C might be greater overall, as compared to the status quo, for both the GOA catcher-vessel and catcher-processor fleet components. CPUE of target species, such as slope rockfish caught with PTR gear and NPT gear at depths shallower than 200 m along the GOA slope edge could be lower than the CPUE of NPT gear in the depth range of 200 m and greater, which is where these species are normally fished. This would likely result in increased fishing effort and associated operational costs to make up the catch and revenue at risk.

Under Alternative 5C, larger catcher vessels and catcher-processors in the GOA would have the physical capability (although, perhaps, not the economic incentive) to take advantage of the option of changing to PTR gear and continuing to operate, targeting slope rockfish, in these areas closed to NPTs. However, the smaller catcher vessels, particularly those 18.3 m (60 feet) and smaller, do not have sufficient horsepower to switch to PTR fisheries, and the equipment costs would likely be prohibitive, given the annual revenue of these vessels. Had Alternative 5C been implemented in 2001, operational costs for the catcher-processor fleet component might have increased due to the redeployment of fishing effort made necessary to attempt to make up the 5.2 percent of the status quo revenue at risk for this fleet component. The requirement that all vessels using NPT gear have and use VMS would result in increased operational costs. Virtually all such vessels probably already have VMS. If this assumption is incorrect, and operators would have to acquire, install, and use VMS to comply with Amendment 5C rules, this could be a relatively significant burden, particularly for the small catch-vessel fleet. Likewise, NMFS' proposed requirement for 100 percent VMS coverage for vessels fishing all bottom-contact gear in the GOA would impose additional operational costs on the entire bottom-contact gear fleet.

In the AI, Alternative 5C would result in some increased operational costs for both the catcher-vessel and catcher-processor fleets. Alternative 5C would require any vessel using NPT gear to have a VMS system. Although, as noted above, all of the vessels fishing the area probably have such a system now, Alternative 5C may require additional VMS operation time (and associated expense) on these vessels beyond that required for SSL regulations. Alternative 5C also requires 100 percent observer coverage for vessels targeting groundfish, which would increase observer costs on the catcher vessels that are currently required to have only 30 percent observer coverage. Alternative 5C would result in a relatively complicated pattern of open and closed areas. This may require fishermen to alter their normal fishing behavior, possibly including exploration of new fishing grounds within the designed open NPT areas and increasing fishing effort to mitigate catch and revenue at risk. All of these fishing strategies would likely result in increased operational costs in the AI catcher vessel and catcher-processor NPT groundfish fleets (Table 3.8-1).

C.3.8.2.4 Safety Impact

Alternative 5C may not significantly affect the safety of any of the fleet components in the GOA, because fishing effort would likely be redeployed to immediately adjacent fishing areas (Table 3.8-1).

Alternative 5C could potentially affect the safety of the catcher-vessel and catcher-processor fleet components in the AI, because fishing effort could be redeployed to new fishing areas, possibly farther from the vessels' home ports.

C.3.8.2.5 Impacts on Related Fisheries

There would be some impact on related fisheries in the GOA from Alternative 5C, because NPT fishing effort displaced from the ten areas closed to NPT fishing would likely be redeployed into adjacent areas. Other fisheries occurring in these areas, including halibut longline, Pacific cod longline (when open), and other NPT fisheries such as shallow water flatfish could be adversely impacted by the redeployment of the NPT fishing effort (Table 3.8-1). These impacts may include crowding externalities, grounds preemption, and gear conflicts resulting in damage and loss of equipment and catch.

There may be impacts on related fisheries from Alternative 5C in the AI as vessels using NPT gear are displaced into adjacent areas where other gear groups such as HAL and POT vessels may be operating. The same adverse impacts cited above could be associated with AI effort redeployment, as well.

C.3.8.2.6 Costs to Consumers

There might be an increase in costs to consumers from Alternative 5C, because increases in operational costs for certain fleet components may be passed on to consumers from harvesters and processors (depending on market conditions such as availability of close substitutes in supply, demand elasticities, vertical integration, etc.). There might also be attributable welfare costs imposed on consumers from changes in availability and timing of supply, product mix, and/or product quality. Data upon which such impacts could be assessed are not presently available to the analysts.

C.3.8.2.7 Management and Enforcement Costs

Management and enforcement costs may increase under Alternative 5C, although it is not possible to estimate by what numerical amount. Additional on-water enforcement may be required to ensure compliance with the fishing impact minimization measures applied in the GOA and AI (Table 3.8-1). Section 3.1.2.7 contains some additional discussion of NMFS Enforcement and Coast Guard responses to resource demands connected with monitoring and enforcing provisions of Alternative 5C.

VMS equipment or 100 percent observer coverage might be needed on all vessels using NPT gear in the GOA and both VMS and 100 percent observer coverage would be required in the AI to ensure compliance with Alternative 5C. Additionally, NMFS has modified the Council's Alternative 5C requirements to extend VMS coverage to all commercial fishing vessels in the GOA using bottom contact fishing gear, to assure enforcement of HAPC requirements.

As discussed in the earlier section on vessel operating costs, most groundfish vessels fishing in the GOA and AI for pollock or Pacific cod are already equipped with VMS, due to SSL regulations. Under provisions of Alternative 5C, vessels without VMS systems operating in these areas would be required to install and operate the VMS equipment when using NPT gear in specified areas and at all times in all areas when participating in any other bottom contact fishery (as defined in regulation). For the GOA management area only, operation of VMS would also be required for commercial fishing vessels when carrying bottom-contact gear onboard when such fisheries are open. The number of additional vessels that would have to add VMS equipment under Alternative 5C is examined in detail in Section C.3.8.4, below. Alternative 5C fishing impact minimization measures are specific to gear (NPT) in the broader area of the AI and in the ten designated GOA areas and may require additional enforcement measures (boarding and inspection) beyond the typical time/area/fishery management measures currently employed. Fishing impact minimization measures specific to all bottom-contact gear in the HAPC in the GOA and in the six designated coral gardens in the AI may require additional management and enforcement measures beyond those currently in use.

C.3.8.3 Distributional Impacts

C.3.8.3.1 Gross Revenue at Risk Effects

C.3.8.3.1.1 Geographic Area Impacts

Alternative 5C, had it been the rule in 2001, would have imposed fishing impact minimization measures in the GOA and AI. Within the GOA, the largest amount of revenue at risk would have been in the WG, with $0.57 million at risk, or 9.1 percent of the $6.25 million 2001 status quo revenue (Table 3.8-2). The revenue at risk in the CG would have totaled $0.56 million, or 2.7 percent of the 2001 status quo revenue of $20.69 million. There would have been $30,000 of revenue at risk in the EG, or 4.6 percent of the $760,000 status quo revenue that year.

In the 2001 AI fisheries, under Alternative 5C, $1.23 million in revenue would have been placed at risk, or 2.2 percent of the $55.81 million of status quo revenue in the affected fisheries (excluding catch and revenue at risk from coral garden area restrictions).

C.3.8.3.1.2 Fishery Impacts

In the GOA, provisions of Alternative 5C affect a number of NPT fisheries, but primarily fisheries targeting rockfish and Pacific cod. The total revenue at risk in the NPT rockfish fishery under Alternative 5C would have equaled $520,000, or 5.5 percent of the status quo revenue of $9.36 million in 2001 (Table 3.8-2). The total revenue at risk in the GOA NPT Pacific cod fishery would have been $320,000, or 4.2 percent of the status quo revenue of $7.66 million.

In the AI, Alternative 5C would place revenue at risk in NPT fisheries for Atka mackerel, Pacific cod, and rockfish. The largest revenue at risk in the AI would be in the NPT Atka mackerel fishery, where, had Alternative 5C been in place in 2001, $620,000, or 1.5 percent of the status quo revenue of $41.01 million, would have been placed at risk (Table 3.8-2). Alternative 5C would have placed $350,000 of revenue at risk in the AI Pacific cod NPT fishery, or 3.6 percent of the status quo revenue of $9.61 million in 2001. Rockfish NPT revenue at risk would have totaled $260,000, or 5.1 percent of the $5.08 million in 2001, in the AI.

Under Alternative 5C, prohibition of bottom contact fishing gear in the six coral garden areas would have placed an additional $234,000 of revenue at risk in the groundfish NPT and HAL fisheries in 2001. Up to 4.4 percent of the AI IPHC area 4B halibut catch would have been placed at risk in the coral gardens. Approximately 0.3 percent of the catch and revenue in the crab fishery in the AI would have been placed at risk by Alternative 5C.

C.3.8.3.1.3 Fleet Component Impacts

In the GOA, had Alternative 5C prevailed in 2001, the catcher-processor fleet would have had the greatest amount of first wholesale revenue at risk, $800,000 million, or 5.2 percent of the $15.38 million status quo total revenue in the catcher-processor fleet. The catcher- vessel fleet would have had $370,000 of ex-vessel revenue at risk, or 3.0 percent of the total ex-vessel revenue of $12.31 million (Table 3.8-2). Under Alternative 5C, the catcher-vessel fleet would have had revenue at risk in the EG of $20,000, or 6.1 percent of status quo; in the CG, $50,000, or 0.5 percent of status quo; and in the WG, $300,000, or 13.4 percent of status quo revenue at risk The GOA catcher-processor fleet would have had revenue at risk mainly in the CG ($510,000, or 4.7 percent of status quo revenue at risk), but also in the WG ($270,000, or 6.7 percent of the $4 million status quo gross revenue) and the EG ($20,000, or 3.5 percent of the $450,000 status quo revenue). Ninety-eight vessels used NPT gear in federal waters of the GOA in 2003. Average gross revenues for these vessels from all federally and State of Alaska managed fisheries in Alaska were about $2.0 million. Fifty-eight of these were considered small entities under SBA criteria (they grossed less than $3.5 million from all federally and State managed sources, and they were not affiliated with an AFA inshore cooperative). These small entities had average gross revenues of $494,000 from all sources.

In the AI, the catcher-processor NPT fleet would have accounted for $1.2 million of first wholesale revenue at risk under Alternative 5C, and the catcher-vessel fleets would have had $30,000 of ex-vessel revenue at risk, or 2.2 percent of the total status quo revenue of $1.32 million. All of the AI NPT catcher-vessel fleet's revenue at risk is in the Pacific cod fishery, $30,000, or 2.3 percent of the $1.32 million status quo revenue. The AI catcher-processor fleet's revenue at risk is mainly in the Atka mackerel fishery, with $620,000 of first wholesale revenue at risk, or 1.5 percent of the $41.61 million status quo revenue, followed by the NPT fishery for Pacific cod, with $350,000, or 3.6 percent of the $9.61 million status quo revenue at risk, and the NPT fishery for rockfish, with $260,000 of revenue at risk, or 5.1 percent of the $5.08 million status quo revenue. Forty-six vessels used NPT gear in federal waters of the GOA in 2003. Average gross revenues for these vessels from all federally and State of Alaska managed fisheries in Alaska were about $3.6 million. Thirteen of these were considered small entities under SBA criteria (they grossed less than $3.5 million from all federally and state managed sources, and they were not affiliated with an AFA inshore cooperative). These small entities had average gross revenues of $626,000 from all sources.

The Alternative 5C prohibition on the use of bottom contact fishing gear in the six AI coral gardens would have placed an additional $234,000 of revenue in groundfish fisheries at risk, with $164,000 at risk in the catcher-processor fleet targeting Pacific cod and $70,000 of additional revenue of risk in the catcher-vessel fleet also targeting Pacific cod. The coral garden restrictions would have placed approximately 4.4 percent of the HAL halibut catch at risk and 0.3 percent of the crab pot fishery revenue at risk, both in the catcher-vessel fleets.

C.3.8.3.2 Impacts on Dependent Communities

C.3.8.3.2.1 Overview

Like Alternatives 5A and 5B, impacts to dependent communities may be significant at the community level, at least for a few communities (specifically King Cove and Sand Point), under Alternative 5C. Adverse impacts to individual operations might occur in other communities (especially Kodiak), but these impacts would probably not be significant at the community level due to the magnitude of the impacts relative to the overall operations of the affected fleet and processing entities (as well as the overall community fishing sectors).

Excluding AI coral garden area impacts, the only fisheries directly affected by Alternative 5C would be groundfish fisheries. Similar to Alternatives 4, 5A, and 5B (but unlike Alternatives 2 and 3), both groundfish and rockfish fisheries would be affected by this alternative. Like Alternatives 4, 5A, and 5B, this alternative would have impacts on GOA and AI fisheries, but unlike those alternatives it would not have impacts on EBS fisheries. Like Alternatives 2, 3, 4, 5A, and 5B, the only gear group directly affected for both catcher vessels and catcher-processors would be non-pelagic trawl (with the exception of the coral garden areas in the AI). It is assumed that the non-pelagic trawl fleet that would have been affected by this alternative would have comprised the same vessels that would have been affected under Alternative 5B. Using 2001 fleet data on the non-pelagic trawl fleet, and assuming this rule had been in effect, a total of 93 vessels (catcher vessels plus catcher-processors) would be affected by this alternative: 28 in Alaska, 12 from Oregon, 47 from Washington, and 6 from other states. Washington and Oregon communities, though significantly engaged in the fishery, are not considered dependent communities, based on the overall economic structure of those communities and the relatively small role the Alaska groundfish fishery plays in the local economy. Using 2001 processor data, 19 shoreside processors in Alaska could potentially have been affected by this alternative. When coral garden area impacts are included, this alternative could potentially have affected an additional 33 vessels that utilized longline gear (but these impacts would likely have been negligible, as discussed below), and between five and ten primarily Seattle-based crab vessels that utilized pot gear.

C.3.8.3.2.2 Catcher Vessels

Based on 2001 data, ownership by Alaska residents of catcher vessels harvesting relevant groundfish species with at-risk revenue under Alternative 5C, is concentrated in the AEB with 19 vessels (King Cove has 8 and Sand Point 11) and Kodiak with 7 vessels. All but two of the AEB vessels are classified as small vessels (i.e., less than 60' LOA), while none of the Kodiak vessels would have been so classified. Anchorage and Girdwood account for the remaining two Alaska-owned vessels; one of these is a small vessel, and one is a large vessel. Ownership in the Pacific Northwest accounts for 44 vessels with at-risk revenues under this alternative (32 from Washington, all but 2 of them large vessels, and 12 vessels, all large, from Oregon). Four vessels (three large and one small) are reported to have been owned by residents of other states.

Catcher vessel-associated community impacts in the GOA, under Alternative 5C, would be similar to those reported under Alternative 5A and 5B. As noted under those alternatives, significant impacts associated with local catcher fleets could accrue to the communities of King Cove and Sand Point. The largest difference in revenue at risk between Alternative 5C and Alternatives 5A and 5B in the GOA is in the rockfish fishery. Under Alternative 5C, only about $20,000 in rockfish revenue (or about 1.0 percent of the total status quo value of $2.33 million) is at risk, while under Alternatives 5A and 5B about $440,000 rockfish in revenue is at risk (18.8 percent of the status quo value). Among Alaskan vessels, the differences in the rockfish revenues at risk would accrue primarily to the Kodiak fleet. Alternative 5C also has about $60,000 less Pacific cod revenue at risk than would be the case under Alternatives 5A and 5B, but this difference represents only about 0.7 percent of the total status quo GOA Pacific cod revenues of the relevant vessels. No other fishery has a greater than $10,000 revenue at risk difference between Alternative 5C and Alternatives 5A and 5B, except the pollock fishery (where there is about $70,000 less GOA pollock revenue at risk under Alternative 5C than under Alternatives 5A and 5B). These differences are not expected to result in different patterns of GOA community level impacts between Alternatives 5A, 5B, and 5C. Similar to Alternatives 5A and 5B, no significant community impacts associated with EBS fisheries are anticipated under Alternative 5C.

For catcher vessels operating in the AI outside of the coral garden areas, the only affected fishery would be Pacific cod. Exclusive of the coral gardens areas, the revenue at risk under this alternative ($30,000) is 2.3 percent of the status quo total ($1.32 million) for affected vessels for the area. Revenue at risk figures given for catcher vessels represent ex-vessel gross receipts, which would tend to understate the cumulative potential loss to associated communities that derive benefits from both harvesting and processing activities, if examined separately. Values for first wholesale revenues at risk by shoreside processors from landings of catcher vessels are referenced in the discussion of shoreside processor locations provided below. Based on known characteristics of the different fleet segments, the ownership of these vessels with at-risk AI revenues would primarily be concentrated in Pacific Northwest communities, and any impacts seen in Alaska would be concentrated in Kodiak. Excluding coral garden related impacts, no significant community level impacts associated with this catcher fleet are anticipated, due to the modest amount of revenue at risk and the relative size and diversity of the economies of these communities (although some vessels would likely experience increased costs and/or decreased harvests).

The prohibition to bottom contact fishing in the six coral garden areas in the AI would impose additional revenue at risk impacts on the non-pelagic trawl catcher vessel fleet of approximately $70,000, mainly in the Pacific cod target fishery. This would bring the combined total revenue at risk (from inside and outside the coral gardens areas) to this fleet to approximately $100,000, or about 7.5 percent of the total status quo AI Pacific cod revenue for this fleet. Based on fleet characteristics, these impacts would likely be concentrated in Pacific Northwest communities, with impacts associated with Alaska owned catcher vessels likely concentrated in Kodiak. Given the relatively modest amount of revenue at risk when spread over the entire fleet, community level impacts are unlikely, but adverse impacts to individual operations are possible. Coral garden impacts on the sablefish fleet would be negligible, estimated at less than $1,000. Coral garden area restrictions on longline gear targeting halibut could effect at least 33 of the 156 vessel catcher vessel fleet, and place up to 4.4 percent of the annual catch from IPHC area 4B at risk (pers. comm., Tom Kong, IPHC staff, March, 10, 2005) based on area percentage factors. But current industry practices would suggest that actual impacts would be much lower, given that coral garden areas (and other areas of similar bottom relief) are routinely avoided due to problems caused by the inability to efficiently retrieve gear. Coral garden impacts in the AI on crab catcher vessels utilizing pot gear and targeting king and Tanner crab would likely affect 5 to 10 of 17 vessels in the fleet and place approximately 0.3 percent of the catch and revenue of the crab fishery in AI at risk. The relevant crab vessels are primarily Seattle-based and no community level impacts would be anticipated, given the small amount of revenue at risk, although it is possible that a very few individual vessels could experience adverse impacts.

C.3.8.3.2.3 Catcher-Processors

Based on 2001 data, Alaska ownership of catcher-processors with revenue at risk is exclusive to Kodiak (three vessels). Ownership in the Pacific Northwest is exclusive to Washington (15 vessels). Because of the small number of entities, information on harvest value cannot be disclosed for Alaska catcher-processors at risk under this alternative.

For catcher-processors, impacts under Alternative 5C would be the same for the GOA as seen under Alternatives 5A and 5B, with the exception of the rockfish fishery. Under Alternatives 5A and 5B, about $2.38 million in GOA rockfish revenue is at risk (about 33.8 percent of the status quo value), but under Alternative 5C the rockfish revenue at risk figure drops to $50,000 (or about 7.0 percent of the status quo value). Catcher-processors would not experience any EBS fishery related impacts under Alternative 5C.

For the AI, catcher-processors affected by the Alternative 5C non-pelagic trawl closure outside of the coral garden areas could experience revenue at risk of $1.20 million, or approximately 2.2 percent of the $54.49 million status quo revenue. Catcher-processors would experience revenue at risk associated with a number of different groundfish species. While some of these species account for a relatively high percentage of revenue at risk, the overall value at risk is comparatively small. Only three targeted species are associated with revenue greater than $10,000 at risk. These are Atka mackerel ($620,000 at risk, which is 1.5 percent of status quo value), Pacific cod ($320,000, 3.9 percent of status quo value), and rockfish ($260,000, 5.1 percent of status quo value). The catcher-processors harvesting and processing these species are primarily head and gut vessels.

The coral garden closures to bottom-contact gear in the AI could place an additional $164,000 of Pacific cod revenue at risk in the catcher-processor fleet. This would bring the total AI catcher-processor revenue at risk to $484,000 (or about 5.8 percent of the 8.29 million status quo value) under Alternative 5C.

Due to confidentiality restrictions, based on a small number of participating entities, value information for Alaska-based catcher-processors with revenue at risk cannot be disclosed for this alternative. Impacts experienced in Alaska would, however, be concentrated in Kodiak. Given the small number of entities involved, and the relative size of the local fishery-based economy, it is assumed that community level impacts associated with catcher-processors would not be significant, although some individual entities may have experienced adverse impacts due to increased costs and/or decreased harvests. While individual Washington-owned entities may experience adverse impacts under Alternative 5C, it is assumed that community level impacts would not be significant under this alternative due to the relatively modest percentages of revenues at risk, compared to the status quo, as well as to the scale of the local economy in those communities.

C.3.8.3.2.4 Shoreside Processors

Following the pattern seen under Alternative 5B, shoreside processors involved in the at-risk harvest (using 2001 data) under Alternative 5C are concentrated in Kodiak (with nine entities). Akutan had two entities, and a number of other communities each had a single processor that processed at least some groundfish from vessels with at- risk revenues under this alternative (King Cove, Sand Point, Unalaska/Dutch Harbor, Ketchikan, Moser Bay [Kodiak Island Borough], Chignik, Sitka, and Cordova).

Under the non-pelagic trawl closure for Alternative 5C, impacts to shoreside processors would be similar to those seen under Alternative 5B. Under Alternative 5B (Option 1), the total first wholesale value at risk for catch delivered inshore for processing represents approximately 8 percent of the total status quo value (about $3.28 million out of $42.45 million) of the relevant fisheries of the GOA area, about 24 percent of the AI status quo value (about $726,000 out of $3.08 million), well below 1 percent for the EBS area, and about 7 percent for all areas combined (about $4.01 million out of $58.84 million), but no breakdown by port of landing is available. Under Alternative 5C, EBS impacts would be eliminated, GOA impacts would be reduced by about 58.9 percent, and AI impacts would be reduced by about 90.3 percent, assuming that processing first wholesale value at risk would proportionally follow catcher vessel revenue at risk decreases between Alternative 5B and 5C. Caution must be exercised in the interpretation of these wholesale value data as (1) they are not additive with ex-vessel values presented above, and (2) they cannot be used as a proxy for potential levels of impacts to specific communities without considering the basic caveats laid out in the introductory paragraphs of Section C.3.3.3.2.4 of the Alternative 2 discussion. Similar to Alternative 5B, processor-associated impacts to dependent communities may be significant in some of the smaller communities in the WG area (for the reasons discussed under Alternative 5A), but data that would be needed to quantify these impacts are confidential. Based on 2001 processor location data, it is assumed that most of the AI Pacific cod catch at risk under this alternative would be processed in Unalaska/Dutch Harbor. In terms of the scale of potential impacts, the $310,000 at risk under Alternative 5B (using 2001 data) is equivalent to 2 percent of the total Pacific cod value ($15 million) processed in the community in 2000, or about 0.2 percent of the total value ($144 million) for all species processed in the community in 2000, the most recent year for which complete community level data are available. Under Alternative 5C, it is assumed that these impacts would be much smaller, given that the AI catcher vessel revenue at risk under Alternative 5C is less than 10 percent of that seen under Alternative 5B. Given that at least some of this catch would likely be made up by redeployment of catcher vessel effort in other areas, along with the low overall proportion of the at-risk totals compared to overall local processing, no significant community impacts associated with processing are likely for Unalaska/Dutch Harbor, although some individual entities may experience a loss of processing volume and/or revenues. No significant community level impacts are anticipated for any other dependent communities.

Shoreside processing related community impacts associated with the coral garden areas in the AI are likely to have been negligible given (1) the small amount of Pacific cod ex-vessel revenue at risk (approximately $70,000), (2) the negligible sablefish revenue at risk, (3) the assumption that halibut revenue at risk would be easily recovered by fishermen, and (4) the less than 1 percent total catch at risk among the crab catcher vessel fleet. No delivery information is readily available for the specific vessels with revenue at risk, but it is assumed that a large proportion of their catch would have been processed at

Unalaska/Dutch Harbor. No community level impacts would have been expected to result from Alternative 5C related impacts, given the relatively modest amount of revenue at risk and the size of the processing sector in that community.

C.3.8.3.2.5 Multi-Sector Impacts

Multiple sector impacts may be significant at the community level under Alternative 5C, similar to Alternative 5B, Option 1. Among Alaska communities, Kodiak, King Cove, and Sand Point participate in more that one sector with at-risk revenues. Kodiak is home to seven locally owned catcher vessels, three locally owned catcher- processors, and nine locally operating shoreside processing entities with at least some revenue at risk. Neither King Cove nor Sand Point is home to locally owned catcher-processors, but both have multiple locally owned catcher vessels (8 and 11 vessels, respectively) and have at least one dominant local processor with at least some revenue at risk under this alternative. Alaska fleet related community impacts would be similar to those seen under Alternative 5B, with revenue at risk for King Cove and Sand Point catcher vessels comprising a higher percentage of total overall ex-vessel revenues than is the case in Kodiak. These vessels represent a much larger proportion of the total community fleet in King Cove and Sand Point than do the affected vessels in Kodiak. Given the smaller vessels in King Cove and Sand Point (with less flexibility of response), the higher proportion of revenue at risk, the higher proportion of the fleet with revenue at risk, and the known challenges that these fleets (and communities) are facing with other fisheries, the WG communities of King Cove and Sand Point may experience social impacts from this alternative that would be significant at the community level. Other Aleutians East Borough communities that derive benefits from revenues generated through borough raw fish taxes on landings in King Cove and Sand Point may have experienced impacts. These impacts to other borough communities would, however, probably not have been significant as the overall quota would have been unchanged, and no changes would have been expected in landing patterns at the regional level. Individual Kodiak entities may experience adverse impacts under this alternative, but impacts at the community level are considered unlikely to rise to the level of significance given the small proportion of revenue at risk for the affected catcher vessels, the low volumes at risk, and the assumption that overall delivery patterns are unlikely to change for Kodiak based shoreside processors under this alternative. Kodiak may experience additional catcher-processor related impacts, but the information that would permit such an analysis is confidential. Some additional Alaska resident crew positions on vessels owned elsewhere but that spend at least part of the year in Alaska ports may have some compensation placed at risk under this alternative. Transient vessels owned outside of Alaska typically also make expenditures in ports of landing, which, in this case, would be concentrated in Kodiak. Given the assumption that overall delivery patterns for the community are unlikely to change, however, any vessel expenditure associated impacts are likely to be minor.

The potential for cumulative impacts is less straightforward. Even if the potential for social impacts under Alternative 5C would not be significant in isolation, this alternative would have the potential, nonetheless, to impose adverse cumulative impacts when evaluated in the context of other factors that are currently affecting North Pacific and EBS fisheries and fishing communities. Cumulative effects could include interactions with the social impacts of, among others, the near-shore closures put in place in 2001 to protect Steller sea lions, rationalization of the BSAI crab and proposed rationalization of GOA groundfish fisheries, and the severe decline in salmon prices. These effects would likely be concentrated in communities with (relatively) significant dependence on small boat fleets and communities that depend on both salmon harvesting and one or more of the fisheries that would be affected by Alternative 5C.

C.3.8.4 NOAA Fisheries VMS Requirement Proposal

C.3.8.4.1 Purpose and Need

In February 2005, the North Pacific Fishery Management Council (Council) adopted measures to protect EFH and HAPC in the AI and GOA, pursuant to the requirements of the Magnuson-Stevens Act. These measures close areas of the ocean to exploitation by different classes of fishing operations. These closure areas are often complex, and located in remote areas that are difficult to observe. There are large numbers of vessels active in Alaska fisheries. These factors complicate enforcement of the closures and can seriously reduce the value of the protection measures.

VMS units integrate global positioning system (GPS) and communications electronics in a single, tamper-resistant package. The units can be set to transmit a vessel's location periodically and automatically to an overhead satellite. The units have provided a cost-effective deterrent to closed area violations in the program of Steller sea lion protection measures, adopted in 2001. Alternative 5C would extend requirements for VMS units to new classes of vessels in order to enforce the proposed EFH and HAPC regulations.

C.3.8.4.2 Description of the Alternatives Under Consideration

GOA

Alternative 1 - No Action (status quo): Vessels operating in any reporting area off Alaska, while any fishery requiring VMS for which the vessel has a species and gear endorsement on its Federal Fisheries Permit (FFP) under 679.4(b)(5)(vi) is open, are required to operate a VMS unit. The FFP under 679.4(b)(5)(vi) refers to the existing Steller sea lion (SSL) coverage for Pacific cod, Atka mackerel, and pollock.

Alternative 2 - (preferred alternative embodied in the proposed regulation): Vessels with FFPs or Federal Crab Vessel Permits (FCVPs) would be required to operate a VMS unit while operating with bottom-contact gear (bottom trawl, dredge, pot, HAL, dinglebar) onboard in the GOA management area. This requirement would extend to the vessel's operations within State of Alaska waters.

- Option 1: Exclude vessels less than or equal to 32 feet LOA from the requirement.
- Option 2: Exclude vessels less than or equal to 30 feet LOA from the requirement.
- Option 3: Exclude vessels less than or equal to 25 feet LOA from the requirement.
- Option 4: Exclude vessels with only dinglebar gear onboard from the requirement.
- Option 5: Exclude vessels with only dredge gear onboard from the requirement.

AI

Alternative 1 - No action (status quo): Vessels operating in any reporting area off Alaska, while any fishery requiring VMS for which the vessel has a species and gear endorsement on its FFP under 679.4(b)(5)(vi) is open, are required to operate a VMS unit. The FFP under 679.4(b)(5)(vi) refers to the existing SSL coverage for Pacific cod, Atka mackerel, and pollock.

Alternative 2 - (Preferred alternative embodied in the proposed regulation): Vessels with FFPs or FCVPs are required to operate a VMS unit while operating in the Aleutian Islands management area. This requirement would extend to the vessel's operations within State of Alaska waters.

- Option 1: Exclude vessels less than or equal to 32 feet LOA from the requirement.

C.3.8.4.3 Background Information

C.3.8.4.3.1 Characteristics of VMS

VMS units are integrated GPS and communications units coupled with an antenna or antennas on top of the vessel. Newer VMS units are typically about the size of a car radio. Units have VHS and GPS antennas (or a combined antenna).

C.3.8.4.3.2 Purchase, Installation, and Operating Costs

The VMS units originally approved for use to help enforce the Steller sea lion protection measures are no longer approved for new adopters. Current users may continue to use these units at a transmission cost of $5 per day. If they replace them, however, they must use other NMFS Enforcement certified units. Approved vendors offer different packages. One firm offers units ranging from $1,550 to $2,500 in list price (plus freight), with transmission costs priced from $2.40 to $3.36 per day.[8]

Another offers a unit for about $1,200, with a $150 activation fee, with various transmission packages ranging in cost from about $20 to $74 per calendar month, for different levels of transmission activity. Additional costs are incurred if the monthly transmission level is exceeded. The highest overage rate for these packages is $2 per thousand characters, which would cover just over one day of transmissions made every half hour. The costliest monthly package covers half-hour transmissions for every day in the calendar month.[9] This firm also offers dry dock fees of $5 per month to cover months during which the vessel is not expected to transmit (this would allow the firm to avoid paying a new activation fee if it stopped transmitting for a long period). The vendor of this model requires the first 6 months of monthly fees in advance from operations that choose not to pay by credit card, in order to reduce billing expenses (Chris Irwin, personal communication, Director of Sales, Skymate Inc.; South Central Radar & Communication staff and Radar Alaska, personal communication).

Users may install their own units, but installation services are also available. Vendors contacted indicated that 1 to 2 hours of installation time are typical and stated that they charged approximately $90 per hour for the service (South Central Radar & Communications staff and Radar Alaska, personal communication). Installation time can take longer. The Paperwork Reduction Act (PRA) analysis for the use of VMS under the new crab rationalization plan estimates installation time to be less than 2 hours, but notes that times up to 6 hours are possible in a worst case scenario. The analysis suggests this could be the case where a 12-volt DC hookup is not convenient to a location where the VMS unit can be installed (NMFS 2005). Vendor and NMFS Enforcement informants suggested that operating problems were more common in user installations than in vendor installations. Placement of antennas with newer VMS units has caused problems (Guy Holt, NOAA, Office of Law Enforcement, personal communications; South Central Radar & Communications staff and Radar Alaska, personal communication).

Upon completion of purchase and installation of the VMS units, and before participation in a fishery that requires VMS, the participant must fax a VMS check-in report. The information on this report will enable NMFS to verify that the VMS system is functioning and that VMS data are being received. The PRA analysis estimates that this would take the vessel operator about 15 minutes (NMFS 2005).

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[8] Accessed at http://www.nmfs.noaa.gov/ole/ak_vmsfaq_thrane.html, on March 30, 2005.
[9] Accessed at http://skymate.com/products/skymateVMS.asp, on March 30, 2005.

It is inevitable that a certain number of VMS units will break down during the course of fishing each year. Future breakdown rates and associated costs are unknown. NMFS Enforcement experience with the units installed under the Steller sea lion protection program suggests a breakdown rate of about 3 percent per year for those units (Guy Holt, NOAA, Office of Law Enforcement, personal communication). While the units would be under warranty at first, parts and labor for repairs would still be an expense in a cost-benefit accounting sense. Operations also face the possibility of lost fishing time. The potential interruptions in fishing activity may be the more expensive concern. While NMFS Enforcement handles breakdowns on a case-by-case basis, making generalizations problematic, it does not normally require a vessel to interrupt a fishing trip and return to port when a breakdown is identified. A vessel with a bad VMS unit will have to get it repaired before it begins a new trip.

Breakdown rates may be higher for smaller vessels than for larger ones. Smaller vessels may have fewer enclosed and moisture free areas, and VMS units may be exposed to severe operating conditions, with resulting higher breakdown rates. In one instance, a small vessel operator had to create a box linked to a vessel heater system for the unit to protect the unit. Since antennas are used to transmit, they require a power source, and this is also reported to be a source of problems. Replacement antennas cost about $100. Information on differential breakdown rates for large and small vessels is anecdotal; statistical information is unavailable (Jeff June, Natural Resources Consultants, Inc., personal communication). To the extent that the 3 percent rate quoted above applies to vessels using VMS in connection with Steller sea lion protection measures, it may be applicable to larger than average vessels and thus be a low breakdown rate to apply to the average vessel covered by this measure.

C.3.8.4.3.3 Sources of Pre-existing VMS Coverage

Various existing or contemplated federal fisheries management programs in Alaska require, or create incentives for, the acquisition of VMS units. To the extent that vessel operators have acquired or would acquire VMS units under these programs, the costs of acquisition, of at least some transmissions, would not be attributable to the EFH and HAPC VMS program analyzed here. If so, an estimate of the cost of the transmissions required by the EFH and HAPC protection measures would have to take these into account to avoid potential double counting.

On January 8, 2002, NMFS issued an emergency interim rule (67 FR 956) to implement Steller sea lion protection measures. Section 679.7(a)(18) requires all vessels using pot, hook-and-line, or trawl gear that are permitted to directly fish for Pacific cod, Atka mackerel, or pollock to have an operable VMS.

> "…it is unlawful for any person to do any of the following:
>
> …operate a vessel in any federal reporting area when a vessel is authorized under §679.4(b)(5)(vi) to participate in the Atka mackerel, Pacific cod or pollock directed fisheries and the vessel's authorized species and gear type is open to directed fishing, unless the vessel carries an operable NMFS-approved Vessel Monitoring System (VMS) and complies with the requirements in §679.28(f)." (§679.7)

Section 679.28(f) describes the requirements that would have to be met by a vessel owner operating a VMS unit. These requirements are necessary to monitor fishing restrictions in Steller sea lion protection and forage areas. VMS must be operated on all vessels permitted for directed fisheries for pollock, Pacific cod, and Atka mackerel during those times when these fisheries are open, regardless of the target species being fished. The only exemption is for vessels using jig gear.

Approximately 168 of the vessels fishing in the AI in 2003, and 928 of those fishing in the GOA, would have been subject to the VMS measures under EFH HAPC protection measures. Of these, an estimated 96 in the AI and 293 in the GOA would have had to carry VMS units that year, under the Steller sea lion protection measures (see Sections 1.8 and 1.9 of this appendix).

A new program for rationalization of the crab fisheries in the BSAI became effective on April 1, 2005. This program reallocates crab resources among harvesters, processors, and coastal communities. Vessels will have to have VMS equipment transmitting under the following conditions: (a) the vessel is operating in any reporting area off Alaska; (b) the vessel has crab pots, crab pot hauling equipment, or a crab pot launcher onboard; and (c) the vessel has or is required to have an FCVP for that crab fishing year. An estimated 200 operations would have to use VMS equipment under this new program (NMFS 2005).

Current regulations may encourage vessels fishing for halibut in the AI to carry VMS units. Similar regulations under consideration in the sablefish fishery may also encourage vessels fishing for sablefish in the AI to carry them. These regulations do not impose requirements to carry the units, but they create incentives to do so by excusing vessels with them from an IPHC vessel clearance regulation requirement. Vessel clearances have been required by the IPHC since the 1960s to discourage illegal fishing and false reporting of catch harvested in the IPHC area. Because of the great distances involved in the BS and AI fishing areas, reduced levels of enforcement presence, and marginal weather, IPHC vessel clearances continue to be very important compliance tools to discourage illegal fishing and promote accurate catch reporting. The operator of any vessel that fishes for halibut in Areas 4A, 4B, 4C, or 4D must obtain an IPHC vessel clearance before fishing in any of these areas and before landing any halibut caught in any of these areas, unless specifically exempted by regulation. There are several exemptions, but the one to be discussed here is the "VMS Exemption," which is administered by NMFS Enforcement.

Any vessel that carries a transmitting VMS transmitter while fishing for halibut in Areas 4A, 4B, 4C, or 4D, and until all halibut caught in any of these areas is landed, is exempt from the IPHC Area 4 vessel clearance requirements, provided that the vessel operator properly registers the VMS transmitter with NMFS Enforcement.

In December 2003, the Council adopted a proposal to require vessels intending to fish sablefish in the AI to obtain clearance from a local port, or to carry a VMS unit. Because of killer whale depredation, higher operating costs, and relatively low catch rates, sablefish fishing in the AI is less profitable than fishing elsewhere. The Council's action was in response to concerns that holders of sablefish individual fishing quotas (IFQs) for the AI might fish their quota elsewhere, and claim it was caught in the AI. The clearance requirement (which allowed fishermen to substitute VMS for the clearance) was adopted to make it possible to verify that fishing activity claimed in the AI actually took place there (Council 2004).

The regulatory amendment to carry this out is under review in the NMFS AKR (as of March 2005). If this regulatory amendment had been effective in 2003, some vessels that did not carry VMS might have voluntarily done so. The Secretary has not yet adopted this regulatory amendment.

C.3.8.4.3.4 Scallop Dredge in the GOA

In 2003, four vessels used dredge gear to fish for scallops in the GOA. It is likely there are even fewer now, given co-op arrangements. These vessels had average gross revenues of about $810,000 from all sources; average gross revenues from scallops were about $617,000. Two of the vessels used other bottom-contact gears in the GOA that would have required them to have VMS under the rule. One of the vessels had VMS; three did not. There may be little potential overlap between scallop fishing areas and protected EFH and HAPC habitats (Gregg Rosenkranz, Alaska Department of Fish and Game, personal communication).

C.3.8.4.3.5 Dinglebar Gear in the GOA

The dinglebar fishery for ling cod is managed by the State of Alaska, although it occurs in federal waters. Fishermen fishing dinglebar gear for ling cod may be able to circumvent the VMS requirement while they are fishing by surrendering their FFPs. Because these vessels could easily avoid the VMS requirement, it may be appropriate to consider exempting this class of bottom-contact gear from this requirement to reduce the burden on small entities.

C.3.8.4.4 Methodology

State of Alaska fish ticket and Federal Catch Accounting System and CDQ data were used to create observations for all vessels using bottom-contact gear in federally managed fisheries in the GOA in 2003 and for all vessels operating in federally managed fisheries in the AI in 2003. Bottom contact gear was defined to include bottom trawls (non-pelagic trawls), hook-and-line gear, pot gear, dredges, and dinglebar gear. Data for 2003 were used for this analysis, because that is the most recent year for which comprehensive gross revenue information on fishing operations was available.

Under the most comprehensive versions of the proposed rules, all vessels operating in the AI and carrying an FFP or FCVP and all vessels operating with bottom-contact gear on board and named on a FFP or FCVP in the GOA must have and operate an approved VMS at all times. This requirement would also extend to such a vessel operating in state waters. If a fishing vessel had an FFP or FCVP and was carrying bottom-contact gear such as crab pots within southeast Alaska, this vessel would have to have and operate an approved VMS at all times.

In this analysis, the vessels assumed to be subject to the requirement to carry VMS were approximated by those vessels that operated in federal waters of the AI, or those vessels that used bottom-contact gear at any time in federal waters in the GOA, during 2003. This identification assumes that vessels operating only in state waters in 2003 would have been unlikely to have carried an FFP or FCVP. Some vessels with an FFP or FCVP may, in actuality, have operated only in state waters of the AI or the GOA in 2003. To the extent that this occurred, this analysis undercounts the vessels that would have been subject to the VMS requirement. A vessel that expected to operate only in state waters would, however, be able to do so without VMS under this program if it surrendered any FFP or FCVP.

Separate data sets were created for vessels fishing in the AI and in the GOA. Each data set contained one record for each vessel that met the conditions for that area. Each record contained information on gross revenues earned by the vessel in all of the federally and State of Alaska managed fisheries in which it operated in 2003. For example, if a vessel had fished with pot gear in federal waters in the GOA, it would appear in the data set. All of its revenues from fishing in the GOA with the pot gear would be included. If the vessel was also used to fish with pot gear in the BS, those revenues would be included. If the vessel was also used to salmon troll on the inside waters of southeast Alaska, those revenues would also have been included.

A small entity flag was created, based on Small Business Administration (SBA) criteria. Large entities were identified as those vessels with over $3.5 million in gross revenues from all sources and/or that participated in an AFA inshore catcher vessel cooperative. All other vessels were considered small entities.

Many of the vessels that would be subject to a VMS requirement under the proposed rule would already carry a VMS as a result of requirements used to help enforce Steller sea lion protection measures. These vessels were identified using a flag variable for the presence of a VMS unit in 2003, as obtained from NMFS Enforcement records. The number of vessels that would have to acquire VMS under the alternatives was estimated by identifying the 2003 vessel records with VMS flags indicating that the vessel had not had VMS that year. Year 2003 VMS data were used to create VMS flags that were consistent with the gross revenue and activity information contained on the vessel records. The VMS requirements for the Steller sea lion protection measures were fully implemented for 2003.

The cost of adding a VMS unit was estimated as $1,550 for these vessels. This is the cost of one of the packages certified for use in the Alaska Region by NMFS Enforcement. This includes purchase and freight costs estimated at $1,200, installation by a vendor, estimated at $200, and an activation fee of $150.

A variable on the number of calendar months in 2003 in which fishing activity covered by the regulation took place was also added to the data set. Fishing activity was considered covered by the regulation if it consisted of using any gear in the AI, or bottom-contact gear in the GOA. Months were credited with fishing activity if fish tickets were created during the month, or if weekly production reports (WPRs) were filed for weeks during the month. The "months" variable included months in which landings were reported from federal or State of Alaska waters. For example, if a vessel that fished 2 months in only federal waters, 1 month in both federal and state waters, and 2 months in only state waters, the months variable would take a value of five. If a vessel was already required to carry a VMS to comply with Steller sea lion protection measures for example, a deduction was made in estimated usage attributable to the EFH and HAPC VMS action calendar months variable, for months during which that vessel was fishing for pollock, Pacific cod, and Atka mackerel with any gear in the AI or with bottom-contact gear in the GOA. Vessels fishing for these species would have been required to carry VMS equipment and to operate it while fishing for these species. These months would not have generated costs under the new EFH and HAPC VMS requirements.

Monthly transmission costs were estimated separately for vessels that are currently required to use VMS because of SSL regulations and for operations that will have to acquire VMS to comply with the EFH and HAPC requirements. Most vessels that currently have VMS are using a service plan under which they are billed $5 per day for the required transmissions. The annual transmission costs for these vessels were estimated as $155 per calendar month of transmissions (this assumes that transmissions occurred each day of a 31-day month). These vessels will not be allowed to replace these units with the same model, because this model is not certified by NMFS Enforcement for new use. As these units wear out, they must be replaced with NMFS Enforcement certified units.

Vessels that will have to acquire VMS were assumed to purchase a VMS coverage package costing $74 per month for each month of fishing activity and were assumed to pay a dry-dock fee of $5 per month for the remaining months. The dry-dock fee provides for months without transmissions and allows the fishermen to avoid paying a new activation fee of $150 upon returning to active operation.

VMS units may require repair during a year. This cost element only applies to new installations required by this regulation. As noted above, NMFS Enforcement experience with existing VMS breakdown rates suggests a breakdown rate of 3 percent. Also, as noted, anecdotal evidence suggests that rates for smaller vessels may be higher. This cost category applies to vessels that must acquire VMS as a result of this regulation. Breakdown rates for vessels over 32 feet are assumed to be 3 percent, while rates for smaller vessels are assumed to be double this, or 6 percent. A breakdown is assumed to result in completely new VMS installation costing $1,550. The resulting average costs are about $47 for a vessel over 32 feet that is acquiring VMS, and about $93 for a smaller vessel acquiring VMS. Averages over the entire fleet of vessels, including both those that already have VMS and vessels that need to acquire it, will be smaller.

These calculations yield estimates of the VMS transmission costs had this rule been in effect in 2003, but using the most recent VMS unit and monthly coverage prices to better reflect prevailing market conditions.

The method used to estimate the acquisition and annual transmission costs of VMS operation is believed to have the following implications for the cost estimates:

- Separate cost and benefit analyses have been done for the GOA and the AI. Some vessels may have fished in both the GOA and the AI during a calendar month. If a vessel did this, it would only have to have paid for 1 month's worth of VMS coverage. However, in this analysis, the vessel would be billed for 1 month of AI coverage and 1 month of GOA coverage.

- Potential regulatory changes to exempt sablefish vessels with VMS from port clearances before fishing in the AI may encourage some vessels to acquire VMS in the absence of the EFH and HAPC requirements. Moreover, some vessels covered by this action may have to adopt VMS under terms of the new crab rationalization rule, even if the EFH and HAPC VMS management action does not take place. These factors may mean that the counts of vessels that would be required to adopt VMS because of this action are overestimated.

- Technological change and increasing competition are likely to reduce the costs of these technologies as time passes. Costs have dropped considerably within the last 4 years, since the SSL VMS requirements were introduced. This may not affect the initial purchase costs, but may lead to reductions in replacement and annual transmission costs through time.

- Annual transmission costs for operations that are not already covered by VMS have been estimated on the basis of $74 per calendar month charge for service. Operators that do not fish for an entire month at a time may find alternative service packages less expensive.

- The installation costs of $200 may be somewhat high. It assumes 2 hours of professional assistance at $100 an hour. This is at the upper range of professional assistance estimates provided and is slightly above the hourly cost estimates obtained. Many operators will be able to install the equipment themselves (but their time would still have opportunity costs). However, there is anecdotal evidence that antenna problems are more common in self-installs than in vendor installs.

- In some instances, operators will be able to alter their operations so as to avoid fishing in federal waters, or to avoid carrying an FFP or FCVP. While these changes would result in lower costs for the acquisition and operation of a VMS, they would also involve additional cost for vessel operators, who would fish differently than as they would have in the absence of the requirement.

C.3.8.4.5 Aleutian Islands VMS Cost Analysis

C.3.8.4.5.1 The Status Quo

Under the status quo, 96 of the 168 vessels operating in the AI in 2003 would have carried VMS units. There would have been no costs to add VMS to additional vessels, and there would have been no changes in the transmission requirements for the vessels carrying VMS.

C.3.8.4.5.2 The Preferred Alternative

The data set showed 168 vessels fishing in federal waters in the AI in 2003; 96 of these had VMS, and 72 did not. These 72 vessels would be expected to acquire and use VMS under this alternative.

Average installation costs were $1,550. Average annual charges were $452 for vessels just acquiring VMS (estimated 6 months of use in AI) and $1,011 for vessels that already had it (estimated 7 months of use in AI).

Total cost of purchase, installation, and activation of new VMS units was estimated to be $112,000. Total annual transmission costs were estimated to be $33,000 for operations acquiring VMS for the first time and $97,000 for operations that already had it. Total annual transmission costs were $130,000.

VMS units may require repair during the year. The average costs for a vessel that has to acquire VMS were estimated to be $47 for vessels over 32 feet and $93 for other vessels. The average cost for all vessels under this alternative was $21. The total fleet costs were about $3,500.

Average gross revenues for operations were $1,913,000. Gross revenue information in this report is from all the operations in Alaska, whether managed by the State of Alaska or the federal government, in which the vessel participated in 2003. This includes revenues from the GOA and the EBS, as well as the AI. Ex-vessel and first wholesale revenues are included, depending on whether the vessel operated as a catcher vessel or a catcher-processor. The mean gross revenues are heavily influenced by a group of groundfish catcher-processors with large gross revenues. The average gross revenue for the four vessels with the greatest gross revenues is about $11 million. The median gross revenue for all the vessels in 2003 was about $1,136,000.

The proposed rule would be a permanent change in regulations. Fishermen would have to replace their VMS units as they wore out or became technologically obsolete. Thus the initial purchase cost underestimates the lifetime costs this requirement would impose on fishermen. One supplier estimates the likely life of their VMS unit as 8 years and the VFH antenna as about 4 years (the supplier estimated the cost of a new VFH antenna as about $100). Technological change and competition would likely reduce the future costs of VMS units below the current estimate of $1,200 used here. The cost of the units required when the SSL protection measures were implemented was about $1,800. It is also possible that, in the absence of this regulation, fishermen would have had to carry VMS for other purposes at some time in the future. This possibility would tend to reduce the cost of this regulation.

C.3.8.4.5.3 Vessels Less Than or Equal to 32 Feet

Two vessels less than or equal to 32 feet were estimated to have fished in federal waters in the AI in 2003. A third vessel with no vessel length information also fished there. The landings of this vessel were relatively small, and it is treated here as a vessel less than or equal to 32 feet.

Assumed average installation costs for these three vessels were $1,550. Average annual transmission costs were $428. Confidentiality rules prevent reporting the average gross revenues of these operations. Average gross revenues were considerably below the AI average. Total installation costs for these three operations were about $5,000. Total annual transmission costs were about $1,000. With annual repair costs averaging about $93, total repair costs for these vessels would be about $300.

C.3.8.4.6 Gulf of Alaska VMS Cost Analysis

C.3.8.4.6.1 The Status Quo

Under the status quo, 293 of the 928 vessels operating in the GOA in 2003 would have carried VMS units. There would have been no costs to add VMS to additional vessels, and there would have been no changes in the transmission requirements for the vessels carrying VMS.

C.3.8.4.6.2 The Preferred Alternative

The data set showed 928 fishing vessels meeting the criteria for inclusion under this action in the GOA in 2003; 293 of these had VMS, and 635 did not. These 635 vessels would be expected to acquire and use VMS under this alternative.

Average installation costs were $1,550. Average annual charges were $423 for vessels just acquiring VMS (estimated 5 months of use in GOA), and $752 for vessels that already had VMS (estimated 5 months of use in GOA).

The fleet-wide total cost of purchase, installation, and activation of new VMS units was estimated to be $984,000. Total annual transmission costs were estimated to be $269,000 for operations acquiring VMS for the first time and $221,000 for operations that already have VMS. Total aggregate annual transmission costs were $489,000.

VMS units may require repair during the year. The average costs for a vessel that has to acquire VMS were estimated to be $47 for vessels over 32 feet and $93 for other vessels. The average cost for all vessels under this alternative was $37. The total fleet costs were about $34,000.

Average (mean) gross revenues for operations were $580,000. Gross revenue information in this report is from all the operations in Alaska, whether managed by the State of Alaska or the federal government, in which the vessel participated in 2003. This includes revenues from the AI and the EBS, as well as the GOA. Ex-vessel and first wholesale revenues are included, depending on whether the vessel operated as a catcher vessel or a catcher-processor. The mean gross revenues are heavily influenced by a group of groundfish catcher-processors with large gross revenues. The average gross revenue for the four vessels with the greatest gross revenues is about $11 million. The median gross revenue for all the vessels in 2003 was about $196,000.

The proposed rule would be a permanent change in regulations. Fishermen would have to replace their VMS units as they wore out or became technologically obsolete. Thus the initial purchase cost underestimates the lifetime costs that this requirement would impose on fishermen. One supplier estimates the likely life of the VMS unit as 8 years and the VFH antenna as about 4 years (the supplier estimated the cost of a new VFH antenna as about $100). Technological change and competition would likely reduce the future costs of VMS units below the current estimate of $1,200 used here. The cost of the units required when the SSL protection measures were implemented was about $1,800. It is also possible that, in the absence of this regulation, fishermen would have had to carry VMS for other purposes at some time in the future. This possibility would tend to reduce the expected cost of this regulation.

The analysis of VMS requirements is based on the assumption that fishing operators that fish only in state waters would surrender their federal fisheries permits to avoid a VMS requirement. Some operators may choose not to do this. To take a more expansive view of the potential application of this rule, cost estimates have been prepared under the assumption that 558 vessels fishing for halibut in state waters in 2003, but not in federal waters, would also have carried VMS equipment and made transmissions. Under these circumstances, 1,193 vessels would have to acquire VMS. Average acquisition costs would be $1,550, average transmission costs would be $400, and average repair costs would be $60. Average gross revenue for these operations would be $161,000. The regulation would cover 299 vessels that currently carry VMS. They would incur additional transmission costs averaging about $800 per vessel. Average gross revenue for these vessels was about $1.2 million.

C.3.8.4.6.3 Alternative Excluding Different Categories of Smaller Vessels

Figure 3.8-1 shows the length distribution of vessels under 40 feet fishing in the GOA with bottom-contact gear in 2003. Anecdotal evidence from NMFS Enforcement agents suggested that vessels 32 feet and under might have more limited ability to participate in federal waters fisheries in the GOA than other vessel classes. Thirty-two feet length overall (LOA) was, therefore, chosen as one of the break points for defining vessel categories. An examination of the data (summarized in Table 3.8-3) suggests that there was a big drop in operation gross revenues between vessels of 32 feet and less and those of 30 feet and less. On this basis, 30 feet was chosen as a second break point. Finally, 25 feet was chosen as a third break point to provide a lower bound sensitivity analysis.

Vessel counts, average costs and revenues, and total costs and revenues were calculated for vessels equal to, or less than, the footage corresponding to each of the three break points. In addition, similar information was estimated for 11 vessels for which length data were missing. These vessels had gross revenues very similar to those of the 30 feet and under vessel class, and may belong in this category. The information for these vessels is summarized in Table 3.8-3.

C.3.8.4.6.4 Exempt Dredge Gear

In the past, the scallop dredge fishery has not been active in the areas protected under the EFH and HAPC measures. It is unlikely that an interest will develop in dredging in these areas, since the habitat being protected is that favored by scallops. It may be possible to reduce the burden of this regulation by exempting this class of bottom-contact gear (although vessels operating dredge gear would still be required to meet the requirement if they were carrying other bottom-contact gear on board).

Four vessels fished for weathervane scallops with dredge gear in 2003. Two of these did not have VMS gear, and did not fish one of the other bottom-contact gears that would have required VMS use. The average cost for buying, installing, and activating the VMS was $1,550. The average annual transmission cost for the two vessels was $578. The average gross revenues for the two vessels cannot be released due to confidentiality restrictions.

Total purchase, installation, and activation costs for these two vessels would have been about $3,100. Total transmission costs would have been about $1,100. Both vessels were greater than 32 feet long; estimated total repair costs (at $47 per vessel) were about $100. Exempting these two vessels would not impact the fleet-wide total VMS program costs attributable to the proposed EFH and HAPC actions significantly.

C.3.8.4.6.5 Exempt Dinglebar Gear

The dinglebar fishery for ling cod is managed by the State of Alaska, although it occurs in federal waters. Fishermen fishing dinglebar gear for ling cod may be able to avoid the VMS requirement while fishing this gear by surrendering their FFPs. Because these vessels may take rockfish incidentally to ling cod fishing, they normally are named on an FFP for purposes of retaining the rockfish. The benefit of retaining and selling the rockfish may be much less than the expense of operating VMS. Therefore, these vessels may be likely to surrender their FFPs. The result would be increased discards of rockfish, which NMFS and the Council want to avoid. For this reason, it may be appropriate to consider exempting this class of bottom-contact gear from the requirement (although vessels operating dinglebar gear would still have to meet the requirement if they were carrying other bottom-contact gear on board).

Twelve vessels fished with dinglebar gear in 2003. Only four of these did not use one of the other bottom-contact gears. An exemption for dinglebar gear, therefore, would only exempt four vessels. None of these vessels carried VMS. All of them were small entities under the SBA criteria. The average cost for buying, installing, and activating the units was $1,550. The average annual transmission cost for the four vessels was roughly $500. One of the four vessels was 32 feet; the other three were larger. Estimated repair costs were about $200. The average gross revenues for the four vessels were $43,000.

Total purchase, installation, and activation costs for these four vessels would have been $6,000. Total operational costs would have been about $2,000. Exempting these 12 vessels would not impact the fleet-wide total VMS program costs attributable to the proposed EFH and HAPC actions significantly.

C.3.8.4.7 Other Costs Associated with the Alternatives

As noted, a certain number of VMS units will break down each year. Although there is limited evidence on breakdown rates, this analysis has used rates of 3 and 6 percent depending on vessel size. While VMS units may be under warranty at first, parts and labor for repairs would still be a cost under cost-benefit accounting. Operations also face the possibility of lost fishing time. Potential interruptions in fishing activity may, indeed, be the more expensive concern. While NMFS Enforcement handles breakdowns on a case-by-case basis, it does not normally require a vessel to interrupt a fishing trip and return to port when a breakdown is identified. A vessel with a bad VMS unit will have to get it repaired before it begins a new trip.

VMS data would have to be monitored and interpreted by NMFS Enforcement. Currently, a VMS program manager, a VMS computer specialist, and an enforcement technician are on staff in the Regional Office to implement the existing VMS program. Because followup EFH investigations would be anticipated based on VMS data, the Alaska Enforcement Division (AED) would require two additional enforcement officers, one in Dutch Harbor and one in Kodiak. These officers would conduct dockside boardings and contacts to ensure compliance with EFH and VMS requirements, follow up on suspected violations, patrol with Coast Guard or other patrol units, and respond to observer affidavits, among other EFH-related tasks. One-time costs for training these new officers on the complexities of the VMS database and software would be required. Additional annual costs would also be incurred for office space, vehicles, and related support for these additional staff. Annual salary and personnel costs for these two officers are estimated to be $110,000 each. NMFS Enforcement also anticipates that it would have to add a VMS technician position to support the extension of the VMS requirements to the new classes of vessels considered here. Such a position is likely to be a contract position, costing about $87,000 per year (salary and benefits).

C.3.8.4.8 Benefits From these Alternatives

A reduction in impacts on the benthic habitats that are being protected by the EFH and HAPC actions will have two important social benefits. These measures will protect the ability of the benthic habitat to support the productivity of fish stocks and the commercial, sport, and subsistence fisheries that depend on those stocks. In addition, many of these habitats, and the ecological systems that depend on them, have intrinsic importance or an existence value to persons who are aware of them. Corals, especially, may be a resource on which people place a relatively large existence value.

It is not currently possible to monetize these benefits, or to estimate how the benefits will change if the habitat is disturbed. Necessary information is incomplete on the linkages between fishing activity (and reductions in fishing activity) and changes in habitat status,[10] the relationship between habitat and the status of fish stocks that depend on it, and the relationship between fish stock status, allowable catch, and fisheries profits. Information is also missing on the value people place on undisturbed benthic habitats and how the values would change with changes in the risk of disturbance to those habitats.

The restrictions on fishing in EFH and HAPC habitats that would be implemented by this rule are meant to reduce the intensity of gear impacts on the protected habitats. Different levels of enforcement can affect the extent to which the restrictions reduce that intensity. An unenforced restriction may not lead to any reduction in intensity at all. An efficiently enforced restriction, combined with appropriate penalties, can reduce the intensity a great deal.

While alternative approaches to effective enforcement are conceivable, they are extremely costly and are not likely to be implemented in the current budgetary and national security environment. The EFH and HAPC areas in the GOA and AI are far offshore, or are located in remote spots, so that enforcement is difficult. The two best methods for monitoring fishing near these areas are by patrol and using VMS. Because NMFS Enforcement does not have patrol vessels or aircraft for these areas, the U.S. Coast Guard (Coast Guard) would be responsible for patrols. The Coast Guard has stated that patrols for fishery enforcement may continue to decrease, and Homeland Security priorities have reduced Coast Guard resources for fisheries enforcement. The expectation that Coast Guard could provide a deterrent effect through patrols cannot be relied on solely to protect these areas.

Requiring VMS in the GOA and AI is the most efficient enforcement tool available considering the current level of resources. The Coast Guard may use VMS to monitor fishing activities around EFH and HAPC areas so aircraft and vessel patrols to these areas may be prioritized. VMS would provide a deterrent effect when the fishing vessel operators know NMFS Enforcement and the Coast Guard have access to data on their vessel's location. In addition to being able to monitor activities near EFH and HAPC areas, NMFS special agents and officers can compare VMS data with reported fishing locations dockside.

VMS gear has additional public and private uses. The gear being added to enforce the EFH and HAPC restricted areas could also be used to enforce a wide range of other, spatially based, fishery regulations.

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[10] Appendix B in the EFH EIS models the impact of fishing gear on habitat as a function of (a) intensity of fishing effort, (b) sensitivity of habitat features to contact with fishing gear, (c) the recovery rates of habitat features, and (d) the distribution of fishing effort relative to different types of habitat (NMFS 2005). The results of the modeling exercise are not sufficiently precise to serve as a basis for the monetization of benefits. Moreover, other problems discussed above in the text remain.

While VMS equipment might not have justified the investment to vessel owners in the absence of this requirement, vessel owners may obtain some benefit from it. They can use this equipment for communications and fleet management.

C.3.8.4.9 Summary of EO 12866 Significance Criteria

The criteria for determining whether or not an action is significant were described in Section 1.2 of this appendix.

As discussed in Sections C.3.8.4.5 and C.3.8.4.6, under the preferred alternative that would require the most extensive VMS coverage, total installation costs in the AI and the GOA are about $1.1 million, and annual transmission costs are about $0.6 million. Therefore, it does not appear likely that this alternative has the potential to impose annual costs of $100 million or more on the U.S. economy, nor to "adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities... (EO12866)."

NMFS has not identified any factors that would (a) "Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency"; (b) "Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof"; or (c) "Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the executive order (EO 12866)."

C.3.9 Alternative 6

Alternative 6 proposes to amend the GOA and BSAI Groundfish FMPs, the Alaska Scallop FMP, the BSAI Crab FMP, and Pacific Halibut Act regulations to prohibit the use of all bottom tending gear (dredges, bottom trawls, pelagic trawls that contact the bottom, longlines, dinglebars, and pots) within approximately 20 percent of the fishable waters (i.e., 20 percent of the waters shallower than 1,000 m) in the BSAI and GOA.

C.3.9.1 Benefits Associated with Alternative 6

C.3.9.1.1 Passive-use Benefits

Under Alternative 6, all bottom-contact fishing activities targeting all FMP managed species would be prohibited from 20 percent of the fishing grounds (areas shallower than 1,000 m) in the GOA, EBS, and AI. While it is currently impossible to provide an empirical estimate of the passive-use value attributable to this protection of EFH, it is assumed that Alternative 6 would yield some incremental increase in the passive-use benefit of EFH over the status quo, Alternative 1 (Table 3.9-1). Alternative 6 would reduce the impact of bottom-contact fishing over 61,991 km^2 of GOA (17.4 percent of the current 356,199 km^2 of habitat), 136,031 km^2 of EBS habitat (17.0 percent of the current 798,870 km^2 of habitat), and 20,729 km^2 of AI habitat (19.7 percent of the current 105,243 km^2 of habitat), for a total of 218,750 km^2, or 17.4 percent of the total fishable area of 1,260,312 km^2 in the GOA, EBS, and AI (Table 1.4-1). See EIS Sections 2.3.3 and 4.3 for details on the fishing impact minimization measures and the environmental consequences of Alternative 6.

C.3.9.1.2 Use and Productivity Benefits

Alternative 6 is designed to reduce the effects of bottom contact fishing on EFH in the GOA, EBS, and AI beyond measures currently in place or planned as part of other fishery management actions. Current scientific knowledge does not permit either a quantitative or qualitative assessment of the use benefits derived from minimizing the effects of fishing on EFH. However, the assumption implicit in the amendment to the Magnuson-Stevens Act requirement to minimize effects of fishing on EFH is that doing so would result in the sustained or enhanced production from FMP species and contribute to a healthy ecosystem (Table 3.9-1). As such, Alternative 6 would contribute additional measures that would further reduce the impacts of fishing on EFH.

C.3.9.2 Costs Associated with Alternative 6

C.3.9.2.1 Industry Revenue at Risk

Assuming, for purposes of this analysis, that Alternative 6 had been in place in the 2001 fishing year, it would have placed $237.2 million of commercial fishing gross revenue at risk, or 18.9 percent of the total $1.26 billion status quo gross revenue, in that year (Table 3.9-1). It is unlikely that all of this revenue at risk could have been recovered by redeploying bottom-contact fishing effort from closed areas into open areas under the fishing impact minimization measures imposed by Alternative 6. Without a thorough understanding of the fishing effort redeployment strategy that would be followed by fishermen in each fishery, and of the impact of effort redeployment among fisheries, it is impossible to accurately predict the amount of revenue at risk that might be recovered.

Alternative 6 could have significant adverse impacts on particular fisheries, due to their location and their operational limitations. For example, Alternative 6 would likely eliminate the small catcher vessel halibut longline fishery in St. George. These vessels have very limited operational range. The substantial area closed to longline fishing (indeed, all bottom contacting gear) around St. George Island, by Alternative 6, could effectively preclude redeployment of fishing effort to remaining open fishing grounds, all of which lie beyond this fleet's safe operating range.

Similarly, Alternative 6 would close significant portions of the GOA and AI scallop fishing grounds. Scallop dredging is conducted I on known beds that are limited in number. ADF&G sets annual guideline harvest ranges (GHRs) for each management district based on the production potential from the scallop beds in each district. Loss of catch and revenue in one district cannot be recovered by transferring GHR to another district, because each district is managed for its maximum sustained production. It is unlikely that fishermen would find new scallop beds in open areas. Therefore, scallop dredge revenue, projected to be at risk under Alternative 6, would more than likely be lost. Similar revenue at risk losses may occur in regional groundfish and crab fisheries in each area.

C.3.9.2.2 Product Quality and Revenue Impacts

Revenue impacts from changes in product quality would be likely under Alternative 6 for the catcher-vessel fleet. The catch and revenue at risk under Alternative 6 would be relatively large for the catcher-vessel fleet component and would likely result in longer fishing trips and extended running time for catcher vessels fishing in open areas. The increased running time, especially in more exposed and extreme sea and weather conditions, is inversely correlated with the quality of groundfish and halibut catch delivered for inshore processing. These conditions are also associated with increased deadloss in crab fisheries.

Product quality might not be affected to an equivalent degree in the catcher-processor fleet component, since these vessels process the catch onboard the vessel. However, the catcher-processor fleet would still be adversely affected if the average size of the fish or their condition were significantly different in the remaining open areas than would have been expected in the closed areas. For a number of economically important species (e.g., pollock, Pacific cod), the size of the fish is highly correlated with its use in the production of specific products. As the fish get smaller, on average, the product forms that can be produced and successfully marketed become fewer. Production that would have supplied a relatively high-value market (e.g., deepskin fillets) might have to be diverted to lower-value product forms, with accompanying adverse effects on net revenues per unit output, and perhaps even downstream impacts on quality, product mix, supplies, and prices to consumers.

C.3.9.2.3 Operating Cost Impacts

Alternative 6 would likely have significant adverse impacts on the operational costs of most, if not all, of the bottom-contact gear groups. Elimination of 20 percent of the fishing grounds in each region would require additional running time to reach open areas and return to port to deliver catch (or product). It is likely to result in fishing in areas with lower CPUE, requiring increased fishing effort to recover catch and revenue at risk. Additionally, it could require costly exploration of unfamiliar fishing grounds, with associated gear damage and loss, and could aggravate gear conflicts that also cause expensive gear loss or damage. Fishermen may attempt to mitigate the loss of revenue at risk in bottom contact fisheries by converting to pelagic gear, when possible, requiring substantial investments in vessel modifications and/or new fishing gear. There may also be additional costs resulting from learning to fish new gear in new areas. This option would not be available to many of the potentially affected operations, because PTR is not a legal gear type for species such as Pacific halibut or any or the crab species. Nor is it an effective means of harvesting many other species for which the target fisheries would be restricted under Alternative 6 (e.g., flatfishes).

C.3.9.2.4 Safety Impact

Adoption of Alternative 6 is likely to adversely affect safety in many of the affected fleet components and fisheries. Large area closures to all bottom-contact gear could result in vessels traveling farther from their homeports and shoreside delivery locations, increasing the length of fishing trips. Fishing in remote areas could impose additional risks of weather-induced safety impacts and increase the time required to run to safe harbor, as well as for response to emergencies. Closures of traditional, local fishing areas may induce fishermen to take additional risks, run the extra miles of open seas, or fish in weather and sea conditions that they would normally avoid, in order to remain economically viable in the fishery. All of these responses to the Alternative 6 closures would place greater strain on vessels and crew, reducing safety margins for the industry.

C.3.9.2.5 Impacts on Related Fisheries

Alternative 6 would be expected to adversely affect related fisheries by concentrating fishing effort. Under Alternative 6, all bottom-contacting fishery gear types would be confined to the remaining fishing grounds that would be unrestricted by fishing impact minimization measures or other management closures. Significantly reducing the area available for bottom-contact fishing could result in incompatible gears attempting to fish the same area at the same time. These gear conflicts can result in loss of catch, ghost fishing by derelict gear (with undesirable ecological impacts), and higher costs for everyone fishing the grounds, even those not directly regulated by the provisions of Alternative 6. In extreme cases, these conflicts can cause considerable damage and can even place vessels and crew at risk.

C.3.9.2.6 Costs to Consumers

There would very likely be an increase in costs and a reduction in welfare to consumers from Alternative 6, because the total catch (and thus, revenue) at risk would almost certainly not be recovered in all areas and for all species (Table 3.9-1). Reducing the supply and product mix produced by these fisheries would be expected to adversely affect both domestic and international markets. This would likely mean shorter supplies at the retail level, a reduced variety of seafood and associated fish products, perhaps lower quality, and higher prices to consumers. These welfare losses, while not amenable to quantification at this time, would nonetheless represent a real cost attributable to Alternative 6. In accordance with OMB guidance, only consumer welfare losses accruing to United States consumers are appropriately included in these benefit/cost calculations. While a significant share of output of these fisheries enters the international marketplace, a substantial portion of the production would be destined for United States domestic consumption.

A decline in the seafood supply from the U.S. EEZ off Alaska may force consumers to use more foreign products as replacements. Potential negative effects include the following:

1. A loss of market share will result in American producers losing revenue, which may be a difficult trend to reverse.
2. Reduction in seafood and associated fish products exported from the EBS, GOA, and AI to Asia and other world markets would negatively impact the U.S. trade balance.
3. Imports into U.S. markets would increase to meet American consumer demand, increasing the U.S. trade deficit.
4. The U.S. tends to incorporate more rigorous environmental standards in its fishery management as compared to some other nations, so increasing consumption of seafood from some foreign suppliers may lead to indirect environmental impacts elsewhere in the world.

C.3.9.2.7 Management and Enforcement Costs

Management and enforcement costs would likely increase under Alternative 6, although it is not possible to estimate by what amount. Additional on-water enforcement may be required to assure compliance with the fishing impact minimization measures applied in the GOA, EBS, and AI (Table 3.9-1). Section 3.1.2.7 contains some additional discussion of the NMFS Enforcement and Coast Guard responses to resource demands connected with monitoring and enforcing provisions of Alternative 6.

VMS equipment or 100 percent observer coverage could be required of all vessels using bottom contact fishing gear in each area. Most groundfish vessels operating in the GOA, EBS, and AI pollock or Pacific cod fishery are already equipped with VMS. Vessels employing bottom contacting gear, but not currently equipped with VMS equipment, could be required to install and operate the VMS equipment while fishing in all regulated areas. Crab, halibut, scallop, and groundfish vessels using pot and jig gear typically do not have VMS. The number of additional vessels that would be required to install and operate VMS under Alternative 6 is not known. Alternative 6 fishing impact minimization measures apply to all bottom-contact gear and are likely to require additional enforcement measures (boarding and inspection) beyond the typical time/area/fishery management measures currently employed.

Although only Alternative 5B specifically requires the development and implementation of a research and monitoring program, it is likely that some form of research and monitoring program may be necessary under Alternative 6 to measure the effectiveness of the Alternative. Accomplishing these research and monitoring projects would require significant additional expenditures by the Alaska Region and Alaska Fisheries Science Center over a period of years.

C.3.9.3 Distributional Impacts

C.3.9.3.1 Gross Revenue at Risk Effects

C.3.9.3.1.1 Geographic Area Impacts

Alternative 6 would impose fishing impact minimization measures in all FMP areas. Had this rule prevailed in 2001, a total of $237.20 million (8.9 percent) of the total status quo revenue of $1.26 billion would have been placed at risk under the fishing impact minimization measures imposed by Alternative 6. Revenue at risk and status quo revenue include the ex-vessel value of landings in the crab, scallop, halibut, and catcher vessel groundfish fisheries and first wholesale value in the catcher-processor groundfish fisheries.

The largest revenue at risk would have occurred in the EBS, with $177.54 million (19.0 percent) of the $934.36 million at risk, in 2001. The GOA would have had revenue of $46.52 million at risk, or 22.0 percent of the 2001 status quo revenue of $211.48 million. The AI would have had $13.14 million at risk, or 11.8 percent of the 2001 total revenue of $111.30 million.

Within the GOA, the CG would have incurred the greatest revenue at risk under Alternative 6, with $29.23 million at risk, or 27.6 percent of the 2001 status quo revenue of $105.92 million. The WG would have had $9.73 million at risk, or 29.2 percent of the $33.20 million total status quo revenue. The EG would have had $7.56 million at risk, or 10.5 percent of the $72.26 million of status quo revenue.

C.3.9.3.1.2 Fishery Impacts

Assuming for sake of argument that the 2001 fisheries had been managed under the provisions of Alternative 6, this rule would have placed $163.76 million of groundfish revenue at risk, or 16.0 percent of the overall Alaska status quo revenue of $1.03 billion (Table 3.9-2). The halibut fishery would have had $38.34 million at risk, or 34.2 percent of the 2001 status quo revenue of $112.16 million. Crab fisheries would have had $34.11 million at risk, or 29.4 percent of the total status quo revenue of $116.0 million. Alternative 6 would have placed $980,000 in revenue at risk in the scallop dredge fishery, or 29.1 percent of the total status quo revenue of $3.37 million.

Alternative 6 would not directly affect salmon fisheries, although indirect impacts may accrue, due to diversified salmon operations being adversely affected in their crab, halibut, or groundfish fishing activities.

Alternative 6 would affect nearly all bottom contact fisheries in each area. In the GOA, Alternative 6 would have the largest effect on the halibut HAL fishery, with $32.12 million in revenue at risk, or 33.9 percent of the 2001 status quo revenue of $94.62 million, had the fishery been governed under this alternative. Sablefish HAL and NPT fisheries would have had $6.66 million in revenue at risk, or 12.5 percent of the status quo revenue of $53.21 million. Rockfish HAL and NPT fisheries would have had $2.29 million of revenue at risk, or 21.5 percent of the status quo revenue of $10.67 million. There would have been \$2.63 million of revenue placed at risk in the GOA HAL and NPT Pacific cod fisheries, or 11.7 percent of the 2001 status quo revenue of \$22.43 million. Alternative 6 would have placed \$940,000 in revenue at risk, or 34.3 percent of the \$2.74 million of status quo revenue in the GOA scallop dredge fishery, had it been in place in 2001. The GOA scallop revenue at risk almost certainly could not have been recovered by redeploying fishing effort to remaining open areas, because the GHR is not transferable between districts.

In the EBS, Alternative 6 would have had the largest effect on the pollock PTR fishery, with \$104.04 million, or 16.8 percent of the total status quo revenue of \$618.60 million placed at risk. Alternative 6 would have placed \$28.45 million in revenue at risk, or 35.3 percent of the \$80.70 million of status quo revenue in the EBS crab POT fisheries. The Pacific cod HAL and NPT fisheries would have had \$23.83 million of revenue at risk, or 17.2 percent of the \$138.80 million in 2001 status quo revenue. Alternative 6 would have placed \$10.65 million of revenue at risk in the yellowfin sole NPT fishery, or 30.1 percent of the status quo revenue of \$35.39 million in this fishery. The halibut HAL fishery would have had \$3.53 million of revenue at risk, or 36.0 percent of the total status quo revenue of \$9.80 million, in 2001.

In the AI, Alternative 6 would have the largest effect on crab POT fisheries, with \$5.30 million in revenue at risk, or 26.5 percent of the status quo revenue, had it been the rule in 2001. The AI HAL halibut fishery would have had \$2.69 million at risk, or 34.7 percent of the \$7.74 million of status quo revenue. The Pacific cod HAL and NPT fisheries would have had \$2.32 million at risk under Alternative 6, or 7.4 percent of the \$31.35 million status quo revenue. Atka mackerel NPT, flatfish NPT, and sablefish HAL and NPT fisheries would also have had revenue placed at risk in the AI under Alternative 6 (Table 3.9-2).

C.3.9.3.1.3 Fleet Component Impacts

If in place in 2001, Alternative 6 would have placed \$86.30 million in revenue at risk for the catcher-vessel fleet component, or 21.6 percent of the total status quo revenue of \$398.67 million in this fleet component (Table 3.9-2). The catcher-vessel fleet component would have had the most revenue at risk in the halibut fishery at \$38.28 million, or 34.2 percent of total status quo revenue. Other impacts to the catcher-vessel fleet would have included the revenue placed at risk in the crab industry (\$31.26 million, or 29.5 percent of status quo revenue) and the groundfish fisheries (\$16.76 million, or 9.3 percent of status quo revenue). The largest impacts in the catcher-vessel fleet would have occurred in the GOA HAL and NPT fisheries, as well as in the EBS and AI HAL and POT fisheries.

For the catcher-processor fleet component, Alternative 6 would have placed \$150.89 million at risk, or 17.6 percent of the \$858.47 million 2001 status quo revenue. Catcher-processors harvesting groundfish would have had \$147 million in revenue at risk, or 17.4 percent of the \$845.01 million status quo revenue in these fisheries. Catcher-processors operating in crab fisheries would have had \$2.85 million in revenue at risk, or 28.6 percent of the status quo revenue in 2001. Catcher-processors operating in the scallop dredge fishery would have had \$980,000 in revenue at risk, or 29.1 percent of the status quo revenue of \$3.37 million. Alternative 6 would primarily affect catcher-processors using HAL and NPT in the GOA; catcher-processors using PTR, NPT, HAL, and POT in the EBS; and catcher-processors using NPT, POT, and HAL in the AI (Table 3.9-2).

C.3.9.3.2 Impacts on Dependent Communities

C.3.9.3.2.1 Overview

Alternative 6 is very different from the other alternatives in terms of potential impacts on dependent communities. Unlike the other alternatives, Alternative 6 would have a direct impact on gear types other than nonpelagic trawl gear and on fisheries other than groundfish. In addition to those involved in the groundfish fishery, communities engaged in or dependent upon the crab, scallop, and halibut fisheries could also experience adverse impacts. Alternative 6 would result in impacts to vessels using hook and line, jig, nonpelagic trawl, pelagic trawl, and pot gear in the groundfish fisheries, as well as pot gear in the crab fisheries, dredge gear in the scallop fisheries, and hook and line gear in the halibut fisheries.[11] This alternative also has a large geographic footprint, and potential impacts could be realized in communities with links to a range of fisheries in the GOA, EBS, and AI areas.

In the following subsections, impacts to catcher vessels, catcher-processors, and shore-based processors are presented, along with the links of these sectors to dependent communities that would realize impacts. In addition to these more or less straightforward impacts, Alternative 6 would also have a different order of magnitude of impacts in some communities, based on interactive impacts.

Unlike the other alternatives, Alternative 6 features large closure areas close by (or immediately adjacent to) a number of communities. Thus, in addition to having impacts to a broad range of fishery participants utilizing wide-ranging fleets, it could result in profound localized impacts for a number of communities with small boat-based fleets through the closure of a significant portion of (or even all) waters within the operational range of small vessels. One example of this would be St. George in the EBS, where over 97 percent of waters within 20 miles of the community would effectively be closed to halibut fishing, which at present is the only commercial fishery pursued by the local resident fleet. This enterprise has received considerable investment of time, effort, and resources, not only by local residents, but by the local CDQ group (Aleutian Pribilof Islands Community Development Association). An attempt to foster a more viable fisheries base for the local economy has not recovered from earlier federal withdrawal from the community. In other communities, local small boat fleets engage in a range of other fisheries that could not be pursued within EFH closure areas under this alternative.

In addition to impacts on communities already engaged in or dependent upon a range of fisheries, this alternative would also make it more difficult, if not impossible, for a number of other communities to develop small boat-based commercial fisheries in the future. Perhaps the most extreme example of this would be Nelson Lagoon in the AEB. While not a major participant in halibut fisheries at present, virtually all waters within 20 miles of the community would be closed to bottom gear, meaning future development of a small boat fishery would effectively be precluded as long as the closure remains in effect. Of course, EFH area closures would be only one of the factors that could impede such development. The fact that halibut fishing is now governed by an IFQ system that restricts entry would be another significant barrier.

The type of localized impacts associated with Alternative 6 would also have interactive effects when applied in conjunction with existing management measures and ongoing dynamics. This type of interaction would, of course, occur under all of the alternatives, but is expected to be most profound in terms of community impacts for Alternative 6. A primary example of this would be the cumulative

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[11] At its April 2003 meeting, the Council clarified that subsistence and recreational fisheries would not be included in Alternative 6; therefore, the discussion in this section assumes that the only potential impacts to these fisheries would be indirect (and would result from direct impacts to commercial fishing).

impact of Alternative 6 closures near communities, combined with Steller sea lion protection measure closures recently put in place near a number of those same communities. Both serve to effectively limit the areas available to small boat fleets.

Another source of interactive or cumulative impacts for a number of communities (and not just those with small vessel fleets immediately at risk under this alternative) would be seen in the fishery management measures not yet in place, but under active consideration for implementation in the immediate or foreseeable future. These include BSAI crab and GOA groundfish fisheries rationalization. Of the two, the BSAI crab rationalization initiative is further along in the alternative development process. It is clear that, depending on the alternative ultimately selected for implementation, at least some of the communities that would experience adverse impacts under Alternative 6 could also experience profound adverse impacts under BSAI crab rationalization. These communities would most obviously include St. Paul and St. George in the Pribilofs but would also include a number of other communities, such as those in the AEB, depending on the features of the particular rationalization approach taken.

Another type of interactive effect that would influence the magnitude of impacts felt under Alternative 6 would be the current dynamics seen in the crab and salmon fisheries. In the case of the crab fisheries, not only would Alternative 6 have direct adverse impacts on the crab fleets or processors in some communities through the closures themselves, but the decline of the crab fishery over the past several years has already resulted in adverse impacts to a number of those communities. Further, while Alternative 6 would not have any direct impact on salmon fisheries, the fact that salmon fisheries have been in a state of economic difficulty (to the point of some affected regions being formally declared economic disaster areas in recent years) means that, for a number of communities, the impacts of Alternative 6 would be magnified. An example of this type of vulnerability can be seen in the community of King Cove in the AEB.

Beyond impacts to communities directly engaged in the groundfish fisheries through the presence of local catcher vessels, catcher-processors, processors, or support service businesses, Alternative 6 also has the potential for generating adverse impacts in the CDQ region communities. These impacts could occur in a number of different forms, with impacts to royalties, vessels that have had CDQ investment, employment and income for fishery-related positions, and other CDQ investments such as infrastructure and fleet development in communities that could be adversely affected by area closures under this alternative. Examples of the latter impact would be investments by the Aleutian Pribilof Islands Community Development Association in the St. George halibut fleet and port development and analogous investments by the Central BS Fishermen's Association in St. Paul.

In the following sections, potential impacts to communities are discussed in terms of links to catcher vessels, catcher-processors, processors, and their respective activities. The likely impacts in any given community depend on the nature of engagement in the fisheries (and the relative level of dependence on the relevant fisheries), and this varies from community to community. Some communities have substantial engagement in the fishery through direct participation of a local catcher-vessel fleet, while engagement for other communities occurs primarily through local processing activity. Some communities are substantially engaged through both harvesting and processing. For others, local fishery support service businesses form a part of the economic foundation of the community. Additionally, a few communities participate through engagement with the catcher-processor sector.

Changes in each of these sectors have the potential for different types of community impacts. For example, local catcher-vessel fleets tend to provide employment and income to local residents. On the other hand, few long-term community residents may be involved in processing operations in a number of communities, but processing activity may underpin local economies through generation of municipal revenues. Both sectors may stimulate business for support service providers many different ways. In the following discussions, engagement by sector by fishery by community is provided, along with associated impacts to dependent communities. A treatment of multi-sector impacts and small boat fleet impacts from near-community closures follows the individual sector discussions.

C.3.9.3.2.2 Catcher Vessels

For catcher vessels, there is revenue at risk in the groundfish, crab, and halibut fisheries (but not the scallop fishery, as all participants in that fishery are classified as catcher-processors). In the groundfish fishery, for the affected catcher-vessel sector as a whole, at-risk revenue accounts for 9.3 percent of total relevant status quo revenue ($16.76 million at risk out of $180.60 million). Both halibut and crab fisheries have higher absolute and relative amounts of revenue at risk, notwithstanding that groundfish status quo revenues are higher than for either crab or halibut. As noted elsewhere, figures given for catcher vessels represent ex-vessel revenues, which would tend to understate the overall value to associated communities that derive benefits from both harvesting and processing activities if examined alone. Values for first wholesale revenues at risk by shoreside processors from landings of catcher vessels are referenced in the discussion of shoreside processor locations provided below. For halibut, 34.2 percent of the status quo revenues of all affected vessels is at risk ($38.34 million out of $112.16 million), with the analogous figure for affected crab catcher vessels being 29.5 percent ($31.25 million out of $106.03 million).[12]

Groundfish Catcher Vessels

The groundfish catcher vessels that would be affected by Alternative 6 are numerous and come from a wide range of communities, as shown in Table 3.9-3. A total of 507 catcher vessels harvested groundfish in 2001 in the areas affected by Alternative 6 (using gear that would not be allowed in these areas under this alternative). Of these vessels, 300 were owned by residents of 40 Alaska communities, and 13 of these communities had 5 or more vessels each. These are Kodiak (with 71 vessels), Sitka (40), Homer (36), Petersburg (28), Anchorage (14), Ketchikan (12), Sand Point (12), King Cove (10), Juneau (7), Cordova (6), Craig (6), Old Harbor (5), and Port Alexander (5). Additional communities with more than two affected vessels include Wrangell (four vessels), Anchor Point (three), Pelican (three), and Unalaska (three). Seven other Alaska communities have two vessels each, with the balance spread as one vessel each among fifteen communities.

Outside of Alaska, ownership of potentially affected groundfish vessels is concentrated in a number of Oregon and Washington communities. A total of 44 affected groundfish catcher vessels are owned by residents of 19 communities in Oregon. Newport dominates the Oregon portion of the fleet with 18 locally owned vessels. Only one other Oregon community (Woodburn) had three vessels, six communities had two vessels each, and the balance of the vessels were spread as 1 vessel each among the remaining ten communities. Washington residents own 146 vessels that would be affected by Alternative 6, of which 71 are from Seattle. Among other Washington communities, only three had five or more affected vessels (Anacortes with eight, Edmonds with seven, and Bellingham with five). Of the

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[12] As a methodological note, fishery revenue totals in the different data sets used for different parts of the analysis in the EFH RIR and EIS are similar but not identical, due to different assumptions and derivations of the information. Further complications are introduced when revenues from a number of different fisheries with different records are distributed to communities, which requires a number of simplifying assumptions. The quantitative information presented in this section is most useful for relative comparisons and for understanding the direction and magnitude of change likely under this alternative, rather than for a precise quantification of the exact dollars involved.

remaining communities, 1 had 4 vessels (Port Townsend), 2 had 3 vessels, 7 had 2 vessels, and the balance of the vessels were spread as 1 vessel each among the remaining 31 communities. Many of the Washington non-Seattle vessels are actually owned in communities within the greater Seattle area. A total of 17 affected vessels are owned outside of Alaska, Oregon, or Washington, with 6 in communities with 2 vessels each and the rest in 1-vessel communities.

Ownership patterns are much more complex for Alternative 6 than for any other alternative and vary by the individual groundfish fisheries that would be affected under this alternative. Of the 507 catcher vessels that would be affected overall, the breakdown is as follows: :

> Deepwater flatfish were harvested by 39 vessels – 44 percent from Oregon, and 26 percent each from Kodiak and Washington.
> Shallow water flatfish were taken by 99 of these catcher vessels – 54 percent from Washington, 26 percent from Oregon, 15 percent from Kodiak, and 5 percent from other places.
> Of the 447 other groundfish boats, 31 percent are from Washington, 9 percent from Oregon, 12 percent from Kodiak, 9 percent from Sitka, 7 percent from Homer, 6 percent from Petersburg, 24 percent from other places in Alaska, and 3 percent from other states.
> Pacific cod were taken by 366 of these vessels – 28 percent from Washington, 10 percent from Oregon, 18 percent from Kodiak, 9 percent from the AEB, 8 percent from Homer, 23 percent from other places in Alaska, and 4 percent from other states.
> Pollock were taken by 180 of these vessels – 41 percent from Alaska (14 percent from Kodiak, 8 percent from Homer, 6 percent from Sand Point, 3 percent from King Cove, and 10 percent from other Alaska communities), 16 percent from Oregon (more than half from Newport), 40 percent from Washington (at least 28 percent from the Seattle area), and 4 percent from other states.
> Rockfish were taken by 375 affected catcher vessels, with the shelf rockfish complex being harvested by 296 of these vessels. Of the 296 vessels, 38 percent were from Washington,11 percent from Oregon, 9 percent from Kodiak, 39 percent from other places in Alaska, and 3 percent from other states.
> Of the 290 catcher vessels that harvested sablefish, 33 percent were from Washington, 9 percent from Oregon, 11 percent from Kodiak, 44 percent from other places in Alaska, and 3 percent from other states.

Catch value figures cannot be disclosed for most communities with potentially affected vessels due to data confidentiality restrictions. Table 3.9-4 provides an aggregated distribution of affected groundfish catcher vessels by community grouping, and Table 3.9-5 provides ex-vessel value of harvest data for these same groupings. Value information is provided for pollock, Pacific cod, other groundfish, halibut, crab, and salmon fisheries for these vessels to allow for a consideration of the relative dependency of the groundfish fleet on the various major fisheries in which these vessels participate. As shown in the table, different area-owned fleets have very different relative levels of dependency on the different fisheries. For example, Kenai Peninsula Borough vessels are far more dependent on other groundfish compared to either pollock or Pacific cod, whereas the reverse is true for vessels from the AEB.

In terms of groundfish species harvested by catcher vessels in the GOA, six fisheries have an at-risk revenue of $10,000 or more. Three of these have relatively modest at-risk revenues: deep water flatfish ($60,000, or 18.1 percent of the status quo revenue of $320,000), shallow water flatfish ($40,000, or 2.2 percent of the status quo value of $1.60 million), and the residual category of other groundfish ($20,000, or 20.5 percent of the status quo figure of $90,000). Due to the low levels of revenue at risk, no catcher vessel-related dependent community impacts are anticipated for these fisheries. The species with more substantive values at risk are Pacific cod ($1.68 million at risk, or 10.9 percent of the status quo figure of $15.34 million), rockfish ($460,000, or 10.9 percent of the status quo figure of $4.25 million), and sablefish ($5.29 million, or 11.5 percent of the status quo value of $45.87 million). Given both more substantive values and the relatively high percentage of revenue at risk when compared to status quo values for these same vessels, there may be significant impacts to these vessels under this alternative. As noted above, ownership for vessels that harvested Pacific cod, rockfish, and sablefish is widely distributed within Alaska, with the result that a number of different communities would be affected. It is assumed that impacts within Alaska would be more concentrated in the communities of King Cove, Sand Point, Anchorage, Homer, and Kodiak than in other communities, based on the sheer number of affected vessels from those communities and the distribution of overall revenues. Each of these communities has at least 10 vessels that would be affected, and it is anticipated that, due to the size and diversity of the local economy, impacts would be less apparent at the community level in Anchorage than they might be in the other four communities.

No groundfish species in the AI have an at-risk value greater than $10,000. Due to the low amounts of groundfish revenue at risk, no community impacts related to AI groundfish fisheries catcher vessels are anticipated. For the EBS, only three species have an at-risk value greater than $10,000, and each of these species represents a relatively small percentage of relevant status quo revenue. These species are Pacific cod ($620,000, or 4.9 percent of the status quo figure of $12.66 million), pollock-midwater ($7.92 million, or 8.5 percent of the status quo figure of $93.44 million), and sablefish ($70,000, or 5.2 percent of the status quo value of $1.42 million). It is assumed that, because of the relatively small percentage of revenue at risk compared to total revenues for these vessels, the at-risk revenues could be recovered relatively easily through effort directed at remaining open areas for sablefish (especially given management under IFQ conditions) and Pacific cod (given a less than 5 percent at-risk figure). Pollock, with its larger at-risk percentage, may be more problematic. Given the distribution of the fleet, associated impacts to Alaska communities would likely be concentrated in Kodiak and Sand Point, in addition to the larger Pacific Northwest ports.

Halibut and Crab Catcher Vessels

Halibut Catcher Vessels

A total of 495 halibut vessels would have revenue at risk under Alternative 6. This includes 491 vessels that are listed in the database as halibut catcher vessels and 4 that are listed as catcher-processors. There is no distinct halibut catcher-processor fleet, as there are groundfish and crab; therefore, for this analysis, all halibut vessels are combined in the catcher vessel category.

A detailed distribution of halibut vessels by community of owner is shown in Table 3.9-6. Among halibut vessels with revenues at risk, 358 vessels (72.9 percent of the total fleet) are owned by residents of Alaska. Washington residents own 92 halibut vessels with at-risk revenues, while 31 are owned by Oregon residents, 6 by California residents, and 3 by residents of other states. Alaska halibut vessels with at-risk revenues are concentrated in Kodiak. With 90 vessels, Kodiak has more than twice as many vessels with revenues at risk than any other community. Marked concentrations are also found in Homer (44 vessels), Sitka (42 vessels), and Petersburg (38 vessels). Four other communities have more than 10 vessels with revenues at risk: Juneau (18), Ketchikan (14), Sand Point (13), and Anchorage (12). Six additional communities have five or more vessels with revenues at risk: Seward, St. George, and Port Alexander (each with eight), Craig and Cordova (seven each), and Anchor Point (five). Ten Alaska communities have two to four vessels each with revenues at risk, and an additional twenty-one communities have one vessel each with halibut revenues at risk.

Thirty-one halibut vessels with revenue at risk under Alternative 6 are owned by Oregon residents, and the pattern of community distribution of these vessels is very different than the pattern seen for either groundfish or crab vessels. Woodburn has more vessels (seven) than Newport (six), and only Warrenton (four) also has more than two vessels. Two other communities have two vessels each, and the remaining ten vessels are distributed among ten different communities. Among Washington communities only 4 have 5 or more vessels out of the 92-vessel fleet: Seattle (with 25 vessels), Anacortes (11), Port Townsend (7), and Edmonds (5), but as was the case with Newport, Seattle is not nearly as dominant relative to other in- state ports for halibut vessels as for groundfish vessels. One additional community has 4 vessels and another 3; the rest of the fleet is divided among 8 communities with 2 vessels each and 21 communities with a single vessel each.

As was the case with groundfish catcher vessels, because of low vessel counts, value information cannot be presented at the community level for many communities that are engaged in the halibut fishery through participation by locally owned vessels. Table 3.9-7 presents vessel count information for halibut vessels with at-risk revenue aggregated to regions, as well as the total revenues associated with these vessels. Within Alaska, the domination of Kodiak and the Kenai Peninsula Borough (primarily by Homer and Seward) in terms of at-risk revenues is clear, but other Alaska communities also contribute significantly in this regard. The greater Seattle area represents the greatest concentration of at-risk halibut revenue for the Pacific Northwest. The total halibut at-risk value is $38.28 million, of which 55 percent is taken by Alaska vessels, 32 percent by Washington vessels, and 8 percent by Oregon vessels. Alaska vessels tend to be smaller than Washington and Oregon boats, and their owners tend to own less quota share than Washington and Oregon owners.

For affected halibut vessels, 34.2 percent of the status quo revenue is at risk ($38.28 million out of $112.04 million). While percentages at risk are similar, the amount of revenue at risk varies considerably by region. Within the GOA, 33.9 percent of the halibut fleet’s status quo revenue is at risk ($32.07 million out of $94.50 million). In the EBS, the percentage of revenue at risk is roughly comparable to what is seen in the GOA (36.0 percent), but the amount at risk is considerably lower ($3.53 million out of $9.80 million). In the AI, 34.7 percent of status quo halibut revenue of the affected vessels would be at risk ($2.69 million out of $7.74 million). Three hundred sixty of the four hundred ninety-five vessels in the affected halibut fleet for all areas also fish for groundfish in the areas to be closed by Alternative 6 and would have additional revenue at risk in those fisheries. The most important fisheries in this regard in the GOA are Pacific cod and rockfish, with deep and shallow flatfish being less significant. Sablefish is also an important fishery for many GOA and EBS halibut vessels in general.

There is considerable variation in halibut fleet composition among GOA, EBS, and AI areas in terms of patterns of community ownership, as well as the numbers of vessels involved. For the GOA taken as a whole, Alternative 6 would affect 336 halibut boats. This represents approximately 34 percent of the total GOA halibut fleet. Most vessels (232 vessels or 69 percent of the fleet) are from Alaska, predominantly from the communities of Kodiak (92), Homer (42), Sand Point (13), Petersburg (12), Anchorage (11), and Sitka (11). Together, these communities account for 78 percent of the affected Alaska fleet. Other Alaska communities with multiple halibut vessels with revenue that would be at risk in the GOA include Seward (eight vessels); Cordova (six vessels); Anchor Point (five vessels); King Cove and Wasilla (three vessels each); and Ketchikan, Port Lions, Seldovia, and Willow (two vessels each). An additional 18 communities ranging from Hoonah in Southeast Alaska to Unalaska/Dutch Harbor in the Aleutians have a single, locally owned halibut vessel with GOA revenues that would be at risk under this alternative. The Alaska vessels with at-risk halibut revenues in the GOA represent a mix of long-range vessels and vessels from small communities fishing relatively nearby waters.

The pattern of revenues that would be at risk under Alternative 6 varies somewhat from overall vessel ownership patterns. The CG represents 55 percent of the total value of the halibut fishery at risk under this alternative, while the WG represents an additional 18 percent of this at-risk fishery, and Southeast Alaska represents 9 percent. For the CG, Alaska boats represent 61 percent of the value of the regional at-risk halibut fishery, with more than half of this attributable to Kodiak (33 percent of the total), followed by Homer, Seward, and Petersburg. Much of this is a resident fleet. Washington vessels represent 25 percent of the central GOA at-risk halibut value, mainly from Seattle. Oregon vessels represent 11 percent of this value, with some concentration of vessels in Newport. The smaller WG at-risk halibut revenue is mainly taken by Washington boats (55 percent) concentrated in Seattle, followed by Alaska boats (36 percent from Sand Point, Kodiak, Anchorage, Homer, and other places). Sand Point vessels would represent the local fleet for the WG. The still smaller Southeast Alaska at-risk halibut harvest is taken mostly by relatively local Alaskan boats (75 percent – Sitka, Ketchikan, Petersburg, Wrangell, and a number of other places) and most of the rest by boats from Washington (greater Seattle area and other places).

Comparatively few halibut vessels would be affected by closure areas in the EBS, although those vessels would comprise approximately 25 percent of the EBS halibut fleet (42 of 166 vessels). Based on 2001 data, of the 42 vessels with at-risk revenues, 21 are owned in Alaska, 12 in Washington, 6 in Oregon, and 3 in other states. Of the Alaska vessels, eight are from St. George, seven are from Kodiak, four are from Homer, and the remaining two vessels are from Juneau and Sitka. With the exception of the St. George local fleet, all of the halibut vessels with at-risk revenues are long-range vessels from outside the EBS area itself. While St. Paul vessels do not show as being affected in the 2001 data, St. Paul-owned vessels have fished these areas in other years, and halibut caught in these areas by vessels from outside the community have consistently been landed and processed in St. Paul. While Alaska accounts for fully half of all vessels with revenue at risk, these vessels account for only about 28 percent of revenue at risk itself. Most of this revenue is associated with boats from Kodiak and Homer. Small boats from St. George account for 3 percent of the revenue at risk, but it is important to note that Alternative 6 would likely shut down the entire St. George small vessel fleet because all waters near the island would effectively closed to halibut fishing (see discussion below). While there is year-to-year variation, 16 different boats from St. George have harvested halibut in areas that would be closed by Alternative 6 since 1998. Washington boats account for 46 percent of the halibut revenue at risk, and Oregon and other states account for about 26 percent.

For the AI area, based on 2001 data, 33 halibut vessels would have revenue at risk under Alternative 6, which is about 54 percent of the total AI halibut fleet (61 vessels). Of the affected vessels, 21 vessels are owned in Alaska, with the balance owned in Washington. Ownership is concentrated in Juneau (seven vessels), Kodiak (five vessels), and Homer (four vessels), while Atka, Gustavus, Petersburg, Seward, and Sitka residents own one vessel with at-risk revenues each. Among Alaska vessels, all are long-range vessels from communities outside the AI area, with the exception of the single vessel from Atka.

In terms of overall halibut revenues at risk, 9 percent is associated with the EBS and 7 percent is from the AI. The EBS at-risk halibut revenue is taken mainly by Washington boats (46 percent) and Alaska boats (28 percent). Most of the Alaska total is represented by vessels from Kodiak, Homer, and St. George. The St. George fleet is the only local fleet component in the at-risk EBS halibut fishery (apparently the 2001 St. Paul halibut harvest did not include any take from areas to be closed by Alternative 6). The AI at-risk halibut fishery is taken primarily by nonlocal Alaska boats (71 percent from Kodiak, Juneau, and Homer), with Washington boats taking the remainder (29 percent from at least half from the Seattle area).

Those communities with vessels representing more than 3 percent of the total revenue at risk in the halibut fishery (all regions) are Kodiak (22.8), Seattle (12.6), Homer (8.0), Sitka (4.3), Petersburg (4.0), and Seward (3.2). About 78 percent of all affected halibut boats also fish for groundfish within areas that would be closed by Alternative 6 and would, therefore, have additional revenue at risk, but this varies by region. For affected Washington halibut vessels, 89 percent also fish for groundfish in these areas, while the figures for analogous Alaska and Oregon vessels are 75 and 67 percent, respectively.

Especially for the halibut fishery (but also for other fisheries as well), Alternative 6 would have the effect of impeding potential future development of small vessel fisheries in a number of small Alaska communities, in addition to impacts to current participation already mentioned. A treatment of these potential future impacts by community is presented in a separate discussion below.

Crab Catcher Vessels

Ownership of the 180 crab catcher vessels that would be affected by Alternative 6 is concentrated in relatively few communities, as shown in Table 3.9-8. Alaska residents own 50 (28 percent) of these vessels, with 25 from Kodiak, 6 from Homer, 5 from Anchorage, 3 each from Petersburg and Sand Point, and 2 each from King Cove and Sitka. Cordova, Kenai, Seldovia, and Yakutat each have a single vessel that would be affected by this alternative. Washington state residents own 111 (62 percent) of the vessels in the affected fleet. These are highly concentrated in Seattle, with 78 vessels owned by Seattle residents. No other community in Washington has more than three vessels, and at least several of these places are part of the greater Seattle area. Oregon residents own 17 affected vessels (or 9 percent of the affected fleet). Of these vessels, 11 are from Newport, and no other Oregon community has more than 2 vessels.

As with the groundfish and halibut fleets, few communities can be discussed in terms of the value associated with local crab vessels due to confidentiality restrictions. Table 3.9-9 provides vessel count and value data aggregated by region. This table clearly shows Kodiak's dominance within Alaska, and Washington is within the overall fishery. By far the greatest number of vessels crabbed in the EBS (156 catcher vessels), while only 18 and 10 vessels fished in the GOA and AI, respectively. Of the GOA vessels, six worked in the WG, eight in the CG, and one in Southeast Alaska.

Catcher-vessel fleet percentage of crab revenue at risk by area would be more variable than anticipated for halibut revenues. In the GOA, only 2.5 percent of affected vessel status quo crab revenue would be at risk ($370,000 out of $15.34 million), while in the EBS, 36.7 percent of the analogous revenue would be at risk ($27.35 million out of $74.42). In the AI, 21.8 percent of affected vessel status quo crab revenue would be at risk ($3.55 million out of $16.27 million).

The EBS, AI, and GOA components of the affected crab fleet vary considerably in the number of vessels involved and the pattern of ownership of those vessels. The EBS crab fleet that would be affected by this alternative consists of 170 out of the 180 vessels (or about 94 percent) of the overall affected fleet and closely reflects the community distribution percentages of the affected fleet as a whole. Of the EBS crab revenues at risk under this alternative, Washington boats would account for 65.3 percent (49.6 percent Seattle boats, 15.7 percent other Washington boats); Alaska boats, 24.1 percent (14.6 percent Kodiak boats, 9.5 percent other Alaska boats); and Oregon boats, 10.2 percent (6.3 percent Newport boats, 3.9 percent other Oregon boats). Potential Alaska-dependent community impacts related to EBS catcher vessel activity would be concentrated in Kodiak. Among other Alaska communities, only Sitka, Homer, Petersburg, and Anchorage would have more than one affected vessel, and these are all relatively large communities by regional standards with comparatively diversified economies. These factors would serve to minimize the intensity of potential community level impacts.

The AI crab fleet that would be affected by Alternative 6 consists of only 11 vessels. Of these, six are owned by residents of Washington State, two by residents of Newport, Oregon, and two by residents of Kodiak, Alaska. Confidentiality concerns prevent disclosing disaggregated information about Alaska and Oregon crab components of this fleet, but Washington vessels, while accounting for over half of the affected fleet, accounted for only about one-third of the at-risk AI crab revenue. Significant impacts to dependent communities would be unlikely to result from impacts to these few vessels. However, a number of individual operations would be expected to experience adverse impacts because it is assumed that recouping at-risk revenues would be difficult, given the percentage of revenue at risk.

The GOA crab fleet that would be affected by this alternative consists of 18 vessels, 10 of which are owned by residents of Alaska. Kodiak residents own four of these vessels, Sand Point residents three, and Homer, King Cove, and Sitka residents own one vessel each. Washington residents own six of these vessels, Oregon residents one, and residents of other states own one vessel. In terms of value, however, Washington boats represent about 48 percent of the GOA crab revenue that would be at risk while Alaska boats represent a substantially smaller percentage than their number of boats would imply. More precise figures cannot be given in order to protect the confidentiality of Oregon's and other states' boats. No dependent community level impacts would be likely to be associated with GOA crab catcher vessel operations, however, given the overall small percentage of revenue at risk and the likelihood that these revenues could be recovered with a minimum of additional effort directed toward areas remaining open under this alternative.

About 88 percent of crab catcher vessel value that would be at risk comes from the EBS. Washington State boats, predominately from Seattle, represent 64 percent of the EBS at-risk crab revenue, and Alaska boats (mainly Kodiak, but also some from Anchorage, Homer, and other places) represent 25 percent. Oregon boats account for most of the rest. The AI crab fisheries represent the next largest piece of the catcher vessel at-risk crab value, at 11 percent. Washington boats represent 50 percent of this at-risk crab revenue. Alaska and Oregon boats split the other 50 percent (Oregon boats have a higher percentage than Alaska boats). Total at-risk crab revenue (all regions and for both catcher vessels and catcher-processors) for Washington-owned boats would be about $20.5 million and for Alaska boats would be somewhat less than $9.5 million – with more than two-thirds of that in Kodiak.

Those communities whose catcher vessels account for most of the at-risk revenue for the crab fishery (all regions) are Seattle (45.3 percent, but actually higher if Seattle area communities are included), Kodiak (15.7 percent), and Newport (8.3 percent). The only other nonconfidential communities are Anchorage (2.2 percent) and Homer (1.2 percent). As a whole, Alaska catcher vessels account for about 24.6 percent of the at-risk crab revenue, Washington boats for about 62.2 percent, and the combined Oregon-other states boats for about 13.3 percent. Most affected crab catcher vessels (about 66 percent) do not fish for groundfish within the areas that would be closed by Alternative 6. There are no marked regional differences in this regard, other than that Oregon-other states boats are somewhat less likely to fish for groundfish than are crab catcher vessels owned by Alaska or Washington residents.

When likely changes are combined for the different areas, it is apparent that dependent community impacts related to crab catcher vessels would be concentrated in Kodiak. While individual operations in other communities could experience a decline of harvest volume and associated revenue, direct community level impacts associated specifically with the crab fleet would likely be relatively small.

However, a number of these smaller communities would also experience at least some level of adverse effects to their local fleet through groundfish and halibut impacts associated with this alternative.

In general, the crab fleet is experiencing both economic and operational uncertainty. Crab harvests in recent years have declined, making for difficult business conditions. There is a considerable amount of uncertainty regarding the future conditions because the BSAI crab fisheries are likely to be rationalized in the near future. Several alternative management structures are actively being considered, with quite different outcomes likely, depending on the ultimate alternative chosen and the set of accompanying options selected. Whichever alternative is implemented, it is likely that the composition and distribution of the crab fleet will look quite different after rationalization than it does under existing conditions due to consolidation in some form. Additional uncertainty regarding future conditions also results from the fact that a crab vessel buy-back program is also currently working its way through the study and implementation process. Taken together, these factors make it more difficult to forecast the precise nature of community impacts that are likely to result from EFH-specific changes.

Catcher Vessel Community Impacts Summary

The likely effects of Alternative 6 on communities through effects on catcher vessels are complex and interactive. Community catcher vessel fleets vary in the extent to which they diversify or participate in multiple fisheries. For example, many of the vessels participating in the EBS groundfish fisheries specialize in pollock and may also fish for some Pacific cod and perhaps for crab. Boats fishing the GOA fisheries tend to participate in more fisheries (although large pollock boats specialize more than others even there). In general, the more diversified a catcher vessel is (i.e., the more fisheries in which it participates), the better able it is to adapt to changes (and especially negative changes) in any one fishery. However, if more than one such fishery is affected at the same time, as would most likely be the case under Alternative 6, fishery diversification may actually intensify such negative effects.

Catcher vessels (and community fleets) also differ in the extent to which they participate in more local versus more distant water fisheries. EBS groundfish boats are almost all distant-water vessels – whether from the Pacific Northwest (Seattle or Newport, for example) or larger Alaska ports (such as Kodiak and Homer). Unlike the groundfish fisheries, there are small local halibut fleets in the EBS (in the Pribilofs). GOA fisheries, on the other hand, tend to have a much more local fleet character due to the participation of many Alaska vessels homeported in or near the GOA, although many vessels from the Pacific Northwest participate in GOA fisheries as distant water vessels. An important aspect of this in terms of community effects is that in a number of ways catcher vessels have direct and often more pervasive ties to the communities in which they are homeported than do catcher-processors or even locally operating fish processing plants. Catcher vessels tend to be operated by year-round community residents who hire other residents and buy goods and services locally. While catcher vessels are relatively small operations compared to other fishery entities, they are numerous and exist in communities of all sizes. In contrast, catcher-processors tend to be from larger communities, and processors are often not well integrated into the day-to-day economic flow of the communities where they operate. While often major contributors to local government revenue, a number of plants import their labor force and buy most goods and services from outside of Alaska.

Under Alternative 6, catcher vessels would be most affected by EFH measures through the pollock, crab, and Pacific cod fisheries in the EBS and the halibut, sablefish, and Pacific cod fisheries in the GOA. Those communities with a catcher-vessel fleet with significant participation in these fisheries form a relatively small class. Seattle and Kodiak stand out because of the magnitude of potential effects in one fishery, the combination of effects in multiple fisheries, or both. However, Seattle is a very large community, and while Alternative 6 effects would no doubt be significant for individual operations and industry sectors, they would not likely be significant on the community level. For Kodiak, however, the catcher fleet would face a significant percentage of their normal harvest as being at risk – an undefined percentage of EBS pollock (and some Pacific cod), about 23 percent of the total halibut at risk, about 16 percent of the total crab at risk, and a significant portion of the sablefish at risk. Halibut and sablefish are primarily GOA fisheries, where Kodiak boats participate as part of a more local fleet. It is not uncommon for Kodiak catcher vessels to participate in several of the affected fisheries, so that individual operations would certainly experience adverse impacts. Because of the number of such operations in Kodiak, there would probably be community-level economic effects as well. Much would depend on the degree to which fishing operations were successful in replacing their harvest from closed areas with harvest in areas that remain open.

Other communities also host vessels that participate in multiple fisheries, so that these communities may also experience effects from multiple fisheries. Most are Alaska communities – Homer, Sitka, and Petersburg. Newport, Oregon, may also fit in that category, although its participating vessels are fewer and less diversified in terms of fisheries. Vessels from these communities participate in the halibut, sablefish, pollock, and Pacific cod fisheries, but not in the numbers that those from Kodiak do. Many of these boats also tend to be more local or to fish strictly in the GOA than do Kodiak boats as a fleet, although many Kodiak boats also follow that pattern. Whether the effects on the fleets of these communities would achieve the threshold to cause community-level effects is not clear. Because much of the at-risk revenue is from GOA fisheries (especially halibut and sablefish) or in EBS fisheries (especially crab and to a degree pollock) in which GOA community fleets participate, Alternative 6 effects on catcher vessels would be most likely to translate into community-level effects for GOA communities. Kodiak and Homer would be the primary communities where these effects would be expected, but a number of other communities would also be affected. In terms of specific effects, much would depend on the ability of fishermen to catch fish in areas other than where they have caught them in the immediate past.

There are also a few other communities for which more fishery-specific Alternative 6 effects should be assessed. These arise because of the nature of catcher-vessel fleets from those communities. The Pribilof communities of St. George and St. Paul both have local fleets whose only harvest is halibut. There has been interest in, and some effort directed toward, including cod jigging as an additional focus for the Pribilof small-vessel fleets, but the current lack of local processing on St. George and the lack of true multi- species processing on St. Paul have limited development in this area. Vessels from St. George harvest a significant portion of the halibut at risk in Alternative 6. This fishery is an important component of the community development of St. George, and any adverse impact on it would be significant. Other effects are also possible. Although not apparent in the 2001 existing conditions data, St. Paul fishermen report that Steller sea lion protection measures and competition from nonlocal (distant water) halibut vessels have resulted in current redistribution of at least some effort to areas that would be closed under Alternative 6. To the extent that such a redistribution has occurred, potential impacts would increase. The communities of Sand Point and King Cove have catcher-vessel fleets that participate in a wide range of fisheries, many of which would be affected by Alternative 6 (pollock, Pacific cod, and halibut, especially). Vessels from these communities tend to be smaller than other groundfish vessels and so may be disadvantaged relative to the overall fleet in terms of ability to fish other areas to replace at-risk catch. The larger boats, participating in these fisheries as a distant water fleet, suffer no such disadvantage (assuming that there are other fish to be found) since this extra distance is a small percentage of their total trip. The local fleets of Sand Point and King Cove are also located such that they are also experiencing effects from Area M (salmon) management measures, as well as restrictions on fishing due to Steller sea lion measures, at the same time that the salmon fishery upon which they also depend is in poor economic shape. These factors would serve to amplify any adverse Alternative 6 impacts.

C.3.9.3.2.3 Mobile Processors

For motherships and catcher-processors, there would be revenue at risk in the groundfish, crab, halibut, and scallop fisheries. For the affected catcher-processor sector in the groundfish fishery as a whole, at-risk revenue accounts for 17.6 percent of total relevant status quo revenue ($147 million at risk out of $845.01 million). Halibut, crab, and scallop fisheries would have higher percentages of revenue at risk for the affected catcher-processors, but much lower absolute at-risk values than seen for groundfish. For halibut, 48.0 percent of the status quo revenues of affected vessels would be at risk, but this is only $60,000 out of $120,000. For crab catcher-processors, 28.6 percent of the status quo revenues of the affected vessels would be at risk ($2.85 million out of $9.97 million), while for scallop catcher-processors, 29.1 percent of the status quo revenues of the affected vessels would be at risk ($980,000 out of $3.37 million).

Groundfish Motherships and Catcher-Processors

The pattern of distribution of the mobile processor fleet by region and community that would be affected by Alternative 6 is much different than the pattern seen for catcher vessels under this alternative (Table 3.9-10). The catcher-processors are much more highly concentrated in Washington than is the catcher- vessel fleet, and those catcher-processors owned by Alaska residents are found in far fewer communities than are catcher vessels. Of the 81 catcher-processors that harvested groundfish during 2001 in areas that would be closed under Alternative 6, 65 were from Washington. Of these vessels, the vast majority (54 vessels) were from Seattle. One other Washington community had three vessels (Edmonds) and one had two vessels (Bellingham), and no other community had more than one vessel. A total of 12 catcher-processors with revenue at risk under this alternative show Alaska ownership. No Alaska community had more than three locally owned catcher-processors: three were from Petersburg; two were from Kodiak; two were from Unalaska; and one each was from Anchorage, Homer, Seward, and Sitka. Four catcher- processors were from other states. All four affected motherships have Seattle ownership.

As was the case for the catcher-vessel fleets, revenue data cannot be disclosed for most communities with catcher-processors due to confidentiality restrictions. Table 3.9-11 presents affected mobile processor ownership by aggregated area, while Table 3.9-12 provides revenue information for these same groupings. The strong dominance of this sector by Washington-owned, catcher-processors is clear from the information shown ($847.64 million out of $888.90 million in total revenues for these vessels).

An important distinction between Alternative 6 and the other alternatives considered with respect to catcher-processors is the type of catcher-processor operation likely to be affected. Under the other alternatives, head and gut vessels were the primary type of operations likely to experience most of the impacts. For Alternative 6, a much larger range of groundfish catcher-processors would be affected, up to and including the largest classes of BSAI pollock- and Pacific cod-oriented catcher-processors. Of the 81 catcher-processors that fished for groundfish in 2001 in areas that would be directly affected by Alternative 6, 79 fished for Pacific cod, 77 fished for pollock, 62 for shelf rockfish, 42 for flathead sole, 43 for Arrowtooth flounder, 47 for sablefish, 39 for rock sole, 34 for yellowfin sole, 30 for Atka mackerel, 16 for Rex sole, and 76 for other groundfish. Harvest diversity information is less detailed for the four motherships active in 2001, but this lack of detail has little bearing on understanding overall patterns. All four processed pollock and cod, while two processed other groundfish as well. However, 98.7 percent of the first wholesale value of their groundfish production was pollock, and industry sources indicate that this is an accurate reflection of current mothership operational dynamics. Species other than pollock are generally too dispersed to process unless pollock is being processed at the same time. These motherships operate in the EBS and possibly the AI when in Alaska waters.

In terms of groundfish species harvested by catcher-processors in the GOA, six fisheries would have an at-risk revenue of $10,000 or more. Flathead sole has a relatively modest amount at risk ($40,000, or 5.5 percent of a status quo value of $770,000). Arrowtooth flounder revenues at risk would be $440,000 (or 13.2 percent of the status quo revenues of $3.37 million for the affected fleet), Rex sole at-risk revenues would be $870,000 (or 17.3 percent of the status quo revenues of $5.02 million for the affected fleet), Pacific cod at-risk revenues would be $960,000 (or 13.5 percent of the status quo revenues of $7.09 million for the affected fleet), sablefish at-risk revenues would be $1.37 million (or 18.7 percent of the status quo revenues of $7.35 million for the affected fleet), and rockfish at-risk revenues would be $1.83 million (or 28.5 percent of the status quo revenues of $6.41 million for the affected fleet). Alaska-owned vessels participating in these fisheries ranged from two (Rex sole) to seven (Pacific cod, rockfish), with intermediate numbers in the others (three each in flathead sole and arrowtooth flounder, five for sablefish). With the exception of one to five vessels in any given groundfish fishery, the rest of the catcher-processors that would be affected (that is, the vast majority) are from Washington. Given the distribution of the fleet, no significant dependent community impacts associated with the GOA catcher-processor fleet would be anticipated for Alaska communities. While individual operations may experience adverse impacts under this alternative, the relatively small number of vessels in communities that are relatively large and economically diversified by Alaska standards are likely to make the impacts less than significant at the community level.

In general, the revenues at risk for groundfish catcher-processors would be much higher for the EBS than the GOA. In terms of groundfish species harvested by catcher-processors in the EBS, nine fisheries would have an at-risk revenue of $10,000 or more.

> Two of these would have relatively modest revenues at risk of under $100,000: arrowtooth flounder ($80,000 at risk, or 2.3 percent of the status quo revenue of $3.40 million) and the residual category of other groundfish ($70,000 at risk, or 13.6 percent of the status quo revenue of $540,000).
> Other fisheries with revenues up to $3 million that would be at risk are Greenland turbot ($790,000 at risk, or 31.1 percent of the status quo revenue of $2.55 million), other flatfish ($1.73 million at risk, or 40.1 percent of the status quo revenue of $4.32 million), flathead sole ($1.84 million at risk, or 12.7 percent of the status quo revenue of $14.46 million), and rock sole ($2.42 million at risk, or 10.2 percent of the status quo revenue of $23.62 million).
> Three fisheries would have revenues between $10 million and $100 million at risk: yellowfin sole ($10.65 million at risk, or 30.1 percent of the status quo revenue of $35.39 million), Pacific cod ($23.22 million at risk, or 18.4 percent of the status quo revenue of $126.14 million), and pollock-mid-water ($96.11 million at risk, or 18.3 percent of the status quo revenue of $525.16 million).

Depending on the individual fishery involved, between two and nine of the EBS catcher-processors were owned by Alaska residents in 2001 and one to six vessels were owned by residents of states other than Washington. The balance (that is, most of the overall fleet) was owned by Washington residents. Nearly all of the largest vessels in the fleet were owned by Washington residents (although Alaska investment – particularly CDQ investment – and partial ownership of the Washington-owned vessels has grown in recent years). Similar to the situation seen in the GOA, given the distribution of the fleet, no significant dependent community impacts associated with the EBS catcher-processor fleet would be anticipated for Alaska communities. While individual operations may experience adverse impacts under this alternative, the relatively small number of vessels in communities that are relatively large and economically diversified by Alaska standards would make the impacts less than significant at the community level. Otherwise, impacts would be concentrated largely in the Seattle area.

All four motherships operate primarily in the EBS and concentrate on pollock. Under the American Fisheries Act (AFA), the BSAI pollock fishery was essentially allocated to harvest vessels, based on their historic participation in the fishery. Thus, catcher-processors as a sector have a stable and known production level. Motherships have no such direct allocation, but do have a stable and known production level through the allocations of the catcher vessels that delivered to them historically. Individual mothership operations must compete for the deliveries from this pool of catcher vessels (as shore plants must compete for deliveries from catcher vessels delivering shoreside). At present, the pollock allocations to mothership catcher vessels have been sufficient for those operations in existence when AFA was implemented to remain in business. If EFH constraints impose additional costs on these operations, or if at-risk pollock cannot be replaced with pollock harvested in other areas, it is likely that at least one operation would be very adversely affected. Catcher vessels that deliver to motherships tend to be more constrained by weather and sea conditions, so that EFH area constraints may hamper their ability to replace at-risk pollock more than for shoreside catcher vessels (or catcher-processors). These effects are not likely to have significant community (Seattle) effects, but would certainly be significant for the industry sector (both the processor operations, as well as the catcher-vessel fleet).

In terms of groundfish species harvested by catcher-processors in the AI, six groundfish fisheries would have revenue at risk over $10,000. Of these, five would have between $10,000 and $100,000 at risk, with the remaining one having over $2 million in revenues at risk. The fisheries with revenues at risk of under $1 million would be rock sole ($40,000 at risk, or 10.5 percent of the status quo revenue of $360,000), Greenland turbot ($220,000 at risk, or 53.9 percent of the status quo revenue of $410,000), sablefish ($770,000 at risk, or 14.1 percent of the status quo revenue of $5.47 million), Atka mackerel ($890,000 at risk, or 2.2 percent of the status quo revenue of $41.18 million), and other groundfish ($30,000 at risk, or 17.2 percent of the status quo revenue of $200,000). The single fishery having over $1 million at risk would be Pacific cod ($2.32 million at risk, or 7.7 percent of the status quo revenue of $29.92 million). The catcher-processor ownership pattern for vessels with at-risk revenue is similar to that seen for the EBS fisheries, as are the likely catcher-processor-associated impacts to Alaska-dependent communities.

Halibut, Crab, and Scallop Catcher-Processors

There are several different catcher-processor fleets that would be affected under Alternative 6. While groundfish catcher-processors also process a range of nongroundfish species, there are specialized and distinct crab and scallop catcher-processor fleets. Potential revenues at risk for these fleets may be smaller than those for the groundfish catcher-processor fleet, but overall revenues are also smaller. This means that these fleets could experience disproportionate impacts relative to the groundfish fleet. There is some double counting between fleets because, for example, catcher-processors that process significant amounts of both groundfish and crab may show up in the data for both fleets. However, there is enough of a distinction between the types of operations and the distribution of the fleet to make separate discussions important for understanding the likely range of associated impacts under this alternative.

Halibut Catcher-Processors

While a handful of vessels appears as halibut catcher-processors in the database used for this analysis, there are no true halibut catcher-processors as a distinct fleet comparable to the groundfish and crab catcher-processors. Groundfish catcher-processors run halibut in limited numbers as part of their operations. For the purposes of this analysis, however, the four vessels listed as halibut catcher-processors (three from Alaska [Anchorage, Sitka, and Gustavus] and one from Washington) in the database are treated as halibut catcher vessels with regard to potential dependent community impacts associated with halibut activities.

Crab Catcher-Processors

Only six crab catcher-processors would be affected by Alternative 6. Of these, five are owned by residents of Seattle and one by a resident of Kodiak. Due to confidentiality restrictions, crab catcher-processor revenues for Alaska cannot be discussed separately. The total at-risk revenue for catcher-processors under this alternative is $2.85 million (compared to at-risk revenues for crab catcher vessels of about $31.26 million). This is split into $1.10 million at risk in the EBS (17.6 percent of a total status quo revenue of $6.27 million) and $1.75 million at risk in the AI (47.3 percent out of a total status quo revenue of $3.69 million). There is no status quo revenue for catcher-processors in the GOA. Given the distribution of the fleet, adverse impacts would be concentrated in Seattle and Kodiak. No significant community level impacts associated with the catcher-processor fleet are anticipated for Seattle or Kodiak, although individual operations may be affected significantly if at-risk crab cannot be replaced by fishing in alternative areas.

Scallop Catcher-Processors

For scallops in the GOA, 34.3 percent of affected catcher-processor status quo revenue would be at risk ($940,000 out of $2.74 million) under Alternative 6. Scallop status quo revenues are much lower for both the EBS and the AI. In the EBS, less than $10,000 in revenue would be at risk (out of a total status quo revenue of $580,000 for the affected vessels), while in the AI, $50,000 in revenue would be at risk out of a total status quo revenue for the affected fleet of only $60,000.

As detailed in Section 3.4.1.4.4 of the EFH EIS, existing conditions for the scallop fishery have changed substantially in recent years with the implementation of a license limitation system and the formation of a co-op within the fishery, which served to decrease the number of participating vessels. In 2001, about 31.8 percent of the Alaska scallop harvest was taken from waters that would be affected by Alternative 6. While (at least in some recent years [since 1998]) multiple vessels from Kodiak along with single vessels from Kenai, Anchorage, and Ester, Alaska, show harvests in the areas that would be affected by Alternative 6, the 2001 at-risk harvest was taken by three vessels, none of which was owned in Alaska – two were from Washington, and one from another state. Most of the 2001 harvest that would be at risk under Alternative 6 was taken by one vessel. The total harvest was taken from the GOA, and none of these vessels fished for groundfish in areas that would be affected by Alternative 6. The scallops harvested by the vessels discussed above were often processed on board the vessel; however, relatively small amounts were processed by other entities. In 2001, the at-risk scallop harvest was, at least in small part, processed by five processors – two from Washington, two from Alaska (Kodiak and Yakutat), and one owned in another state. Due to the small number of vessels involved and the fact that, at least recently, none of the at-risk harvest has been taken by Alaska vessels, no dependent community impacts appear likely from connections to scallop catcher-processor vessels. As detailed in an earlier section, significant impacts to a number of the catcher-processors and the fishery as a whole are likely under this alternative; however, it is not apparent that these would translate into dependent community impacts for Alaska communities or those in Washington or other states.

Catcher-Processor and Motherships Community Impacts Summary

Overall, community impacts associated with catcher-processors under Alternative 6 would be concentrated in Seattle, with a few exceptions. These exceptions include the few communities in Alaska with individual catcher-processor ownership, and CDQ entities with group ownership interests in catcher-processors.

Although there would likely be adverse impacts to a number of the fishery participants in the catcher-processor sector, impacts to Seattle as a community would potentially be insignificant due to the size and the diversity of the local economy and the fact that the workforce for the catcher-processor sector is not drawn from any single community. Catcher-processor employment, at least for the processing positions for vessels owned by Seattle residents, is mostly transient and drawn from a large region, primarily the Pacific Northwest, but also includes other western states in the continental United States, as well as Alaska. Mothership operation ownership is concentrated exclusively in Seattle. As is the case with catcher-processors, while individual operations may experience adverse impacts under this alternative, no community-level impacts are anticipated associated with motherships.

Catcher-processor-related impacts to Alaska communities under Alternative 6 would accrue to few communities (primarily Kodiak, Petersburg, and Unalaska). As detailed earlier, however, community-level impacts associated specifically with catcher-processors would potentially be less than significant. Impacts directly associated with catcher-processors, due to the mobile nature of their operations and their limited numbers, would be much less apparent in engaged communities than are larger catcher-vessel fleets and continuously present shoreside processors. The activities of these latter two groups also tend to generate more indirect local activity than catcher-processors due to more frequent local activity. Catcher-processor support service businesses are, however, important for some Alaska communities, especially Unalaska and, in more recent years, Ketchikan. CDQ group investments in the catcher-processor fleet have grown substantially in recent years, and CDQ communities would be vulnerable to adverse impacts to the Seattle catcher-processor fleet with whom they partner or with whom they have capital invested. The level of significance of these impacts would depend on a number of factors and is unknown at this time.

C.3.9.3.2.4 Shoreside Processors

As shown in Table 3.3-3, the total first wholesale value at risk of catch delivered inshore for processing represents approximately 21 percent of the total status quo value ($53.61 million out of $261.26 million) of the relevant fisheries of the GOA area, about 23 percent for the AI area ($7.97 million out of $35.04 million), about 14 percent for the EBS area ($71.20 million out of $514.54 million), and about 16 percent for all areas combined ($132.77 million out of $810.84 million), but no breakdown by port of landing is available. Caution must be exercised in the interpretation of these wholesale value data as (1) they are not additive with ex-vessel values presented above, and (2) they cannot be used as a proxy for potential levels of impacts to specific communities without considering the basic caveats laid out in the introductory paragraphs of Section C.3.3.3.2.4 of the Alternative 2 discussion. Overall revenue at risk is more than 33 times greater for any of the other alternatives. The following sections provide information on potential processor-related community impacts by major species group by community.

Groundfish Shoreside Processors

Shoreside groundfish processors include both floating processors and shore plants. While theoretically mobile, floating processors are defined as inshore operations by inshore/offshore and AFA-related management structures, and they function as fixed operations during processing seasons. From the perspective of community impacts, shore plants and floaters may be very different types of operations. In some cases, floaters may operate outside of communities or boroughs, while in other cases they may operate within communities and function effectively as shore plants from the community perspective. Shore plants (and floaters) vary from operation to operation and community to community in the degree to which they are integrated with the local economy or act as an enclave outside of the day-to-day workings of the community.

Table 3.9-13 provides a detailed community distribution of groundfish shoreside processors that took deliveries from catcher vessels with at least part of their catch in 2001 from areas that would be affected by Alternative 6. As shown, 60 shore plants in 36 Alaska communities over a very wide area ran product from these vessels, along with 1 entity in Seattle. Of the four floaters that took delivery from potentially affected vessels, two were in Alaska (Akutan and Unalaska), and two were in Seattle.

Groundfish processing value information cannot be disclosed for most communities due to confidentiality restrictions. Table 3.9-14 provides processor count information by aggregated area, and Table 3.9-15 provides processor revenue data by those same groupings. For the groundfish fisheries, the predominance of the Aleutians West Census Area (including Unalaska, among other communities), the AEB (including Akutan, King Cove, and Sand Point, among others), and Kodiak are clear from these data.

Halibut Shoreside Processors

Because of confidentiality restrictions, comparatively little information can be provided by community or even area for halibut shoreside processors. Overall, 88 percent of the at-risk halibut is processed in Alaska, 7 percent in Washington, and 4 percent is unknown. In terms of the CG, 90 percent of the at-risk halibut in 2001 was processed in Alaska. Kodiak processors accounted for 35 percent of this, followed by Homer and Seward (confidential percentages). Many other places accounted for small percentages. For the WG, Alaska processors accounted for 88 percent of the regional at-risk total. Percentages are confidential, but a list of significant places is Homer, Kenai, King Cove, Kodiak, Ninilchik, Sand Point, Seward, and Unalaska. For Southeast Alaska, processors in Alaska communities accounted for 94 percent of the at-risk halibut, primarily in Juneau, Ketchikan, Petersburg, Sitka, and Wrangell.

The EBS at-risk halibut fishery was similarly processed primarily in Alaska (93 percent) – Homer, Seward, and Unalaska being the three busiest communities in that regard. The AI at-risk portion of the halibut fishery was processed 75 percent in Alaska (11 percent unknown), primarily in Anchorage, Atka, and Unalaska.

Nine communities each processed at least 2 percent, and together 79.2 percent, of the total (all regions) at-risk halibut fishery. In alphabetical order, they were Bellingham, Homer, Kenai, Kodiak, Ninilchik, Sand Point, Seward, Sitka, and Unalaska. Among this group, the individual community figures can be disclosed only for Kodiak, at 21.3 percent of the at-risk harvest, and Unalaska, at 8.8 percent of the overall at-risk harvest. A total of 4.1 percent of the at-risk harvest is taken by vessels in the unknown community category in the database.

Crab Shoreside Processors

The EBS crab fisheries represent 87 percent of the catcher vessel at-risk crab value. The EBS at-risk catcher vessel crab is delivered, as might be expected, primarily to shore plants located in Alaska.

Unalaska receives more of the EBS at-risk catcher vessel crab value (40 percent) than any other community, but confidentiality restrictions prevent a ranking of other Alaska communities in terms of processing. The top six Alaska communities processed about 85 percent of the EBS catcher vessel at-risk crab value in 2001. In alphabetical order, they are Akutan, King Cove, Kodiak, Petersburg, Saint Paul, and Unalaska. Each had more than $1.5 million of affected vessel crab value processed locally in 2001. For processors, the AI catcher vessel at-risk crab value can be discussed only at the level of all processors, or in qualitative terms. Most is processed in Kodiak and Unalaska. Overall, the at-risk crab value would affect the same six EBS communities that were the largest AI crab processors in 2001. Processors in Unalaska processed about $13.8 million of at-risk catcher vessel crab in 2001(all BSAI region). Kodiak processors also processed a significant amount (precise numbers for shore processors are confidential to avoid divulging information for the one catcher-processor from Kodiak), as did four other Alaska communities (confidential due to low processor numbers).

St. Paul may be a special case in terms of shoreside processing-related community impacts for the crab fishery under Alternative 6. This alternative would place 30 percent of the EBS opilio crab revenue at risk, by far the species most commonly processed on St. Paul. With the decline in the overall fishery in recent years and the potential for flow of processing away from the Pribilofs under crab rationalization, the impacts of Alternative 6 associated with shoreside processing could be profound. While two of the three alternatives currently being considered for BSAI crab rationalization incorporate a regionalization component in order to provide some protection to communities (especially the Pribilofs) against sudden loss of crab production capacity (and the municipal revenues that accompany landings and processing), these protections are not assured at this time. Even if such protections were in place, the crab fleet may find it difficult to find sufficient crab to replace that lost to restricted areas and still deliver it in a cost-efficient way to St. Paul within a regionalized crab management system.

Specialty or Niche Types of Shoreside Processors

Several other types of processors exist, although details of how such enterprises operate can be spotty. Four such categories of processor are discussed here:

> Catcher/Shore Processor. A shore-based fishing operation that also processes its catch onshore (perhaps smoking operations and such).
> Catcher/Seller. A shore-based operation that sells its catch directly to consumers (over the dock or at a market). Such enterprises cannot process their catch. They may head, gut, and ice their catch, but they may not freeze it.
> Catcher/Exporter. Essentially the same as a catcher/seller, except that it sells outside of the country.
> EEZ Operator. An offshore operation that fishes in the EEZ in a fishery for which the management has been deferred to the state of Alaska.

The existing conditions count of these types of operations, along with the count of those that would be affected by Alternative 6, is given in Table 3.9-16. It can be seen that while such operations are not uncommon, they are not numerous. In 2001, as a measure of existing conditions, there were total operations that processed groundfish. Of these 59 operations, 50 were located in Alaska. Similarly, Alaska communities dominated in these operations for halibut (22 of 28), crab (23 of 32), and salmon (23 of 30). There was no large concentration of such enterprises, with many communities being home to one or a handful of operations. Those communities with more than one such enterprise were Sitka (six catcher/shore processors), Kodiak (four catcher/exporters), Homer (two catcher/shore processors, two catcher/exporters), Petersburg (three catcher/sellers), Haines (three catcher/shore processors), King Cove (three catcher/exporters), Sand Point (three catcher/exporters), Juneau (three catcher/exporters), Wrangell (two catcher/shore processors), and four communities each with two catcher/ exporter operations (Unalaska, Old Harbor, Anchorage, and Douglas). Catcher/seller operations were the most numerous, and Pacific cod was the most common species of fish in such operations. Pollock was the least common groundfish for these operations.

None of the alternatives except for Alternative 6 would affect more than five of these operations, which is likely to be an insignificant effect in terms of fishery-dependent communities. Alternative 6 has the potential to affect approximately 33 percent of all such groundfish, halibut, and salmon operations and about 25 percent of the crab operations. Given the usual small scale of these operations and their dependence on and adaptation to local conditions, it is not possible to predict how such operations would fare under EFH regulations. It is possible that Alternative 6 may, in fact, provide more opportunities for small niche marketers of specialty product, or it could just as easily upset the conditions that have fostered the development of this sort of operation in any given community. These effects are likely to be felt at the individual, household, and enterprise levels, however, and not at the community level.

Shoreside Processors Community Impacts Summary

Analysis of potential community effects due to Alternative 6 on shoreside processors is less straightforward than for other sectors. Initially, how communities are affected by shore plants depends upon how those shore plants are affected by catcher vessels that are affected by Alternative 6-related changes. Secondly, the quantitative information available on processors is less amenable to analysis and more subject to confidentiality restrictions than the vessel-related information.

The primary avenues for Alternative 6-related effects on processors to affect communities would appear to be related to a limited number of fisheries:

EBS crab
EBS pollock and, to a lesser degree, EBS Pacific cod
GOA halibut
GOA sablefish
GOA rockfish
GOA Pacific cod

Shore plants located in the EBS communities did not process at-risk GOA fish in 2001, but processors located in GOA communities did process at-risk BSAI crab that same year.

In the EBS, Unalaska processors would potentially be affected by Alternative 6 through the crab, pollock, and Pacific cod fisheries. These three fisheries represent a significant (and typically predominant) percentage of Unalaska shore plant production, and any reduction in the volume of fish would translate into direct effects on these operations. In addition, these shore plants (and the deliveries associated with them) are an important source of tax revenue to the communities in which they are located, primarily through fish taxes. Reductions in volumes of fish processed would translate directly into reduced community tax revenue. The degree to which potential Alternative 6 effects would be realized would depend on the ability of the catcher fleets that deliver to these plants to replace the at-risk fish with harvest from areas where they have not fished in the immediate past. Even if the volume could be replaced, if catcher vessels incur increased costs that must be passed on to the processors, some operational effects are possible (although this may actually increase tax receipts for communities). Given the relatively large amount of fish and crab involved, some degree of effect, at least in terms of fish tax revenues, can be anticipated. Other EBS shore plant locations cannot be discussed in detail due to confidentiality restrictions. The plant in Akutan is probably similar in potential effects to those in Unalaska.

The Pribilofs, and especially St. Paul, may be a special case in terms of potential impacts due to effects on processors from multiple fisheries affected by Alternative 6. The processor(s) in St. Paul rely very heavily on opilio crab and have also processed halibut in recent years. The local catcher-vessel fleet relies strictly on halibut, but local halibut processing is reported to be highly dependent upon crab processing in the sense that halibut alone would not induce a processor to operate on St. Paul (although crab processing in the absence of halibut processing has been viable). Local halibut processing relies on deliveries from outside vessels, as well as local vessels. The boats that would have at-risk revenues under Alternative 6 that delivered halibut in recent years to St. Paul were from Gig Harbor, Homer, Kodiak, Newport, Seattle, and St. Paul itself (although the data show St. Paul vessels delivering at-risk revenue catch only in 2000). Amounts processed in the community are confidential, but halibut numbers taken from the areas to be closed by Alternative 6 were modest from 1998 to 2000, before rising substantially in 2001. The effects of Alternative 6 on these processing dynamics are uncertain, particularly because crab processing in the Pribilofs has varied in the past. A number of apparently unconnected services available in the community are often related to local processing and fishing activities. For a given community, for example, the frequency of air service may decrease (along with the capacity of the planes used for this service), and the costs of air passenger and cargo service may increase, if commercial fishing-related demand decreases significantly or ceases. This is certainly the case in the Pribilofs and Adak, as well as in many of the smaller communities in the GOA. Similarly, surface shipping-related services are also affected by the presence of local processing. In the case of St. Paul, for example, the container-shipping operation that serves the local processor's needs also serves the community. Ships returning to the community with empty containers for the processor also bring non-fishing-related goods at reduced cost. If local processing were discontinued, special cargo deliveries would have to be arranged to meet community needs, and the costs of shipping goods would increase significantly. This is also a common situation for other small communities, and these types of air and sea transportation-related impacts have an effect on the cost of living, as well as on the general quality of life in these communities.

GOA processors are concentrated in Kodiak, and Kodiak processors would potentially be affected through the GOA halibut, sablefish, rockfish, pollock, and Pacific cod fisheries. In addition, Kodiak processors (and others in the GOA) have processed an increasing amount of EBS crab from 1998 to 2001. The dependence of any processor on this mixture of fisheries was not available for this analysis, but potentially a significant percentage of the fish Kodiak processors have depended on in the past would be at risk. The degree to which the catcher fleet that delivers to these plants can replace those fish at risk would determine the extent of effects. The catcher fleet is composed of both local and nonlocal (distant waters) vessels, which differ in their capabilities in harsh weather and sea conditions. Assuming that alternative locations for productive fishing exist to replace those closed by Alternative 6, potential effects on the catcher fleet should be at least partly mitigated.

Other processors in Sitka, Petersburg, and perhaps other locations could also be affected in similar ways to those in Kodiak, although the number of vessels delivering to them is fewer than for Kodiak. Their fleets tend to be more local and, thus, may be less able to find productive alternative fishing areas to those that would be closed by Alternative 6. These processors would be more affected by the halibut, sablefish, rockfish, Pacific cod, and, in some cases, the EBS fisheries than the pollock fishery.

Information sufficient to discuss potential effects on communities due to effects on niche processors is not available. The loss of such enterprises could be significant for small communities, and small vessels and these processing enterprises/outlets may be quite interdependent in such locations.

C.3.9.3.2.5 Multi-Sector Impacts

Individual communities would experience different outcomes resulting from Alternative 6 based on a variety of factors involving the specific attributes of local fishery engagement and dependency. Different communities have various constellations of local fleets, processors, and support service sectors. Communities also differ in the way municipal revenues are derived from fisheries-related activities including, in some cases, local raw fish taxes, business taxes, sales taxes, fuel taxes or transfer fees, fees for the provision of services, or similar mechanisms in various combinations. Communities also variously derive fishery-associated revenue benefits from the resource landing tax and state shared taxes. In the case of boroughs, communities that have little if any direct engagement in commercial fisheries may substantially benefit from fishery-related revenues generated in other communities within the borough, or activities outside of city boundaries but still within borough jurisdiction. Other benefits vary from community to community based on a number of factors, including the presence and composition of local private sector businesses that, to varying degrees, may derive revenue or income directly or indirectly from fisheries-related activities.

The fisheries themselves are also different in ways that would serve to channel impacts differently depending on a community's relative dependency between fisheries. For example, some fisheries that would be affected by Alternative 6 are managed quite differently than others. The halibut fleet is fully rationalized under an IFQ management approach, EBS pollock is partially rationalized under a harvester cooperative allocation system, and the crab fleet still participates in derby-type fisheries. These different management systems would likely lead to differences in the relative ability to recover revenues, perhaps for the fishery as a whole, but certainly for individual fishing enterprises (vessels) within each fishery. All other things being equal, if there are fish to be found to replace those harvested in the past in areas that would be closed by Alternative 6, rationalized fisheries give the best chance for each individual vessel to do so, because rationalization imparts quasi-property rights to a known share of the TAC to each quota holder (or group of cooperating operations), whether large or small. Under rationalized fishing rules (e.g., ITQ, QS, cooperatives), no vessel (or cooperating group of vessels) can increase its relative harvest share without lawfully acquiring harvesting rights from someone else in the fishery willing to part with those rights. Under open access fishing rules, on the other hand, vessels would be expected to display a differential pattern of success in replacing at-risk catch and revenues (i.e., the race for fish goes to the swiftest, most technologically advanced, most seaworthy, vessels). This, in turn, would lead to different community outcomes.

As noted earlier, Alternative 6 would potentially affect a number of different fisheries. While often managed more or less independently, for many fishing enterprises these different fisheries are highly interdependent. Thus, impacts to fisheries-dependent communities under Alternative 6 would be interactive and would vary by fishery and relative community dependence upon particular fisheries (through individual sectors or combinations of sectors). While the groundfish harvest database used for this analysis currently does not have information on the region from which vessels caught their fish, those fisheries for which such information exists for 2001 (halibut and crab) indicate that GOA fishing fleets that would be affected by Alternative 6 tend to be more local than affected BSAI fishing fleets (with some exceptions). The same Alaska communities tend to have the greatest number of vessels participating in the halibut and crab fisheries as in groundfish – Kodiak, Homer, Sand Point, Petersburg, and Sitka. Kodiak vessels also participate heavily in EBS fisheries. All of these communities are heavily engaged in fishing, and several are relatively dependent upon fishing, with Sand Point perhaps the most extreme case. Several communities stand out as likely to experience multi-sector impacts from Alternative 6.

Kodiak, as mentioned in earlier sector discussions, is engaged in the most heavily affected GOA and BSAI fisheries through its local groundfish, halibut, and crab catcher-vessel fleets, locally owned catcher-processors, and locally operating shoreside processors. No other Alaska community has the same depth of multi-sector engagement with fisheries at risk under this alternative. Kodiak is predominant in virtually all the major catcher vessel fisheries, with the exception of the BSAI halibut fishery. As a community, Kodiak derives substantial benefits from support service activities, as well as through public sector means, such as harbor fees. While Kodiak has a relatively large and diversified economy, multi-sector impacts from the different fisheries would likely be evident at the community level. Impacts may also have been felt in other Kodiak Island Borough communities as a result of a decline in borough revenues generated by fishing-related activities in Kodiak.

Within the AEB, Sand Point would experience multi-sector impacts through substantial catcher-vessel participation in the major at-risk GOA groundfish fisheries, the EBS pollock fishery, the GOA halibut fishery, and through local shoreside processing of at-risk harvests. Sand Point, in general, is heavily engaged in and dependent upon commercial fishing; as noted earlier, a number of other factors that have weakened local commercial fisheries make Sand Point especially vulnerable to any level of impact from EFH-related actions. King Cove, also within the AEB, would experience similar impacts, but likely to a lesser degree due to an apparently lower level of engagement in at-risk fisheries. Impacts may also have been felt in other Aleutians East Borough communities as a result of a decline in borough revenues generated by fishing-related activities in King Cove and Sand Point.

St. George and St. Paul in the Pribilofs would experience a range of local fleet and processor impacts. While at present only St. Paul has local processing, the local St. George catch is currently tendered to St. Paul, meaning adverse impacts to St. Paul processors would likely be felt in both communities. St. Paul itself is particularly vulnerable to adverse impacts to opilio processing under this alternative.

Within the Kenai Peninsula Borough, Homer is a port of ownership for vessels that harvest a substantial portion of the at-risk catch in the major GOA groundfish fisheries and BSAI groundfish fisheries and, thus, would be affected by Alternative 6 primarily through its local fleet. Processing would be affected relatively little compared to some other communities. The Kenai Peninsula Borough community of Seward would also feel impacts through its local fleet, but to a lesser degree than Homer. Overall, due to a diversified, road-connected local economy and their relatively large size, these communities are less dependent on fishing in general than either Kodiak or the AEB communities noted. While individual sector impacts may involve higher values than seen for the AEB communities, Homer and Seward would be expected to be less adversely affected at the community level than are Kodiak and the AEB communities.

The Southeast Alaska communities of Sitka and Petersburg are involved in a number of affected fisheries through both local catcher-vessel fleets and shoreside processing and, in the case of Petersburg, through catcher-processor ownership. In general, however, dependency on Alternative 6 at-risk revenues would generally be lower for these communities than that seen in some of the other communities, due to the size of the local fleets and the overall relative size and diversity of the local economies.

Unalaska would experience impacts primarily through local shoreside processing, but there is some local ownership of affected catcher-processors as well. Unalaska has a relatively large fisheries economic sector, so it is not likely that the level of risk associated with Alternative 6 would be significant at the community level, although a degree of uncertainty for processor impacts remains.

Alternative 6 would also likely have resulted in impacts to employment and income for fishing vessel crew members from non-fishing Alaska communities working on vessels owned by residents of other communities. Documenting the residential patterns of all potentially affected crew members is, however, beyond the scope of this analysis. This alternative would likely have resulted in indirect impacts in a number of both fishing and non-fishing communities in the form of decreased fishery-related transportation demand that, in turn, would have resulted in increased costs of goods and services in general for some of the more remote communities. The data to quantify such impacts are, however, not available. Community Development Quota (CDQ) in western Alaska would also have been vulnerable to adverse impacts under this alternative, but the level of significance of these impacts would depend on a number of factors and is unknown at this time.

Seattle would experience a wide range of impacts under Alternative 6. Seattle is the most heavily engaged of any community in the at-risk fisheries in terms of catcher vessel, catcher-processor, and mothership participation, and it is the dominant center of shoreside processor ownership as well. Given the size and the diversity of the local economy, however, Seattle cannot be considered a community that is dependent upon the affected fisheries, despite the fact that if Seattle engagement were to end, a number of the affected fisheries would be a fraction of their current size. While individual operations and sectors based in Seattle may experience adverse impacts under this alternative, community-level impacts are not forecast for the city.

C.3.9.3.2.6 Small Boat Fleet Impacts from Near-Community Closures

As noted earlier, Alternative 6 features large closure areas close to a number of communities. This could result in profound localized impacts for a number of communities with small-vessel-based fleets through the closure of a significant portion of (or even all) waters within the range of small vessels. In addition to having impacts on communities already engaged in, or dependent on, a range of fisheries, this alternative would also make it more difficult, if not impossible, for a limited number of other communities to develop small-vessel-based commercial fisheries in the future due to permanent closures of nearby waters. While it is impossible to quantify these future effects that may or may not occur, closure areas near communities would create different potential futures with and without Alternative 6.

The actual range of community small-vessel fleets varies considerably based on a number of factors, including the size of vessels in the fleet and nearby ocean conditions. All things being equal, larger vessels have greater range, as do fleets from communities with relatively protected nearby waters.

As a simplifying assumption, the first step in identifying those communities most likely to experience small-vessel-related impacts (or potential future impacts) due to nearby closures was to consider coastal communities within 20 miles of a closure area. To identify these communities, a 20-mile buffer was drawn around areas that would be closed under Alternative 6 (Figure 3.9-1). A second buffer was drawn inland 5 miles from those areas of the coast that were touched by the first buffer. Communities within the intersection of these two buffers (that is, within 20 miles of an EFH closure area and within 5 miles of the coast) were identified as coastal communities with nearby Alternative 6 closure areas within the assumed range of a local small-boat fleet. While actual small-boat fleet ranges vary, and communities more than 5 miles inland could also be affected (meaning that a greater or lesser number of communities could be affected), these simplifications were used to derive an initial list of affected communities.

Using this methodology, 26 communities were identified, including 25 contemporary civilian communities and the Coast Guard/military station at the historic community of Attu.

To establish a potential measure of gross, spatial-based, effects, maps were compiled by drawing a 20-mile radius around the identified communities to show the assumed range of locally based small vessels. The maximum available ocean area within this radius was calculated (area within the radius, minus existing Steller sea lion closures). Under actual conditions, some area less than the maximum would actually be available for fishing, due to factors such as bathymetric constraints. Within the total existing conditions maximum available ocean area, the area that would be closed under Alternative 6 was calculated, as well as the area that would remain open, along with the area that would be closed as a percentage of existing conditions maximum available area. As shown in Table 3.9-17, identified communities ranged from having well less than 1 percent to more than 98 percent of nearby waters closed under this alternative. Of the communities identified as having at-risk catcher vessel revenues under Alternative 6, St. George would have by far the largest percentage (97.1 percent) of nearby waters closed under this alternative. Five communities (Nelson Lagoon, St. George, Port Heiden, Nikolski, and Akhiok) would have more than 70 percent of the maximum available nearby waters closed, an additional four communities (Toksook Bay, Larsen Bay, Tununak, and Chenega Bay) would have between one-third and one-half of otherwise available nearby waters closed, and a further nine communities would have between 10 and 25 percent of nearby waters closed under this alternative.

In terms of actual consequences that could result from these closures, the existing conditions maximum available ocean area varies greatly between communities due to the geography of nearby land forms, with the result that percentage closed areas might not be the most important variable in determining overall spatial-related impacts. For example, a community located on a small island would have a great deal more ocean area available to it than a community along a coast with a concave geometry. As shown in the table, areas available in nearby waters range from more than 1,222 to 353 m^2. A 50 percent closure near a community with a large available area nearby, all things being equal, might leave enough waters within range of the community to support a local fleet, but the same might not be true for communities with a relatively small area accessible under existing conditions. Again, real world constraints would determine the utility of those waters for productive fishing. Table 3.9-18 provides this same type of closure information, but with communities grouped by region. As shown, communities in many different areas of Alaska would potentially be affected by nearby waters closures. Figure 3.9-1 graphically displays open and closed areas within 20 miles of identified communities. This figure also displays overall Alternative 6 closure areas in the same regions.

Of the potential existing conditions small-vessel fisheries affected by nearby waters closures, halibut is clearly the most important, and only a subset of the communities identified as potentially affected actively participate in the fishery. A multi-step method was used to identify communities with currently active small-vessel halibut fisheries, as well as the potential scale of effects. The first step was to search Alaska Commercial Fisheries Entry Commission (CFEC) permit records by community to define those communities with current (in 2001) resident halibut permit holders in the vessels less than 60 feet in length category. Unfortunately, this also includes fairly large vessels, but permit types are not broken down into smaller length increments. Communities that lack active resident permit holders were eliminated from the list of potentially affected communities. The 13 relevant communities with current halibut permit holders (less than 60-foot category) are Chignik Lagoon, False Pass, King Cove, Mekoryuk, Old Harbor, Pilot Point, Port Alexander, Port Lions, St. George, St. Paul, Toksook, Tununak, and Yakutat. Information on the number of permits held, permits fished, total pounds landed, and estimated gross earnings by community for 2001 is presented in Table 3.9-19. As shown, 210 halibut permits are held in these communities, and the number of permits held by residents of individual communities ranged from 1 to 43.

Estimating small-vessel harvest placed at risk under Alternative 6 is problematic. Such an analysis would be possible, in part, through extensive queries of AKFIN halibut harvest data on a vessel-by-vessel basis, but (even if successful) the fundamental difficulty in performing such queries is that much of the data are confidential and cannot be reported. In fact, CFEC harvest data are restricted due to confidentiality for several of the 13 relevant communities. If one were to add another set of criteria defining small vessels as those under 28 feet in length, for example, the confidentiality restrictions would make consistent evaluation of the potential effects on communities using vessel-by-vessel data impractical.

Three other sets of data with less problematic confidentiality restrictions provide information on the scale of potential effects on communities. First, the closed ocean surface area in specific statistical reporting areas within 20 nm of the affected communities was calculated, as was the percentage that each of these closures represents of the total surface area in the affected statistical area. This differs somewhat from the total nearby waters closed area data presented in earlier tables because it is broken down by statistical area. The list of affected statistical areas was extracted from the GIS mapping of the intersection of 20 nm ranges from communities with EFH Alternative 6 closure areas. The second set of data provided is halibut landings in ports from NMFS Restricted Access Management (RAM) program reports. Due to the halibut fishery being managed through an IFQ structure, these data are publicly available. They are, however, only available for that subset of the 13 relevant communities defined by RAM as ports (Chignik, King Cove, Old Harbor, Port Lions, St. George, St. Paul, and Yakutat). Finally, 2001 total halibut harvest data by statistical area from AKFIN are included. While these data are from statistical areas near the communities, however, the reported catch for these areas may be (and in some cases surely is) associated with vessels from more distant communities. These three types of data are summarized in Table 3.9-20 and discussed below.

The available data suggest that the small-vessel halibut fleet from several potentially affected communities would probably experience only slight effects from Alternative 6. For example, Old Harbor, Pilot Point, and Port Lions would all have nearby ocean areas closed under this alternative; however, no harvest was reported in the affected statistical areas in 2001. In the case of False Pass, two adjacent statistical areas within 20 nm of the community would be closed, in part, under Alternative 6. While approximately 40 percent of one of these statistical areas and nearly 20 percent of the other would be closed, only the statistical area with the 20 percent closure had reported harvest (about 14,000 pounds). Thus, small-vessel effects in False Pass appear slight and may be recovered in nearby open areas. A similar condition exists for King Cove where closure areas would range from less than 1 to more than 43 percent of the statistical areas within 20 nm of the community. King Cove is also a major port, with 69 vessel deliveries totaling 679,374 pounds in 2001. Less than 20,000 pounds (under 3 percent of the total) was, however, harvested in the affected statistical area. Thus, small-vessel effects in King Cove appear slight and might be recovered in nearby open areas.

Two statistical areas around Mekoryuk would be affected by EFH closures under Alternative 6. One of these would have just under 22 percent of its area closed, and the other would have nearly 60 percent of the area closed within 20 nm of the community. The total harvest in those statistical areas combined was, however, just over 6,000 pounds. Affected statistical areas around Tooksook Bay and Tunanak also accounted for just over 6,000 pounds of total harvest. Thus, based on 2001 data, small-vessel effects in the Mekoryuk, Toksook, and Tunanak area appear slight and might be recovered in adjacent open areas.

Closure areas around Yakutat would be limited to two statistical areas and relatively small percentages of each. Yakutat is a major halibut delivery port with more than a million pounds landed in 2001. However, just over 40,000 pounds was harvested from the two affected statistical areas. Thus, while some effects might accrue to the Yakutat small-vessel fleet component, they are likely to be slight.

In contrast to the communities that appear to have a very small localized harvest, several communities appear to have the potential for considerable small-vessel-related effects. In the Chignik area, three statistical areas would be affected by EFH Alternative 6 closures, with a range of 5 to almost 41 percent closed. The Port of Chignik received landings from 38 vessels in 2001, totaling 478,257 pounds. Harvest in the three affected statistical areas combined was almost 300,000 pounds, which is equivalent to a vast majority of the total landings in the port. Thus, it is possible that EFH Alternative 6 closures might have considerable impacts on small-vessel halibut fleet components in the Chignik area, but much of the affected catch would be taken by vessels from outside of the community. It could also mean that those outside vessels would choose to fish and land catch elsewhere due to the closures, which would have its own impacts on the community unrelated to the local small vessel fleet.

Port Alexander has four affected statistical areas within 20 nm, with less than 1 to nearly 55 percent of each statistical area closed within the 20 nm range. The total harvest for these statistical areas was just under 800,000 pounds with just over 700,000 pounds coming from the statistical area with a 55 percent closure. Thus, based on these 2001 data, it appears that considerable impacts could accrue to the Port Alexander small-vessel halibut fleet.

Similarly, St. Paul and St. George would have very large portions of nearby statistical areas closed by EFH Alternative 6. In fact, between approximately 43 and 93 percent of the three statistical areas around St. George would be closed. Given that the St. George harvests are spread among these statistical areas, considerable impacts on the St. George small-vessel halibut fleet would be likely under EFH Alternative 6. Similarly, the vast majority of harvest around St. Paul is caught in a statistical area that would have an 85 percent closure.

It is assumed that small-vessel subsistence activity would not be directly regulated or otherwise restricted by EFH closures under Alternative 6, but some indirect impacts to subsistence users might accrue through loss of joint production opportunities if vessels used for both commercial and subsistence purposes were affected (or if income derived from commercial fishing that otherwise would be used to facilitate subsistence production were unavailable). In 2003, NMFS began to issue subsistence halibut permits to residents of rural communities and to tribal members. As of June 18, 2003, 6,673 subsistence halibut registration certificates (SHARCs) were issued, and this count is continuously increasing. While it is impossible to estimate the joint production effects EFH Alternative 6 closures might have on subsistence users, Table 3.9-21 provides the count of SHARCs for each rural community identified as having EFH closures in nearby waters. As shown, 127 permits are held by residents of these communities, with individual communities ranging between 0 and 24 permits held locally.

C.3.10 Summary of Benefits and Costs Among Alternatives

Until Alternative 5C is approved by the Secretary (assuming that it is) and an alternative is selected and implemented, and the industry has an opportunity to adjust fishing patterns and behavior in accordance with the new regulations, it is unlikely that even the industry members themselves can fully anticipate the size and distribution of effects of the fishing impact minimization alternatives. However, the analyses presented above provide, wherever possible, some quantitative estimates of the benefits and costs of the measures under consideration by the Council. For example, it was possible to make a monetary estimate of the gross revenues placed at risk under each alternative. While gross measures are not suggested here to be equivalent to, nor necessarily even good proxies for, net effects, they can be used to gain insights into the expected nature and likely distribution of impacts that may be expected to emerge from implementation of each of the competing alternatives. Lacking the data necessary to derive empirical net results, and with the legal and administrative obligation to use the best available quantitative and qualitative information to draw informed conclusions about the potential net national effects of adopting one or another of the proposed actions, the foregoing analysis makes a good-faith effort to meet these requirements. The relative differences in costs and benefits between the individual alternatives, to the degree that they could be meaningfully distinguished, are provided in a summary table (Table 3.10-1) for the principal cost and benefit categories treated in greater detail above for each alternative. The distributional impacts, in terms of gross revenue at risk by geographic area, FMP fishery, gear type, and target species are also presented across the different alternatives in a summary table (Table 3.10-2).

C.4 CONSISTENCY WITH OTHER APPLICABLE LAWS

This section summarizes the consistency of the proposed action and supporting analyses with the Initial Regulatory Flexibility Act and EO 12898.

C.4.1 Initial Regulatory Flexibility Analysis (IRFA)

The Regulatory Flexibility Act (RFA), first enacted in 1980, was designed to place the burden on the government to review all regulations to ensure that, while accomplishing their intended purposes, they do not unduly inhibit the ability of small entities to compete. The RFA recognizes that the size of a business, unit of government, or nonprofit organization frequently has a bearing on its ability to comply with a federal regulation. Major goals of the RFA are 1) to increase agency awareness and understanding of the impact of their regulations on small business, 2) to require that agencies communicate and explain their findings to the public, and 3) to encourage agencies to use flexibility and to provide regulatory relief to small entities.

The RFA emphasizes predicting significant adverse impacts on small entities as a group distinct from other entities and on the consideration of alternatives that may minimize the impacts while still achieving the stated objective of the action. Except in the case when an agency can certify that there is no likelihood of a significant adverse impact on a substantial number of small entities, when an agency publishes a proposed rule, it must prepare and make available for public review an Initial Regulatory Flexibility Analysis (IRFA) that describes the impact of the proposed rule on small entities. When an agency publishes a final rule, it must prepare a Final Regulatory Flexibility Analysis (FRFA). Analysis requirements for the IRFA are described below in more detail. In the case of the issues and alternatives considered in this analysis (Amendments 55/55/8/5/5 to FMPs for BSAI groundfish, GOA groundfish, crab, scallops, and salmon), the Council will make recommendations for the preferred alternative[13], and, if approved by the Secretary, NMFS will develop proposed regulatory amendments to implement the Council's preferred alternative.

Many, but by no means all, of the directly regulated entities would be considered small entities under the RFA (Section 601(3)). To ensure a broad consideration of impacts and alternatives, an IRFA has been prepared pursuant to 5 USC 603, without first making the threshold determination of whether or not this proposed action would have a significant adverse economic impact on a substantial number of small

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[13] At its October meeting, the Council identified a preliminary preferred alternative to facilitate public review and comment. It will take action to identify a final preferred alternative, based on review, comment, and subsequent analysis as the EIS/RIR/IRFA undergoes edits and revisions.

entities. A definitive assessment of the impacts on small entities, however, is dependent on the specific alternative and options selected by the Council and, thus, cannot be conducted until after final action.

The IRFA must contain the following:

- A description of the reasons why action by the agency is being considered
- A succinct statement of the objectives of, and the legal basis for, the proposed rule
- A description of, and where feasible, an estimate of the number of small entities to which the proposed rule will apply (including a profile of the industry divided into industry segments, if appropriate)
- A description of the projected reporting, recordkeeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities that will be subject to the requirement and the type of professional skills necessary for preparation of the report or record
- An identification, to the extent practicable, of all relevant federal rules that may duplicate, overlap or conflict with the proposed rule
- A description of any significant alternatives to the proposed rule that accomplish the stated objectives of the Magnuson-Stevens Act and any other applicable statutes and that would minimize any significant economic impact of the proposed rule on small entities. Consistent with the stated objectives of applicable statutes, the analysis shall discuss significant alternatives, such as the following:

    1. The establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities
    2. The clarification, consolidation, or simplification of compliance and reporting requirements under the rule for such small entities
    3. The use of performance rather than design standards
    4. An exemption from coverage of the rule, or any part thereof, for such small entities

In determining the scope, or universe, of the entities to be considered in an IRFA, NMFS generally includes only those entities, both large and small, that are directly regulated by the proposed action. If the effects of the rule fall primarily on a distinct segment, or portion thereof, of the industry (e.g., user group, gear type, geographic area), that segment would be considered the universe for the purpose of this analysis. NMFS interprets the intent of the RFA to address negative economic impacts, not beneficial impacts, and, thus, such a focus exists in analyses that are designed to address RFA compliance.

C.4.1.1 Definition of a Small Entity

The RFA recognizes and defines three kinds of small entities: 1) small businesses, 2) small non-profit organizations, and 3) small government jurisdictions.

Small businesses. Section 601(3) of the RFA defines a small business as having the same meaning as a small business concern, which is defined under Section 3 of the Small Business Act (SBA). Small business or small business concern includes any firm that is independently owned and operated and not dominant in its field of operation. The SBA has further defined a small business concern as one "organized for profit, with a place of business located in the United States, and which operates primarily within the United States or which makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor. A small business concern may be in the legal form of an individual proprietorship, partnership, limited liability company, corporation, joint venture, association, trust or cooperative, except that where the form is a joint venture there can be no more than 49 percent participation by foreign business entities in the joint venture."

The SBA has established size criteria for all major industry sectors in the United States, including fish harvesting and fish processing businesses. A business involved in fish harvesting is a small business if it is independently owned and operated and not dominant in its field of operation (including its affiliates) and if it has combined annual receipts not in excess of $3.5 million for all its affiliated operations worldwide. A seafood processor is a small business if it is independently owned and operated, not dominant in its field of operation, and employs 500 or fewer persons on a full-time, part-time, temporary, or other basis, at all its affiliated operations worldwide. A business involved in both the harvesting and processing of seafood products is a small business if it meets the $3.5 million criterion for fish harvesting operations. Finally, a wholesale business servicing the fishing industry is a small businesses if it employs 100 or fewer persons on a full-time, part-time, temporary, or other basis, at all its affiliated operations worldwide.

Small organizations. The RFA defines small organizations as any not-for-profit enterprise that is independently owned and operated and is not dominant in its field.

Small governmental jurisdictions. The RFA defines small governmental jurisdictions as governments of cities, counties, towns, townships, villages, school districts, or special districts with populations of fewer than 50,000.

C.4.1.2 Reason for Considering the Proposed Action

The purpose of this action is to determine whether and how to amend the Council FMPs pursuant to section 307(a) of the Magnuson-Stevens Act. More specifically, the three-part purpose of this action is to analyze for each fishery a range of potential alternatives to 1) identify and describe EFH for managed species, 2) adopt an approach for identifying HAPC, and 3) identify measures to minimize to the extent practicable the adverse effects of fishing on EFH (see also EIS Chapter 1, Purpose and Need for Action).

C.4.1.3 Objectives of, and Legal Basis for, the Proposed Action

The description and identification of EFH and HAPCs would not in and of itself have any direct environmental and/or socioeconomic impacts. The requirement to minimize the adverse effects of fishing on EFH would, however, likely result in environmental and/or socioeconomic impacts. Therefore, the effects of these alternatives on small entities must be evaluated. The objective of the action is to minimize, to the extent practicable, adverse effects on EFH caused by fishing, per the EFH requirements of the Magnuson- Stevens Act section 303(a)(7) and the regulatory guidelines developed by NMFS in accordance with section 305(b)(1)(A).

C.4.1.4 Number and Description of Affected Small Entities

The entities that would be directly regulated by this action are those that operate vessels fishing for groundfish, halibut, crab, salmon, and scallops in federal EEZ waters off of Alaska. Although harvest and gross revenue information is confidential for individual vessels, T the numbers of groundfish fishing vessels that are believed to qualify as small entities (based on the less than $3.5 million in annual gross revenues) were estimated at 1,178 in 2000, and 1,047 in 2001 (Hiatt et al. 2002). For purposes of the IRFA, nearly all of the vessels targeting halibut, crab, and salmon may be assumed to be small entities, when considered individually. In 2001, there were 1,994 vessels (1,985 CVs and 9 CPs) Pacific halibut operators, 11,160 salmon operators, and 1,163 crab operators active in Alaska fisheries that are believed to meet the small entity gross revenue criterion. These totals beg the question of affiliation, which (if data were available to objectively evaluate business linkages and relationships) would likely reduce this number.

Based on the gross ex-vessel value from the entire scallop fishery and the numbers of vessels participating, it appears that the nine vessels involved in this fishery could, if taken individually, be considered small entities (ADF&G 2003). It is probable, however, that this overstates the number of small entities in the scallop fishery, because six of the nine vessel operators coordinate fishing effort, through means of membership in a cooperative, which under SBA rules, may make their collective earning the appropriate threshold criterion. In that case, the cooperative would not qualify as a small entity (nor would any one of its member operations) by definition (see Section C.2.1.4).

Many vessels, throughout the GOA and BSAI, participate in both federal and state-managed fisheries and gross revenue from all fisheries combined may exceed the $3.5 million threshold. The vessels that would be considered large entities were either affiliated (e.g., ownership of multiple vessels, fishing cooperative members) or were catcher-processors with total revenues exceeding $3.5 million annually from all their commercial activities combined. However, little is known about the ownership structure of the vessels in the fleet, so it is possible that this IRFA overestimates the number of small entities owing to ownership, contractual arrangement, or other formal affiliation mechanisms.

C.4.1.5 Recordkeeping and Reporting Requirements

These alternatives all involve complicated closures of fishing areas. As noted earlier, many of the measures to protect EFH from fishing impacts depend heavily on the strict regulation of the location of fishing activities targeting many of the target fisheries in Alaska. Traditional methods of monitoring compliance with fishing regulations do not fully meet NMFS' need to monitor fishing activities, especially as envisioned under the fishing impact minimization alternatives. An electronic VMS is generally acknowledged to be an essential component of monitoring and management for complicated geographic area fishing closures. Different alternatives require extension of the VMS requirement, and associated reporting requirements, to different classes of fishing vessels. VMS equipment costs about $2,000 per vessel, installation costs about $160, and transmission costs average $5 a day, although many vessels in the affected fisheries already have and use VMS.

C.4.1.6 Relevant Federal Rules that May Duplicate, Overlap, or Conflict with Proposed Action

This analysis did not uncover any existing federal rules that duplicate, overlap, or conflict with any of the actions proposed in the alternatives.

C.4.1.7 Description of Significant Alternatives

The alternatives eliminated from consideration for the minimization of fishing impacts on EFH are described in Section 2.4.3 of the EIS. The alternatives accepted by the Council for consideration in the EIS are described in detail in Section 2.3.3 of the EIS and are mentioned briefly in Section 1.4.

- Alternative 1 is the No Action (Status Quo) alternative, under which no additional measures would be taken at this time to minimize the effects of fishing on EFH.
- Alternative 2 would amend the GOA Groundfish FMP to prohibit the use of bottom trawls for targeting slope rockfish in 11 designated areas of the GOA upper slope (200 to 1,000 m), but allow

vessels endorsed for trawl gear, to fish for rockfish in these areas with fixed gear or pelagic trawl gear.

- Alternative 3 would amend the GOA Groundfish FMP to prohibit the use of bottom trawl gear for targeting GOA slope rockfish species anywhere on the upper slope area (200 to 1,000 m), but allow vessels endorsed for trawl gear, to fish for slope rockfish with fixed gear or pelagic trawl gear.
- Alternative 4 would amend the GOA and the BSAI Groundfish FMPs to prohibit the use of bottom trawl gear in designated areas of the EBS, AI, and GOA. In the EBS only, bottom trawl gear used in the remaining open areas would be required to have disks/bobbins on trawl sweeps and footropes.
- Alternative 5A would amend the GOA and BSAI Groundfish FMPs to prohibit the use of bottom trawl gear in expanded designated areas of the EBS, AI, and GOA. In the EBS only, bottom trawl gear used in the remaining open areas would be required to have disks/bobbins on trawl sweeps and footropes.
- Alternative 5B would amend the GOA and BSAI Groundfish FMPs to prohibit the use of bottom trawl gear in designated areas of the EBS and GOA. In the AI, there would be a combination of measures designed to reduce the effects of trawling on corals and sponges. Each AI combination is reflected in one of three "optional" configurations of the 5B alternative. Additionally, for the EBS only, bottom trawl gear used in the remaining areas open to trawling would be required to have disks/bobbins on trawl sweeps and footropes.
- Alternative 5C (Preferred Alternative) would amend the FMPs to prohibit the use of bottom trawl gear in designated areas of the AI and GOA, so as to reduce the effects of fishing on corals, sponges, and hard bottom habitats. In the AI, there would be a combination of measures designed to reduce the effects of all bottom contact gear on corals and sponges. The management measures established by this alternative would be in addition to existing habitat protection measures (e.g., area closures, gear restrictions, and limitations on fishing effort). Additionally, all bottom contact fishing would be prohibited in six coral garden sites, located off Semisopochnoi Island, Bobrof Island, Cape Moffet, Great Siskin Island, Ulak Island, and Adak Canyon, in the AI. To ensure adequate enforcement, NMFS would add to the Council's recommended preferred alternative, a requirement for a vessel monitoring system (VMS) on all commercial fishing vessels in the AI as well as a provision that would require VMS on all commercial fishing vessels participating in (or carrying gear onboard that is utilized for) bottom contact fisheries, during any period when said fisheries are open in the GOA. Alternative 5C would not include new management measures for the EBS, because available information indicates that the EBS does not support the kind of hard bottom habitats that sustain extensive corals and other particularly sensitive benthic invertebrates. However, under this alternative, the Council would initiate a subsequent analysis, specifically designed to consider potential future habitat conservation measures for the EBS (including the management options identified in this EIS, as well as other options).
- Alternative 6 would amend the GOA and BSAI Groundfish FMPs, the Pacific Salmon FMP, the Alaska Scallop FMP, the BSAI Crab FMP, and Pacific Halibut Act regulations to prohibit the use of all bottom tending gear (dredges, bottom trawls, pelagic trawls that contact the bottom, longlines, dinglebars, and pots) within approximately 20 percent of the fishable waters (i.e., 20 percent of the waters shallower than 1,000 m) in the BSAI and GOA.

For a more detailed treatment of each of these alternatives, options, and suboptions, refer to Section 4.3 of the EIS. The comprehensive economic and socioeconomic analyses of all of the alternatives and options under consideration are provided in Section 3 of this appendix.

By a simple enumeration, most firms operating in the fisheries directly regulated by the proposed action are assumed to be small entities, as this term is defined under RFA, given their expected annual gross revenues of less than $3.5 million. As noted above, an IRFA should contain "a description of any significant alternatives to the proposed rule that accomplish the stated objectives of the Magnuson-Stevens Act and any other applicable statutes and that would minimize any significant economic impact of the proposed rule on small entities" (RFA [Section 601]). The RIR for this action analyzes the potential economic and operational impacts of ten alternatives (i.e., Alternatives 1 through 4; 5A; 5B, Option 1; 5B, Option 2; 5B, Option 3; 5C; and 6). At present, several of the fishing impact minimization alternatives under consideration contain explicit provisions designed to mitigate the potential adverse effects of the respective alternative on small entities.

For example, Alternatives 2 and 3 explicitly prohibit GOA bottom trawling for slope rockfish, a fishery dominated by "small" fishing businesses. Each does, however, simultaneously provide an opportunity for displaced bottom trawl vessels (virtually all of which are small) to change gear and continue to fish these EFH areas. This is a substantial (potential) accommodation, because, if adopted, this provision would effectively waive the conflicting LLP gear endorsement requirement for these operators. Neither of these alternatives has been chosen as "preferred" by the Council, principally for the following reasons. First, the areas of the GOA slope EFH designated for protection under Alternative 2 or Alternative 3, while of indisputable importance, do not adequately encompass the full range of EFH the Council believed needs protection, through the EFH Fishing Impact Minimization Action, under consideration. Furthermore, the very provisions of Alternative 2 or Alternative 3 designed to eased the burden of this action on small entities using NPT to target slope rockfish, by, in effect, waiving the LLP gear endorsement requirement, thus allowing use of fixed or pelagic gear, was determined to impose potential hardships on other small entities (e.g., those currently holding LLP endorsements for fixed gear bottom fishing in the GOA). These adverse impacts include, as the RIR demonstrates, additional competition for the existing fixed gear sector, increased fishing effort for slope rockfish in areas which can effectively be fished with fixed gear (i.e., crowding externalities), and a reduction in the capitalized market value of the existing fleet member's fixed gear LLP endorsement. As the analysis suggests, result of adopting either one of these alternatives may well have resulted in little more than a transference of the economic and operational burden from one "directly regulated" group of small entities (i.e., GOA NPT slope rockfish operators), to another "not directly regulated" group of small entities (i.e., GOA fixed gear slope rockfish operators). This is clearly an undesirable outcome, and a manifest example of the law of unintended consequences.

The other significant alternative under consideration that contains provisions which, if adopted, would reduce the potential burden on small entities is Alternative 5C, the Council's preferred alternative. Alternative 5C was specifically crafted, after the initial environmental and economic analyses were completed, reviewed by the Council, SSC, and AP in open public meetings, and following the formal public comment period. Based upon all of these sources of information, Alternative 5C was designed to employ the best available information, objectively weigh that information within the context of the status quo EFH and fisheries contexts, and adopt provisions which have the potential to meet the Council's EFH fishing impact minimization objectives, without unduly and unnecessarily imposing economic, operational, or regulatory burdens on the fishing industry. To this end, Alternative 5C intentionally omits any EFH fishing impact minimization actions for the EBS management area at this time. The Council determined that current EFH knowledge and management experience in the EBS were insufficient to justify immediate action. This was particularly so, given the projected size of the adverse economic, social, and operational impacts, revealed in the supporting RIR and EIS (above). By delaying implementation of any EFH fishing impact minimization actions in the EBS, pending additional study, Alternative 5C effectively relieves the potentially substantial adverse effects on small entities(as well as large) operating in the directly regulated EBS fisheries that would have accompanied actions contained among the other alternatives under consideration.

To ensure adequate enforcement, NMFS added to the Council's preferred alternative a requirement for a vessel monitoring system on all fishing vessels with bottom contact gear in the GOA. The Council's preferred alternative would have a lesser potential to impose adverse economic impacts on directly regulated small entities, but would not be as effective due to the difficulty of detecting violations based solely on patrol vessels and overflights.

The attributable costs associated with the proposed VMS requirements in the GOA and AI are treated at length in Section C.3.8.4. A more focused assessment, specifically characterizing the potential impacts on small entities, which might be attributable to NMFS' modified Alternative 5C, appears in the following sections. The objective of this aspect of the proposed action is to provide for effective enforcement of EFH and HAPC areas through the use of VMS equipment by vessels that carry an FFP or FCVP and fish in any fishery in the AI, or those that carry an FFP or FCVP and have bottom contact commercial fishing gear onboard while operating in the GOA.

C.4.1.7.1 Small Entities Directly Regulated by VMS Provision

The vessels that are directly regulated by the proposed VMS requirement are (1) those that carry an FFP or FCVP and fish in any fishery in the AI, or (2) those that carry an FFP or FCVP and have commercial bottom contact fishing gear onboard while operating in the GOA.

Fishing operations were considered small, according to the SBA criteria, if they had estimated 2003 gross revenues of $3.5 million or less from all their commercial activities and they were not affiliated with an AFA inshore catcher vessel cooperative.

An estimated 124 vessels fishing in federal waters in the AI in 2003 met these criteria; 53 of these had VMS, and 71 did not. An estimated 865 vessels fishing in the GOA in 2003 met these criteria; 230 of these had VMS, and 635 did not.

C.4.1.7.1.1 Attributable Costs of the VMS Proposal in AI

Average installation costs were reportedly approximately $1,550 for a first time user. The average annual charges for data transmission, etc., were approximately $450 for vessels just acquiring VMS (estimated 6 months of use in AI), and $994 for vessels which already had VMS (estimated 6 months of use in AI). The daily operating costs for the older VMS, implemented to support the SSL action are substantially higher than the new service costs. Average annual gross revenues for operations in the AI fisheries in question were $950,000, and the median was $887,000.

The total fleet-wide cost of purchase, installation, and activation of new VMS units was estimated to be $110,000. The total fleet-wide annual operational costs were estimated to be $32,000 for operations acquiring VMS for the first time and $53,000 for operations that already had it. The total fleet-wide annual operational costs were $85,000. The total fleet-wide gross revenues from all sources were $117,756,000.

VMS units require repair and maintenance during a year. The average repair costs for a vessel that has to acquire VMS were estimated to be $47 for vessels over 32 feet (an assumed 3 percent failure rate) and $93 for smaller vessels (an assumed 6 percent failure rate). The average cost for all vessels under this alternative was estimated to be $28. The total fleet costs were about $3,500.

Two vessels less than or equal to 32 feet were reported to have fished in federal waters in the AI in 2003. A third vessel with no vessel length information also fished there. The landings of this vessel were relatively small, and it is treated here as a vessel less than or equal to 32 feet. All three of these vessels were small entities, according to SBA criteria.

Average VMS installation costs for these three vessels were estimated at $1,550. Average annual transmission costs would be on the order of $428. Confidentiality rules prevent reporting the average gross revenues of these operations. Average gross revenues were considerably below the AI average. Aggregate installation costs for these three operations total $5,000. Total annual transmission costs would approach $1,000. With annual repair costs averaging about $93, total repair costs for these vessels would be about $300.

C.4.1.7.1.2 Attributable Costs of the VMS Proposal in GOA

The preferred alternative would affect 865 small entities (based upon SBA criteria). Six hundred and thirty-five of these would have to acquire VMS, while 230 already had it in 2003. Average installation costs were $1,550; average annual charges were $423 for vessels just acquiring VMS (estimated 5 months of use in GOA) and $671 for vessels that already had VMS (estimated 4 months of use in GOA). As explained in Section 3.8.4, the daily transmission cost for the old VMS system is substantially higher than the cost for the new system). Average gross revenues for directly regulated GOA operations were $349,000, and the median was $175,000.

The aggregate fleet-wide cost of purchase, installation, and activation of new VMS units was estimated to be $984,000. The total fleet-wide annual operational costs were estimated to be $269,000 for operations acquiring VMS for the first time and $154,000 for operations that already had VMS. The total fleet-wide annual operational costs were $423,000.

VMS units will require repair and maintenance during a year. The average repair costs for a vessel that has to acquire VMS were estimated to be $47 for vessels over 32 feet and $93 for smaller vessels (owing to assumed differential failure rates). The average cost for all vessels under this alternative was estimated to be $37. The total fleet costs were about $34,000.

As described in the discussion of VMS alternatives, in Section 3.8.4, three options were proposed and examined containing VMS program exemptions for different length categories of smaller vessels. The SBA small entity impacts of these three options are examined in Table 4.1-1.

Four vessels fished for weathervane scallops with dredge gear in 2003. All four were small entities under SBA criteria. Two did not have VMS gear and did not fish one of the other bottom contact gears for which VMS would be required. Under the VMS rule, even if dredge gear was exempted, vessels operating dredge gear would still be subject to the VMS requirement if they were carrying any other bottom contact gear onboard. The average cost for buying, installing, and activating the units was $1,550. The average annual transmission cost for the two vessels was $578. The average gross revenues for the two vessels cannot be released, due to confidentiality restrictions.

Total purchase, installation, and activation costs for these two vessels would have been $3,200. Total transmission costs would have been about $1,200. Both vessels were greater than 32 feet long, so estimated total repair costs ($47 per vessel) were under $100. Exempting these four vessels would not impact the fleet-wide total VMS program costs attributable to the proposed EFH and HAPC actions significantly. It would, however, somewhat reduce the potential adverse economic effects of the proposed action on small entities at little or no cost in the form of lost enforcement data.

Twelve vessels fished with dinglebar gear in 2003. All of these were small entities under SBA criteria. Only four of these did not use one of the other bottom contact gears at some time during the year. An exemption for dinglebar gear would only have impacted four vessels (although even vessels operating dinglebar gear would still be required to meet the requirement if they were carrying any other designated bottom contact gear onboard). None of these vessels carried VMS. All of them were small entities under SBA criteria. The average cost for buying, installing, and activating the units was $1,550. The average annual transmission cost for the four vessels was roughly $500. One of the four vessels was 32 feet; the other three were larger. Estimated repair costs (based on assumed failure rates) were about $200. The average gross revenues for the four vessels were $43,000.

The aggregate purchase, installation, and activation costs for these four vessels would have been $6,000. Total transmission costs would have been $2,000. Exempting these 12 vessels would not significantly impact the fleet-wide total VMS program costs attributable to the proposed EFH and HAPC actions. It would, however, diminish the potential adverse economic effects of the proposed action on small entities, at little or no cost in the form of lost enforcement data.

The analysis of VMS requirements is based on the assumption that fishing operators that fish only in state waters would surrender their federal fisheries permits to avoid a VMS requirement. Some operators may choose not to do this. To take a more expansive view of the potential application of this rule, cost estimates have been prepared under the assumption that 558 small entities fishing for halibut in state waters in 2003, but not in federal waters, would also have carried VMS equipment and made transmissions. Under these circumstances, 1,193 small entities would have to acquire VMS. Average acquisition costs would be $1,550, average transmission costs would be$400, and average repair costs would be $60. Average gross revenue for these operations would be $161,000. The regulation would cover 236 six small entities that currently carry VMS. They would incur additional transmission costs averaging about $700 per vessel. Average gross revenue for these entities was about $563,000.

C.4.1.7.2 Recordkeeping and Reporting Requirements of VMS Proposal

This action would add new reporting requirements for (1) vessels that carry an FFP or FCVP and fish in any fishery in the AI, or (2) vessels that carry an FFP or FCVP and have commercial bottom contact fishing gear onboard while operating in the GOA. These fishing operations would have to carry VMS units and report their locations every half-hour while they were in fisheries subject to the requirement. Moreover, they would have to notify NMFS Enforcement that their VMS unit was active, once it was installed, and before it was used for fishing activity. They would have to notify NMFS Enforcement if a breakdown occurred in the unit.

C.4.1.7.3 Assessing the VMS Alternative Options

An IRFA is required to have “a description of any significant alternatives to the proposed rule that accomplish the stated objectives of the proposed action, consistent with applicable statutes, and that would minimize any significant economic impact of the proposed rule on small entities” (RFA [Section 601]).

The objectives of this action are to provide for effective enforcement of EFH and HAPC areas through the use of VMS equipment by vessels fishing in federally managed fisheries in the AI and vessels fishing with bottom-contact gear in federally managed fisheries in the GOA. For this reason, due to the exemptions based on vessel length were not adopted as part of the preferred alternative due to the small number of operations that might be exempted and the nearshore proximity (accessibility) of the AI and GOA coral HAPC sites. Especially in the case of the GOA, these vulnerable areas are close enough to be readily accessible to small vessels from numerous southeast Alaska ports.

Dinglebar vessels were not exempted because of the small number of entities that would be affected and because ling cod fishing areas, exploited by these vessels, occur in portions of GOA Coral HAPC. Similarly, a very small number of entities would have been included in a dredge exemption. Moreover, while this gear is not presently expected to be fished in areas protected by EFH and HAPC measures, dredge gear would have an unusually adverse impact on these bottom habitats if it was to be fished there. For these reasons, the alternatives incorporating special exemptions were not expected to accomplish the primary objective of EFH fishing impact minimization action.

C.4.2 Executive Order 12898

Executive Order 12898 (Environmental Justice, 59 Fed. Reg. 7629) focuses on environmental justice, relative to minority and low-income populations. EPA defines environmental justice as the “fair treatment for people of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies.” This EO was spurred by the growing need to address the impacts of environmental pollution on particular segments of our society. EPA responded by developing an environmental justice strategy that focuses the agency’s efforts to address these concerns. This strategy is also used by other federal agencies. To determine whether environmental justice concerns exist, the demographics of the affected area should be examined to decide whether minority populations and low-income populations are present. If they are, the agencies must determine whether implementation of the alternatives might cause disproportionately high and adverse human health or environmental effects on these populations. Environmental justice concerns typically embody pollution and other environmental health issues, but EPA has stated that addressing environmental justice concerns is consistent with NEPA. Thus, all federal agencies are required to identify and address these issues. NOAA environmental review procedures[14] state that, unlike NEPA, the trigger for analysis under EO 12898 is not limited to actions that are major or significant. Hence, federal agencies are mandated to identify and address, as appropriate, “disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.”

Detailed existing conditions demographic information relevant to environmental justice analysis for many of the affected communities is available elsewhere (Downs 2003), and the same source also provides an overview of environmental justice issues of concern for several of the relevant Alaska commercial fisheries. That information is not repeated here, but several areas of potential environmental justice concerns are summarized in this section. These are impacts to Alaska Native communities, impacts to minority populations specifically associated with the affected fishery sectors, CDQ program impacts, and subsistence impacts.

The two communities identified as potentially experiencing significant impacts under Alternative 5A, and each of the options under Alternative 5B, King Cove and Sand Point, may be considered Alaska Native communities. According to 2000 census data, both King Cove and Sand Point have Alaska Native pluralities within their overall populations (47 and 42 percent, respectively). If persons living in group quarters (most of whom are relatively short-term processing workers) are deducted from the

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[14] NOAA *Environmental Review Procedures for Implementing the National Environmental Policy Act* (Issued 06/03/99)

population, however, both of these communities have Alaska Native majority populations; in King Cove, 75 percent of the total population is Alaska Native, and 66 percent in Sand Point is Alaska Native. To the extent that high and adverse effects are felt at the community level under either of these alternatives, these would trigger environmental justice concerns.

Among the communities identified as potentially experiencing significant impacts under Alternative 6, a number may be considered Alaska Native communities in terms of their contemporary populations. In addition to King Cove and Sand Point in the Aleutians East Borough, St. George and St. Paul in the Pribilof Islands are likely to experience significant adverse effects related to disruption of ongoing commercial fishing activities. Both St. George and St. Paul have strong Alaska Native majority populations; in St. George, 92 percent of the total population is Alaska Native, and in St. Paul, 86 percent is Alaska Native. To the extent that these communities would experience disproportionately high and adverse impacts under Alternative 6, there would be environmental justice concerns. Impacts to the Pribilof communities are unlikely to be high and adverse under any of the other alternatives, including the preferred alternative.

Kodiak, which would be affected by adverse impacts to a number of different sectors under Alternative 6, has a contemporary population that is 10 percent Alaska Native. Other communities noted as potentially experiencing a higher level of effects than other communities are also largely non-Native (Homer's population is 5 percent Alaska Native, Petersburg's is 7 percent, and Sitka's is 19 percent). There is no indication that impacts experienced in these communities would disproportionately accrue to Alaska Native residents under any of the alternatives, including the preferred alternative.

Area closures under Alternative 6 may also result in disproportionate high and adverse impacts to Alaska Native communities through exclusion or preclusion of local small vessel fleets from significant portions of potential fishing areas near the communities. Of the 17 civilian communities listed in Table 3.9-17 as having 10 percent or more of the potential fishing area within 20 miles of the community closed, all but 2 (Port Alexander and Cold Bay) have Alaska Native majority populations. All 10 communities having 23 percent or more of the potential fishing area within 20 miles of the community closed under Alternative 6 are Alaska Native communities. These closures would result in environmental justice concerns.

As detailed in a number of different sources (including Downs 2003), significant pockets of minority, but non-Alaska Native, populations are employed in the Alaska fishing industry and would be vulnerable to disproportionate impacts, if management actions were to result in significant loss of employment. The most obvious of these are the workforces at the major seafood processing plants in Alaska coastal communities. For example, according to industry data supplied on 2000 workforce demographics for five of the seven major groundfish shoreside plants in the Alaska Peninsula/Aleutian Islands region, a total combined reported processing (and administrative) workforce of 2,364 persons was classified as 22.5 percent white or non-minority and 77.5 percent minority. Reporting facilities ranged from having a three-quarters minority workforce to a more than 90 percent minority workforce. The group classified as Asian/Pacific Islander was the largest minority group in two-thirds of the plants in any region reporting detailed data, and the group classified as Hispanic was the largest minority group in the remaining third. Impacts to processor employment are unclear under Alternative 6, but any adverse impacts that did occur would accrue to minority populations. As detailed elsewhere (Downs 2003), availability of alternate employment for displaced employees from this workforce is more limited than for the general population for a number of reasons. Impacts to processors are likely to be insignificant for all other alternatives, including the preferred alternative.

The CDQ region of western Alaska is a specific area of concern for environmental justice issues. The CDQ program was explicitly designed to foster fishery participation among, and to direct fishery benefits toward, minority populations (87 percent of total population in these villages consists of Alaska Native residents) and low-income populations in the economically underdeveloped communities in western Alaska (CDQ region existing conditions are discussed in greater detail elsewhere [Council website 2002]). To the extent that the CDQ program has achieved these objectives, negative impacts to the CDQ program and communities are essentially, by definition, environmental justice impacts. Impacts to the program, or at least some groups depending on specific investments in different industry sectors, may be significant under Alternative 6. Impacts to the program are likely to be insignificant under the other alternatives, including the preferred alternative.

Subsistence impacts are also potential environmental justice issues, given the disproportionate involvement of Alaska Natives in subsistence activities. While this has been an issue of concern in other recent fishery management action analyses (e.g., the Steller sea lion SEIS and the groundfish SEIS), this is unlikely to be a significant issue for direct EFH management actions, based on the assumption that subsistence activities themselves would not be at risk, nor would subsistence resources decline under any of the alternatives. Indirect impacts could be possible through loss of joint production opportunities (where vessels and gear are used for both commercial and subsistence purposes) and/or loss of income that otherwise would be directed toward subsistence pursuits. These types of impacts might be possible under Alternative 6 for the relevant identified Alaska Native communities, but would be unlikely under any of the other alternatives, including the preferred alternative.

Under Alternative 6, some beneficial impact to subsistence may occur through the reallocation of nearshore resources from commercial to subsistence activities, due to near-community closures that would exclude some commercial, but not subsistence, fishing activities. Available information does not allow a quantification of the degree to which commercial activities may be having an adverse impact on the subsistence take of relevant species in the proposed closure areas, under existing conditions. As a result, potential subsistence gains under this alternative, which may result from the elimination of any such adverse impact, cannot be quantified.

Field experience does suggest, however, that conflicts between existing commercial and subsistence resource use of relevant species are generally low level and infrequent, but that specific instances of localized adverse effects of relatively limited duration may occur from time to time. In general, eliminating some or all potential for these near-community conflicts would have a beneficial effect on subsistence resource use. Given the complex relationship between commercial and subsistence users in most affected communities (for example, the same individuals and vessels may be involved in both activities), however, it is unclear whether there would be a net positive benefit to the subsistence user attributable to the proposed action when all factors are considered.

Where potential resource use conflicts with commercial vessels from outside, rather than inside, the community are eliminated, it is more likely that localized subsistence impacts would be positive. In general, however, given the known structure of the relevant fisheries and the communities with proposed nearby closures, it is assumed that any such gains would be relatively slight.

C.5 LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). 2003. Weathervane Scallop Fishery in Alaska with a Focus on the Westward Region, 1967-2002. Alaska Dept. of Fish and Game, Regional Information Report No. 4K03-5, February 2002.

Bishop Museum. 2000. Search for Invertebrates Yields Ten New Sponge Species Found in Single Sinkhole at Pearl and Hermes Atoll. Bishop Museum New Release No. 17. October 10, 2000.

Council (North Pacific Fishery Management Council). 2005. Draft for NOAA Fisheries Review. Regulatory Impact Review and Initial Regulatory Flexibility Analysis for Seven Proposed Amendments to Regulations that Implement the Halibut and Sablefish IFQ Program. 605 West 4th Avenue, Suite 306. Anchorage, Alaska 99501-4424. March 5, 2005.

Downs, M. 2003. Socioeconomic and Environmental Justice Existing Conditions: Alaska Groundfish Fisheries and BSAI Crab Fisheries. Unpublished paper prepared for the National Marine Fisheries Service Alaska Region, Juneau, Alaska. May 2003.

Hiatt, T., R. Felthoven, and J. Terry. 2002. Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Gulf of Alaska and the Bering Sea/Aleutian Islands Area: Economic Status of the Groundfish Fisheries off Alaska, 2001. Economic and Social Sciences Research Program, Resources Ecology and Fisheries Management Division, Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle, WA. November 12, 2002.

Holt, G., and R. Antaya. Personal communications. NOAA, Office of Law Enforcement, Alaska Region, Juneau, AK 99802.

Irwin, C. Personal communications. Director of Sales, Skymate Inc., 14000 Willard Road, Suite #2, Chantilly, VA 20151.

June, J. Personal communications. Natural Resources Consultants, Inc., 1900 West Nickerson St., Suite 207, Seattle, WA 98119-1650.

Lincoln, J.M., and G.A. Conway. 1999. Preventing commercial fishing deaths in Alaska. *Occup. Environ. Med.,* 56:691-695.

Loomis, J.B., A. Gonzalez-Caban, and R. Gregory. 1996. A contingent valuation study of the value of reducing fire hazards to old-growth forests in the Pacific Northwest. Res. Paper PSW-RP-229-Web. Albany CA: Pacific Southwest Research Station, Forest Service, Department of Agriculture; 26p.

NMFS (National Marine Fisheries Service). 2005. Supporting Statement NMFS Alaska Region Vessel Monitoring System (VMS) Program. OMB Control No 0648-0445. (Paperwork Reduction Act analysis). February 2005.

NMFS. 2004. Vessel Monitoring Systems (VMS); Approved Mobile Transmitting Units for Use in Alaska Fisheries Requiring VMS. 69 *FR* 19985; April 15, 2004.

NMFS. 2002a. Fisheries of the United States 2001. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics and Economics Division, Silver Spring, Maryland, September 2002.

NMFS. 2002b. Sustaining and Rebuilding NMFS: The 2002 Report to Congress, The Status of U.S. Fisheries. National Marine Fisheries Service, Office of Sustainable Fisheries, Silver Spring, Maryland, April 2003.

NMFS. 2002c. Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions. NMFS Plan Team for the Groundfish Fisheries of the BSAI. November 2002.

NMFS. 2002d. Results of the 2000 NMFS Bering Sea Crab Survey: Executive Summary. 2000 Crab Stock Assessment and Fishery Evaluation, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252.

NMFS. 2001a. Alaska Groundfish Fisheries Draft Programmatic Supplemental Environmental Impact Statement. National Marine Fisheries Service Alaska Region, Juneau, Alaska.

NMFS. 2001b. Steller Sea Lion Protection Measures Final Supplemental Environmental Impact Statement, DOC, NOAA, National Marine Fisheries Service, Alaska Region, P.O. Box 21668, Juneau, Alaska 99802-1668. pp. Volumes I-III, p. 2,147.

NOAA Office of Law Enforcement (OLE), Alaska Region. 2005. Frequently Asked Questions About Vessel Monitoring Systems (VMS). Web page accessed at http://www.nmfs.noaa.gov/ole/ak_faqs.html on March 22, 2005.

Rosenkranz, G. Personal communication. Scallop Biometrician, Alaska Department of Fish and Game, 211 Mission Road, Kodiak, AK 99615.

South Central Radar & Communications and Radar Alaska. Personal communications with staff. 770 Fish Dock Road, Suite 1, Homer, AK 99603 and 218 Shlikof, Kodiak, AK 99615.

List of Preparers

Ben Muse, Ph.D., NOAA, NMFS, Sustainable Fisheries Division, Alaska Region, PO Box 21668, Juneau, Alaska 99802

Steve Lewis, NOAA, NMFS, Analytical Team, Alaska Region, POBox 21668, Juneau, Alaska 99802

Camille Ruse, Resource Data Inc. ,1205 E. International Suite 100, Anchorage, AK 99518

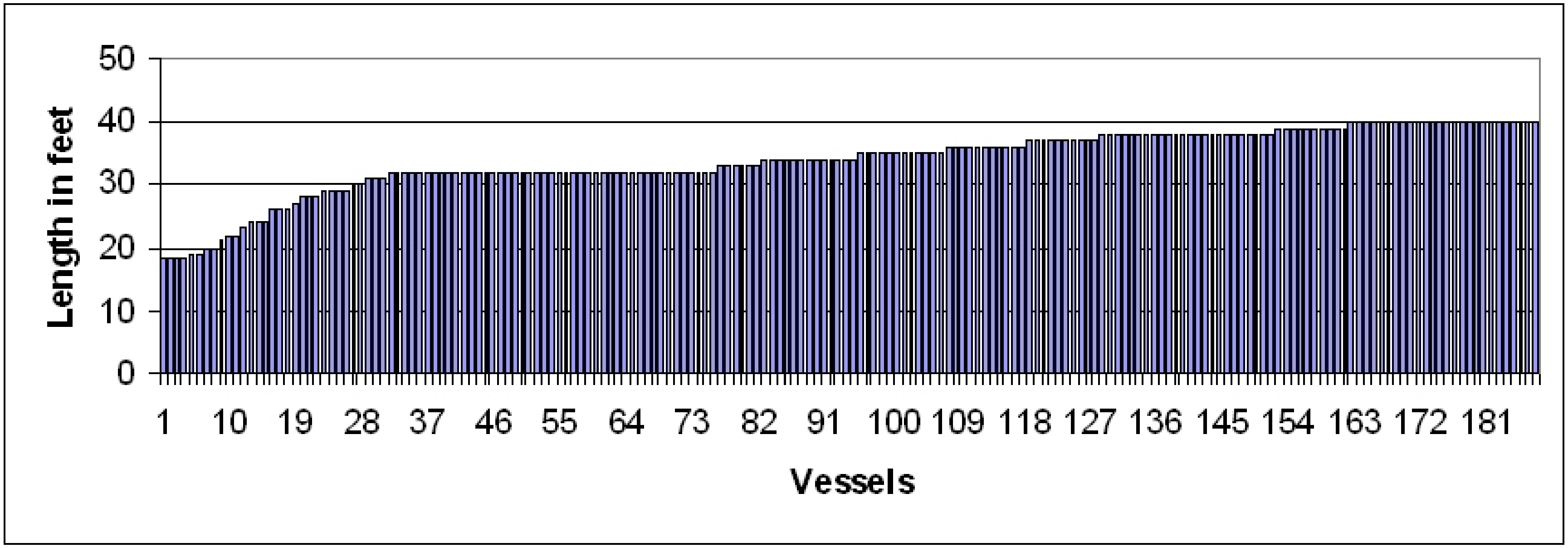
Persons consulted

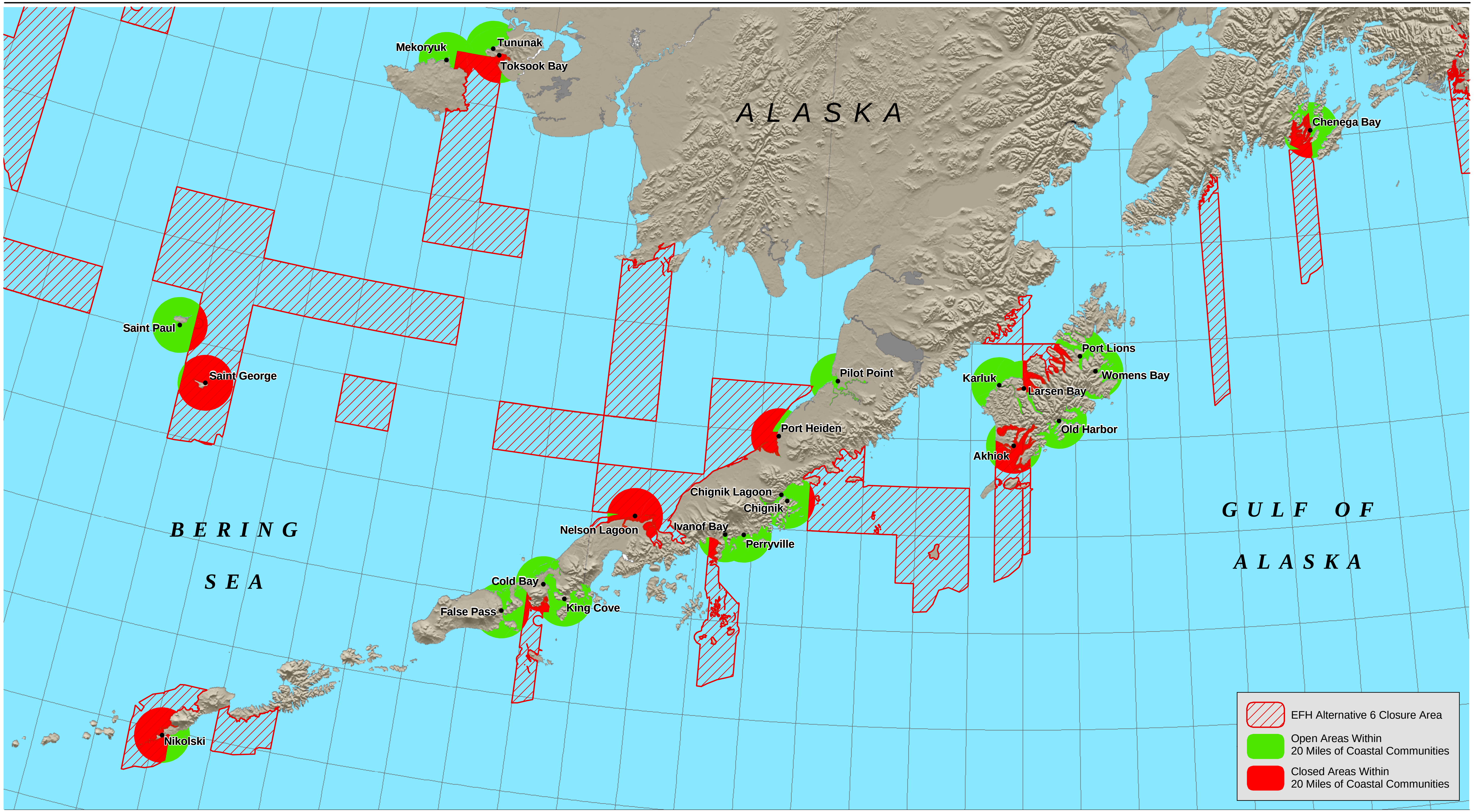
Melanie Brown, NOAA, NMFS, Sustainable Fisheries, Alaska Region, PO Box 21668, Juneau, Alaska 99802

Scott Miller, NOAA, NMFS, Analytical Team, Alaska Region, POBox 21668, Juneau, Alaska 99802

Lewis Queirolo, Ph.D., Alaska Regional Economist, NOAA, NMFS, Alaska Region, 440 Eagle Crest Rd., Camano, Island, WA 98282

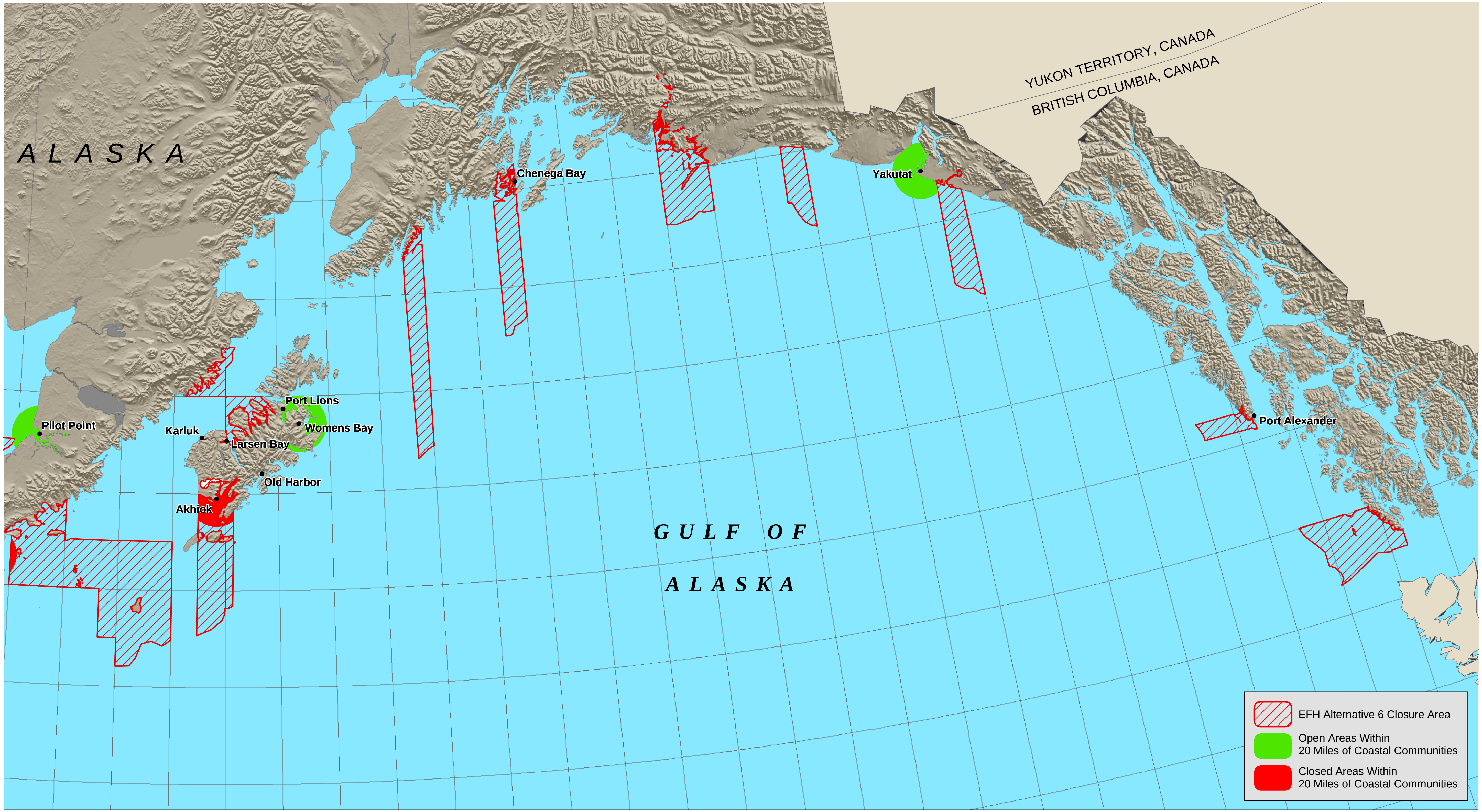
Figure 3.8-1. Length Distribution of Vessels Under 40 Feet Long Fishing with Bottom-contact Gear in the GOA in 2003





Source: NOAA, 2003

Figure 3.9-1
EFH Alternative 6
Closed Areas Within 20 Miles of Coastal Communities
(1 of 2)



Source: NOAA, 2003

Figure 3.9-1
EFH Alternative 6
Closed Areas Within 20 Miles of Coastal Communities
(2 of 2)

Table 1.4-1. Alternatives 2 through 6 Area Closure Effects

Region	Closures	Area Closed by Alternative (km^2)	Fishable Area (km^2)	Percent Closed
Alternative 2				
GOA [1]	NPT Slope Rockfish 11 Areas	10,228	279,874	3.65%
Alternative 3				
GOA [1]	NPT Slope Rockfish 200 to 1,000 m	29,059	279,874	10.38%
Alternative 4				
GOA [1]	NPT Slope Rockfish 11 Areas	10,228	279,874	3.65%
BS Rotating "A"	NPT All Species	49,679	798,870	6.22%
BS Rotating "B"	NPT All Species	47,868	798,870	5.99%
BS Rotating "C"	NPT All Species	47,313	798,870	5.92%
BS Rotating "D"	NPT All Species	47,085	798,870	5.89%
BS Rotating Average		47,986	798,870	6.01%
AI [3]	NPT All Species Designated Areas	22,883	105,243	21.74%
ALT 4 TOTAL		**81,097**	**1,183,987**	**6.85%**
Alternative 5A				
GOA [1]	NPT All Species 10 Areas	2,845	279,874	1.02%
GOA [1]	NPT Slope Rockfish 200 to 1,000 m	29,059	279,874	10.38%
Total GOA Total [1]		31,904	279,874	11.40%
BS Rotating "A"	NPT All Species	65,760	798,870	8.23%
BS Rotating "B"	NPT All Species	63,251	798,870	7.92%
BS Rotating "C"	NPT All Species	62,915	798,870	7.88%
BS Rotating Average		63,975	798,870	8.01%
AI [3]	NPT All Species Designated Areas	32,235	105,243	30.63%
ALT 5a TOTAL		**128,114**	**1,183,987**	**10.82%**
Alternative 5B				
GOA [1]	NPT All Species 10 Areas	2,845	279,874	1.02%
GOA [1]	NPT Slope Rockfish 200 to 1,000 m	29,059	279,874	10.38%
Total GOA [1]		31,904	279,874	11.40%
BS Rotating "A"	NPT All Species	65,760	798,870	8.23%
BS Rotating "B"	NPT All Species	63,251	798,870	7.92%
BS Rotating "C"	NPT All Species	62,915	798,870	7.88%
BS Rotating Average		63,975	798,870	8.01%
AI [3]	NPT All Species Designated Areas	82,023	105,243	77.94%
AI (Option 2 Only)	All Bottom-Contact Gear All Species Coral Gardens	380	105,243	0.36%
ALT 5B TOTAL		**177,902**	**1,183,987**	**15.03%**
Alternative 5C				
GOA	All Bottom-Contact Gear All Species 10 Areas	7,157	279,874	2.56%
AI [2 3 4]	NPT All Species Designated Areas	63,713	108,243	58.86%
AI	All Bottom-Contact Gear All Species Coral Gardens	380	108,243	0.35%
Total AI		64,093	108,243	59.21%
ALT 5C TOTAL		**71,250**	**388,117**	**18.36%**
Alternative 6				
Gulf of Alaska	All Bottom-Contact Gear All Species Approximately 20% of Area	61,991	356,199	17.40%
Bering Sea	All Bottom-Contact Gear All Species Approximately 20% of Area	136,031	798,870	17.03%
Aleutian Islands	All Bottom-Contact Gear All Species Approximately 20% of Area	20,729	105,243	19.70%
ALT 6 TOTAL		**218,750**	**1,260,312**	**17.36%**

[1] NMFS reporting areas 649, 650, and 659 are not included in 1,000 m denominator since these alternatives do not affect these areas.

[2] Although Alternative 5B appears to close approximately 78 percent of the fishable area, that is an artifact of the way the areas were defined. Observer data were used to create open areas and would not affect the fishery as much as the area calculations make it appear.

[3] Includes the overlap with SSL protection measures and other no-trawl areas. All EFH alternatives were cut at 1,000 m "fishable area."

[4] Analyses of observer and recent bathymetry data for Alternative 5C resulted in a slightly larger fishable area in the AI than other alternatives.

[5] GOA fishable area under Alternative 6 includes water deeper than 1,000 m.

Table 2.1-1. Groundfish Catch Off Alaska by Area, Vessel Type, and Gear, 1997-2001
(1,000 metric tons, round weight)

		Gulf of Alaska			Bering Sea and Aleutian Islands			All Alaska		
Gear	**Year**	**Catcher Vessels**	**Catcher-Processors**	**Total**	**Catcher Vessels**	**Catcher-Processors**	**Total**	**Catcher Vessels**	**Catcher-Processors**	**Total**
Hook and Line										
	1997	19	6	26	3	151	154	22	157	180
	1998	19	5	25	2	128	130	22	133	155
	1999	19	8	27	1	110	112	20	118	138
	2000	22	7	29	2	124	126	24	131	156
	2001	19	6	25	2	135	138	21	141	163
Pot										
	1997	9	0	9	17	5	22	26	5	31
	1998	0	0	0	10	4	14	0	0	0
	1999	14	4	19	12	4	16	27	8	35
	2000	16	1	17	16	3	19	32	4	36
	2001	6	2	7	14	3	17	19	5	24
Trawl										
	1997	161	33	193	581	1,073	1,654	742	1,105	1,847
	1998	177	32	208	535	941	1,476	712	972	1,685
	1999	150	31	180	583	713	1,296	733	743	1,477
	2000	124	36	160	663	798	1,461	787	834	1,621
	2001	119	30	149	771	888	1,659	891	918	1,809
All Gear										
	1997	189	39	228	602	1,229	1,831	791	1,268	2,059
	1998	207	37	244	548	1,073	1,621	755	1,110	1,865
	1999	183	43	226	598	827	1,425	781	870	1,651
	2000	162	45	207	683	925	1,608	846	969	1,815
	2001	144	38	182	789	1,027	1,815	932	1,064	1,997

Source: Hiatt et al. 2002

Table 2.1-2. Ex-Vessel Value of the Groundfish Catch Off Alaska by Area, Catcher Category, and Gear, 1997-2001 (millions of dollars)

		Gulf of Alaska			**Bering Sea and Aleutian Islands**			**All Alaska**		
Gear	**Year**	**Catcher Vessels**	**Catcher-Processors**	**Total**	**Catcher Vessels**	**Catcher-Processors**	**Total**	**Catcher Vessels**	**Catcher-Processors**	**Total**
Hook and Line										
	1997	$75.0	$10.0	$85.0	$4.0	$79.0	$83.0	$78.0	$89.0	$168.0
	1998	$49.0	$7.0	$56.0	$3.0	$47.0	$50.0	$52.0	$54.0	$106.0
	1999	$53.0	$10.0	$63.0	$2.0	$62.0	$65.0	$55.0	$73.0	$127.0
	2000	$69.0	$12.0	$81.0	$4.0	$70.0	$74.0	$73.0	$82.0	$155.0
	2001	$54.0	$9.0	$63.0	$6.0	$66.0	$72.0	$59.0	$75.0	$135.0
Pot										
	1997	$6.0	$0.0	$6.0	$4.0	$2.0	$6.0	$9.0	$2.0	$11.0
	1998	$7.0	$0.0	$7.0	$3.0	$2.0	$4.0	$9.0	$2.0	$11.0
	1999	$12.0	$3.0	$15.0	$8.0	$2.0	$10.0	$19.0	$5.0	$25.0
	2000	$15.0	$1.0	$16.0	$10.0	$2.0	$12.0	$25.0	$3.0	$28.0
	2001	$8.0	$1.0	$10.0	$7.0	$2.0	$9.0	$15.0	$3.0	$18.0
Trawl										
	1997	$39.0	$9.0	$48.0	$130.0	$214.0	$344.0	$169.0	$223.0	$392.0
	1998	$34.0	$7.0	$41.0	$87.0	$139.0	$226.0	$121.0	$146.0	$267.0
	1999	$40.0	$9.0	$49.0	$118.0	$143.0	$261.0	$159.0	$151.0	$310.0
	2000	$42.0	$8.0	$49.0	$176.0	$185.0	$361.0	$217.0	$193.0	$410.0
	2001	$38.0	$7.0	$44.0	$176.0	$169.0	$346.0	$214.0	$176.0	$390.0
All Gear										
	1997	$119.0	$19.0	$138.0	$137.0	$195.0	$432.0	$256.0	$314.0	$571.0
	1998	$90.0	$14.0	$104.0	$93.0	$188.0	$280.0	$182.0	$202.0	$384.0
	1999	$105.0	$21.0	$126.0	$128.0	$208.0	$336.0	$233.0	$229.0	$462.0
	2000	$126.0	$20.0	$146.0	$190.0	$257.0	$447.0	$316.0	$277.0	$592.0
	2001	$100.0	$17.0	$117.0	$189.0	$237.0	$426.0	$289.0	$254.0	$543.0

Source: Hiatt et al. 2002

Table 2.1-3. Number of Vessels That Caught Groundfish Off Alaska by Area, Catcher Category, and Gear, 1997-2001

		Gulf of Alaska			Bering Sea and Aleutian Islands			All Alaska		
Gear	**Year**	**Catcher Vessels**	**Catcher-Processors**	**Total**	**Catcher Vessels**	**Catcher-Processors**	**Total**	**Catcher Vessels**	**Catcher-Processors**	**Total**
Hook and Line										
	1997	946	29	975	93	44	137	958	46	1,004
	1998	866	22	888	72	43	115	884	43	927
	1999	902	30	932	75	41	116	926	44	970
	2000	1,008	21	1,029	105	43	148	1,048	44	1,092
	2001	933	20	953	118	45	163	967	45	1,012
Pot										
	1997	141	4	145	69	13	82	186	13	199
	1998	166	1	167	71	7	78	211	7	218
	1999	200	11	211	89	13	102	254	13	267
	2000	249	5	254	90	11	101	298	12	310
	2001	150	4	154	70	6	76	205	8	213
Trawl										
	1997	173	32	205	108	59	167	201	60	261
	1998	167	24	191	115	51	166	205	51	256
	1999	154	18	172	126	40	166	202	40	242
	2000	123	18	141	117	39	156	207	40	247
	2001	117	18	135	123	39	162	201	40	241
All Gear										
	1997	1,179	65	1,244	267	113	380	1,257	116	1,373
	1998	1,104	47	1,151	238	99	337	1,184	99	1,283
	1999	1,149	58	1,207	285	88	373	1,266	91	1,357
	2000	1,246	44	1,290	305	88	393	1,410	90	1,500
	2001	1,115	40	1,155	308	90	398	1,285	91	1,376

Source: Hiatt et al. 2002

Table 2.2-1. First Wholesale Value in Millions of Dollars for Shoreside Processors, 2001

	Groundfish			Salmon			Crab			Halibut			Other			Total	
Processor Group	**Number of Processors**	**Value**	**% of Total**	**Number of Processors**	**Value**	**% of Total**	**Number of Processors**	**Value**	**% of Total**	**Number of Processors**	**Value**	**% of Total**	**Number of Processors**	**Value**	**% of Total**	**Value**	**% of Total**
Alaska Peninsula/Aleutians	11	$49.6	3.6%	20	$117.1	8.5%	7	$48.6	3.5%	12	$23.4	1.7%	5	$4.4	0.3%	$242.9	17.7%
Bering Sea (Pollock)	7	$421.8	30.7%	0	$0.0	0.0%	8	$45.9	3.3%	4	$6.2	0.4%	1/	1/	1/	$473.9	34.4%
Kodiak	9	$69.1	5.0%	9	$64.8	4.7%	6	$5.7	0.4%	7	$13.2	1.0%	7	$2.2	0.2%	$155.1	11.3%
South Central	18	$28.0	2.0%	43	$127.2	9.2%	14	$1.3	0.1%	22	$27.1	2.0%	1/	1/	1/	$183.4	13.3%
Southeastern	24	$41.1	3.0%	43	$203.9	14.8%	19	$19.8	1.4%	28	$42.2	3.1%	36	$13.6	1.0%	$320.6	23.3%
Total	69	$609.5	44.3%	115	$512.9	37.3%	54	$121.3	8.8%	73	$112.0	8.1%	48	$20.2	1.5%	$1,376.0	100.0%

1/ Value or "other" processed products combined with crab due to confidentiality requirements.

Source: Terry Hiatt, NMFS, based on ADF&G Commercial Operators Annual Report, ADF&G Intent to Process.

Table 2.3-1. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Residence of Owner of Vessel for Selected Fisheries Groups, 2001

			Vessels Participating in Fisheries for:							
Geographical Area	**Community**	**Total Unique Catcher Vessels**	**Pollock**	**Pacific Cod**	**Other Groundfish**	**Halibut**	**Crab**	**Scallops**	**Salmon**	**Herring**
Alaska										
Aleutians East Borough	False Pass	1	0	1	1	1	0	0	0	0
	King Cove	13	6	13	2	3	13	0	11	0
	Sand Point	28	17	28	15	13	22	0	21	4
Aleutians East Borough Subtotal		42	23	42	18	17	35	0	32	4
Aleutians West Census Area	Unalaska	5	1	5	3	2	1	0	1	1
Anchorage Borough	Anchorage	11	6	10	7	7	5	0	3	0
	Girdwood	1	1	1	1	1	0	0	1	0
Anchorage Borough Subtotal		12	7	11	8	8	5	0	4	0
Juneau Borough	Juneau	2	1	2	2	1	0	0	0	0
Kenai Peninsula Borough	Anchor Point	8	5	8	5	7	0	0	8	0
	Homer	51	22	44	35	44	2	1	37	2
	Kasilof	3	0	2	3	3	0	0	2	0
	Kenai	2	0	2	1	2	0	0	1	0
	Nikiski	1	0	1	1	1	0	0	1	0
	Nikolaevsk	5	5	5	5	5	0	0	4	0
	Ninilchik	1	0	1	0	1	0	0	1	0
	Seldovia	4	0	4	4	4	0	0	0	0
	Seward	3	0	3	3	3	0	0	2	0
	Soldotna	4	0	3	4	4	0	0	3	0
	Sterling	1	0	1	1	1	0	0	1	0
Kenai Peninsula Borough Subtotal		83	32	74	62	75	2	1	60	2
Kodiak Island Borough	Kodiak	53	29	52	40	35	27	0	5	0
	Ouzinkie	1	0	1	0	1	0	0	1	0
Kodiak Island Borough Subtotal		54	29	53	40	36	27	0	6	0
Lake and Peninsula Borough	Chignik Lagoon	2	0	2	0	1	1	0	1	0
Matanuska-Susitna Borough	Palmer	1	0	1	0	0	1	0	1	0
	Wasilla	2	0	2	1	1	0	0	0	0
	Willow	5	3	5	5	4	0	0	3	0
Matanuska-Susitna Borough Subtotal		8	3	8	6	5	1	0	4	0
Sitka Borough	Sitka	3	0	3	3	2	2	0	1	0
Southeast Fairbanks Census Area	Delta Junction	1	1	1	1	1	0	0	1	0
Valdez-Cordova Census Area	Cordova	9	1	2	9	8	1	0	6	0
Wrangell-Petersburg Census Area	Petersburg	2	1	2	2	2	1	0	1	0
Total Alaska		**223**	**99**	**205**	**154**	**158**	**76**	**1**	**117**	**7**
Oregon	Astoria	1	1	1	1	0	0	0	0	0
	Brookings	1	1	1	1	0	0	0	0	0
	Cloverdale	1	1	1	1	1	0	0	0	0
	Coos Bay	1	1	1	1	0	0	0	0	0
	Dallas	1	1	1	1	0	0	0	0	0

Table 2.3-1. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Residence of Owner of Vessel for Selected Fisheries Groups, 2001 (continued)

			Vessels Participating in Fisheries for:							
Geographical Area	**Community**	**Total Unique Catcher Vessels**	**Pollock**	**Pacific Cod**	**Other Groundfish**	**Halibut**	**Crab**	**Scallops**	**Salmon**	**Herring**
Oregon (continued)	Depoe Bay	2	1	2	1	1	1	0	0	0
	Florence	2	2	2	2	0	1	0	0	0
	Gervais	1	0	0	1	1	0	0	1	0
	Mapleton	1	0	1	1	1	0	0	0	0
	Molalla	1	0	0	1	1	0	0	1	0
	Newport	19	17	19	18	3	6	0	0	0
	Port Orford	1	1	1	1	0	0	0	0	0
	Feedsport	1	1	1	1	0	1	0	0	0
	Salem	1	0	0	0	1	0	0	1	0
	Saletz	1	1	1	0	0	0	0	0	0
	Seal Rock	1	0	1	1	1	1	0	1	0
	Siletz	2	2	2	2	0	2	0	1	0
	Silverton	1	0	1	1	1	0	0	1	0
	Sisters	2	0	2	2	2	2	0	0	0
	South Beach	1	1	1	1	0	0	0	0	0
	Warrenton	1	1	1	1	1	0	0	0	0
	Woodburn	4	0	2	3	4	0	0	3	0
Total Oregon		**47**	**32**	**42**	**42**	**18**	**14**	**0**	**9**	**0**
Washington	Aberdeen	2	2	2	2	0	1	0	0	0
	Anacortes	3	3	3	3	1	0	0	0	0
	Bainbridge Island	1	1	1	1	1	0	0	1	0
	Bellingham	4	4	4	4	1	2	0	0	1
	Blaine	3	3	3	3	1	0	0	0	0
	Camas	1	1	1	1	0	1	0	0	0
	Cathlamet	1	0	1	1	1	0	0	1	0
	Duvall	1	0	1	1	1	0	0	0	0
	East Wenatchee	1	1	1	1	1	0	0	0	0
	Edmonds	3	3	3	3	0	2	0	1	0
	Everett	1	0	0	0	1	0	0	1	0
	Federal Way	1	0	1	0	0	1	0	0	0
	Fox Island	1	1	1	1	1	0	0	0	0
	Gig Harbor	2	1	2	1	0	2	0	2	0
	Granite Falls	1	0	1	1	1	0	0	0	0
	Issaquah	1	1	1	1	0	1	0	0	0
	Kingston	1	1	1	1	0	0	0	0	0
	Kirkland	1	0	1	1	1	0	0	0	0
	Leavenworth	1	0	1	1	0	0	0	0	0
	Lynden	1	1	1	1	1	0	0	0	0
	Lynnwood	1	1	1	0	0	0	0	0	0
	Mercer Island	1	1	1	1	0	1	0	1	0
	Mill Creek	1	0	1	0	0	1	0	0	0

Table 2.3-1. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Residence of Owner of Vessel for Selected Fisheries Groups, 2001 (continued)

			Vessels Participating in Fisheries for:							
Geographical Area	**Community**	**Total Unique Catcher Vessels**	**Pollock**	**Pacific Cod**	**Other Groundfish**	**Halibut**	**Crab**	**Scallops**	**Salmon**	**Herring**
Washington (continued)	Mukilteo	3	1	3	1	0	3	0	0	0
	Port Townsend	1	0	1	0	1	0	0	1	0
	Poulsbo	1	0	1	1	0	1	0	0	0
	Reardon	1	1	1	1	1	0	0	1	0
	Renton	1	0	1	0	0	1	0	0	0
	Seattle	69	59	68	63	6	32	0	3	0
	Seaview	1	0	1	0	1	0	0	0	0
	Shoreline	3	3	3	3	2	1	0	0	0
	South Bend	1	1	1	1	0	0	0	0	0
	SQURMAMISH	1	1	1	1	0	0	0	0	0
	Stanwood	1	0	1	1	0	0	0	1	0
	Sumner	1	0	1	1	0	0	0	1	0
	Vashon	1	1	1	1	1	0	0	1	0
Total Washington		**119**	**92**	**117**	**103**	**24**	**50**	**0**	**15**	**1**
Other States	Bay City	1	0	1	1	0	0	0	0	1
	Boise	1	0	1	0	1	0	0	1	1
	Half Moon Bay	2	2	2	2	0	0	0	0	0
	Hayfork	1	1	1	0	0	0	0	0	0
	Kailua Kona	1	1	1	1	1	1	0	1	0
	Lemmon	1	0	1	0	0	0	0	0	0
	Magnolia Springs	1	0	1	0	0	1	0	0	0
	Meridian	1	0	1	0	0	1	0	0	0
	Post Falls	1	0	1	1	1	0	0	0	0
	Richmond	1	1	1	1	1	1	0	0	0
	San Pedro	1	0	1	1	1	1	0	0	0
	Santa Barbara	1	1	1	1	1	1	0	0	0
	Stryker	1	0	1	0	0	1	0	0	0
	Swan Lake	1	0	1	0	1	1	0	0	0
Total Other States		**15**	**6**	**15**	**8**	**7**	**8**	**0**	**2**	**2**
Grand Total All Areas		**404**	**229**	**379**	**307**	**207**	**148**	**1**	**143**	**10**

Source: AKFIN data set 2003

Table 2.3-2. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Geographical Area of Residence of Owner of Vessel for Selected Fisheries Groups, 2001 1/ 2/

Geographical Area	Total Unique Catcher Vessels	Vessels Participating in Fisheries for: Pollock	Pacific Cod	Other Groundfish	Halibut	Crab	Salmon
Alaska							
Aleutians East Borough	42	23	42	18	17	35	32
Kenai Peninsula Borough	83	32	74	62	75	2[3/]	60
Kodiak Island Borough	54	29	53	40	36	27	6
Other Alaska	44	15	36	34	30	12	19
Total Alaska	**223**	**99**	**205**	**154**	**158**	**76**	**117**
Oregon	47	32	42	42	18	14	9
Washington	119	92	117	103	24	50	15
Other States	15	6	15	8	7	8	2
Grand Total	**404**	**229**	**379**	**307**	**207**	**148**	**143**

1/ This table does not count vessels classified as catcher-processors but credited with ex-vessel earnings.

2/ Scallop and herring values cannot be disclosed for any area and have therefore been dropped from this table.

3/ Shaded cells suppressed in accompanying value table to preserve confidentiality.

Source: AKFIN data set 2003

Table 2.3-3. Total Ex-Vessel Value of Harvest for Groundfish Catcher-Vessels Harvesting in Areas Potentially Affected by Any Alternative by Geographical Area of Residence of Owner of Vessel for Selected Fisheries Groups, 2001

	Ex-Vessel Value of Selected Fishery for Vessels from the Indicated Geographical Unit (thousands of dollars)						
Geographical Area	**Pollock**	**Pacific Cod**	**Other Groundfish**	**Halibut**	**Crab**	**Salmon**	**Total Ex-Vessel Value**[1/]
Alaska							
Aleutians East Borough	$3,992,004	$3,573,803	$24,790	$1,556,450	$439,121	$1,657,098	$10,673,869
Kenai Peninsula Borough	$214,676	$1,980,666	$2,463,510	$7,165,975	2/	$1,544,482	$10,407,220
Kodiak Island Borough	$4,889,247	$4,474,297	$3,582,187	$8,509,815	$2,007,766	$475,082	$19,729,872
Other Alaska	$1,338,567	$2,191,843	$2,315,644	$3,681,468	2/	$1,478,399	$10,923,851
Total Alaska	**$10,434,494**	**$12,220,609**	**$8,386,132**	**$20,913,709**	**$4,431,536**	**$5,155,061**	**$51,734,812**
Oregon	$16,872,338	$7,081,505	$2,539,012	$3,787,724	$2,350,166	2/	$30,923,128
Washington	$118,541,965	$11,137,475	$5,685,232	$6,952,382	$8,910,548	$1,124,420	$148,935,957
Other States	$4,609,447	$1,064,019	$980,641	$2,434,563	$1,063,475	2/	$9,316,277
Grand Total	**$150,458,243**	**$31,503,607**	**$17,591,018**	**$34,088,377**	**$16,755,724**	**$6,793,054**	**$240,910,175**

1/ Individual fisheries do not sum to total given. The total is an estimate because more than one data source went into constructing the AKFIN database.

2/ Cell value suppressed to protect confidential data.

Source: AKFIN data set 2003

Table 2.3-4. Count of Mobile Groundfish Processors (motherships and catcher-processors) Operating in Areas (or processing catch from areas) Affected by Any Alternative by Community of Ownership, 2001

Geographical Area	Community	Pollock	Pacific Cod	Other Groundfish	Total Groundfish
Motherships					
Washington	Seattle	4	4	2	4
Catcher-Processors					
Aleutians West Census Area	Unalaska	2	2	2	2
Anchorage Borough	Anchorage	1	2	1	2
Kenai Peninsula Borough	Homer			1	1
	Seward			1	1
Kenai Peninsula Borough Total				2	2
Kodiak Island Borough	Kodiak	1	2	1	2
Sitka Borough	Sitka			1	1
Wrangell-Petersburg Census Area	Petersburg	3	3	3	3
Unknown		1	1	1	1
Alaska Total		**8**	**10**	**11**	**13**
Washington	Anacortes	1	1	1	1
	Bellevue	1	1	1	1
	Bellingham	2	2	2	2
	Edmonds	3	3	3	3
	Mill Creek	1	1	1	1
	Redmond	1	1	1	1
	Renton	1	1		1
	Seattle	53	57	53	57
	Woodinville	1	1	1	1
Washington Total		**64**	**68**	**63**	**68**
Other States	Richmond, CA	1	1	1	1
	Rockland, ME	3	3	3	3
Total Other States		**4**	**4**	**4**	**4**
Total Catcher-Processors		**76**	**82**	**78**	**85**
Total Motherships and Catcher-Processors		**80**	**86**	**80**	**89**

Source: AKFIN data set 2003

Table 2.3-5. Count of Mobile Groundfish Processors (motherships and catcher-processors) Operating in Areas (or processing catch from areas) Affected by Any Alternative by Grouped Area of Ownership, 2001[1/]

Geographical Area	Pollock	Pacific Cod	Other Groundfish	Total Groundfish
Motherships				
Washington	4	4[2/]	2	4
Catcher-Processors				
Alaska				
Aleutians West Census Area	2	2	2	2
Kodiak Island Borough	1	2	1	2
Other Alaska	4	5	7	8
Unknown	1	1	1	1
Alaska Total	**8**	**10**	**11**	**13**
Washington	64	68	63	68
Other States	4	4	4	4
Total Catcher-Processors	**76**	**82**	**78**	**85**
Combined Total Motherships and Catcher-Processors	**80**	**86**	**80**	**89**

1/ Scallop, salmon, and herring values cannot be disclosed for any area and have therefore been dropped from this table.

2/ Shaded cells suppressed in accompanying value tables to preserve confidentiality.

Source: AKFIN data set 2003

Table 2.3-6. First Wholesale Value of Mobile Groundfish Processors (motherships and catcher-processors) Operating in Areas (or processing catch from areas) Affected by Any Alternative by Grouped Area of Ownership, 2001

Geographical Area	Pollock	Pacific Cod	Other Groundfish	Total Groundfish
Motherships				
Washington	$122,030,329	1/	1/	$123,690,790
Catcher-Processors				
Aleutians West Census Area	1/	1/	1/	1/
Kodiak Island Borough	1/	1/	1/	1/
Other Alaska	$289,345	$11,623,107	$2,246,046	$14,158,497
Unknown	1/	1/	1/	1/
Alaska Total	**$442,919**	**$22,946,543**	**$3,618,231**	**$27,007,693**
Washington	$625,385,384	$113,473,930	$110,582,182	$849,441,495
Other States	$2,277,019	$5,732,493	$6,260,976	$14,270,487
Total Catcher-Processors	**$628,105,322**	**$142,152,965**	**$120,461,388**	**$890,719,675**
Combined Total Motherships and Catcher-Processors	**$750,135,650**	**$143,805,158**	**$120,469,657**	**$1,014,410,465**

1/ Cell value suppressed to protect confidential data.
Source: AKFIN data set 2003

Table 2.3-7. Vessel Acquisitions by CDQ Groups as of 2000

CDQ Group	Vessel Acquisitions (percent ownership in parentheses)
APICDA	• Starbound (20%) 240-foot pollock factory trawler • Bering Prowler (25%) 124-foot longline vessel harvesting Pacific cod and sablefish • Prowler (25%) 114-foot longline vessel harvesting Pacific cod and sablefish • Golden Dawn (25%) 148-foot catcher vessel harvesting Pacific cod, pollock and crab • Ocean Prowler (20%) 155-foot longline-processing vessel harvesting Pacific cod and sablefish • Farwest Leader (25%) 105-foot pot vessel harvesting crab and Pacific cod • Stardust (100%) 56-foot longline vessel harvesting Pacific cod and halibut • Bonanza (100%) 38-foot longline vessel harvesting halibut • AP#1, AP#2, AP#3 (100%) 36-foot longline vessels harvesting halibut and Pacific cod • AP#4, AP#5 (100%) 35.5-foot longline vessels harvesting halibut and Pacific cod • Konrad 1 (75%) 58-foot trawler/pot/tender vessel harvesting Pacific cod and pollock, salmon tender • Nikka D (100%) 28-foot vessel harvesting halibut • Agusta D (100%) 28-foot sportfishing charter vessel • Grand Aleutian (100%) 32-foot sportfishing charter vessel
BBEDC	• Arctic Fjord (20%) 270-foot pollock factory trawler • Bristol Leader (50%) 167-foot longline vessel harvesting Pacific cod, halibut and sablefish • Neahkahnie (20%) 110-foot pollock catcher processor • Northern Mariner (45%) 110-foot crab vessel • Bristol Mariner (45%) 125-foot crab vessel • Nordic Mariner (45%) 121-foot crab vessel • Cascade Mariner (40%) 100-foot crab vessel
CBSFA	• American Seafoods, LP (22.5%), which owns the following 270- to 340-foot catcher processors harvesting pollock, Pacific cod, yellowfin sole and rock sole: American Dynasty, Katie Ann, Northern Eagle, Ocean Rover, Northern Jaeger, American Triumph, and Northern Hawk • Zolotoi (20%) 98-foot crab vessel • Ocean Cape (35%) 98-foot crab vessel
CVRF	• American Seafoods, LP (22.5%), which owns the following 270- to 340-foot catcher processors harvesting pollock, Pacific cod, yellowfin sole and rock sole: American Dynasty, Katie Ann, Northern Eagle, Ocean Rover, Northern Jaeger, American Triumph, and Northern Hawk • Ocean Prowler (20%) 155-foot longline-processing vessel harvesting Pacific cod and sablefish • Ocean Harvester (45%) 58-foot longline vessel harvesting halibut and Pacific cod • Silver Spray (50%) 116-foot crab vessel and Pacific cod freezer boat
NSEDC	• Glacier Fish Company (50%), which owns the following 201- to 276-foot catcher processors harvesting pollock and Pacific cod: Northern Glacier and Pacific Glacier • Norton Sound (49%) 139-foot longline vessel • Golovin Bay (100%) tender • Norton Bay (100%) tender
YDFDA	• Emmonak Leader (75%) 103-foot catcher vessel harvesting pollock • Alakanuk Beauty (75%) 105-foot catcher vessel harvesting pollock • Golden Alaska (19.6%) 308-foot pollock mothership • Blue Dolphin (100%) 47-foot longline/crab vessel • Lisa Marie (100%) 78-foot trawl/pot/longline vessel

Source: DCED 2001

Table 2.3-8. Inshore Processing Plant Acquisitions by CDQ Groups as of 2000

CDQ Group	Inshore Plant Acquisitions (percent ownership in parentheses)
APICDA	• Atka Pride Seafoods, Inc. (100%) processes halibut. • Bering Pacific Seafoods (50%) processes Pacific cod, salmon and other species.
NSEDC	• Norton Sound Seafood Products (100%) processes mainly salmon. • Norton Sound Crab Company (100%) processes mainly crab.

Source: DCED 2001

Table 2.3-9. Count of Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels Fishing in Areas Affected by Any Alternative by Community of Operation of Processor, 2001

Geographical Area	Community	Pollock	Pacific Cod	Other Groundfish	# of Unique Groundfish Processors	Halibut	Crab	Salmon	Herring
Floating Processors									
Alaska									
Aleutians East Borough	Akutan	1	1		1				
Aleutians West Census Area	Unalaska	1	1	1	1				
Alaska Total		**2**	**2**	**1**	**2**				
Washington	Arlington							2	
	Seattle	2	2	1	2		7	10	9
	Sequim							1	
Washington Total		**2**	**2**	**1**	**2**		**7**	**13**	**9**
Total Floating Processors		**4**	**4**	**2**	**4**		**7**	**13**	**9**
Shore Plants									
Aleutians East Borough	Akutan	1	1	1	1	1	1		1
	King Cover	1	2	1	2	1	1	2	1
	Port Moller							1	
	Sand Point	1	1	1	1	1	1	1	
Aleutians East Borough Total		3	4	3	4	3	3	4	2
Aleutians West Census Area	Atka			1	1	1			
	Saint Paul Island	1	2	1	2	2	1	1	
	Unalaska	3	7	5	7	6	5		2
Aleutians West Census Area Total		4	9	7	10	9	6	1	2
Anchorage Borough	Anchorage		2	2	2	4	1	4	
Bristol Bay Borough	Naknek							4	2
Dillingham Census Area	Dillingham							1	
	Ekuk							1	1
Dillingham Census Area Total								2	1
Haines Borough	Haines			2	2	2	2	4	
Juneau Borough	Douglas							1	
	Juneau	1	3	4	4	4	5	9	1
Juneau Borough Total		1	3	4	4	4	5	10	1
Kenai Peninsula Borough	Anchor Point					1		1	
	Homer		4	2	4	3		2	
	Kasilof							3	
	Kenai		1	1	1	3		7	
	Ninilchik	1	1	1	1	1	1	1	
	Seward	1	3	3	3	3		2	
	Soldotna					1		1	1
Kenai Peninsula Borough Total		2	9	7	9	12	1	17	1

Table 2.3-9. Count of Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels Fishing in Areas

Table 2.3-14. Count of Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Operation of Processor, 2001 (continued)

Geographical Area	Community	Pollock	Pacific Cod	Other Groundfish	# of Unique Groundfish Processors	Halibut	Crab	Salmon	Herring
	Ketchikan		2	2	2	2	1	5	3
Kodiak Island Borough	Kodiak	7	9	9	9	7	8	8	5
	Moser Bay		1	1	1	1		1	1
Kodiak Island Borough Total		7	10	10	10	8	8	9	6
Lake and Peninsula Borough	Chignik		1	1	1	1		2	
	Egegik					1		1	1
Lake and Peninsula Borough Total			1	1	1	2		3	1
Prince of Wales-Outer Ketchikan Census Area	Craig					1		2	1
	Metlakatla			1	1	1		1	
Prince of Wales-Outer Ketchikan Census Area Total				1	1	2		3	1
Sitka Borough	Sitka		4	5	5	2	3	6	3
Skagway-Yakutat-Angoon Census Area	Elfin Cover							1	
	Excursion Inlet					1		1	
	Gustavus			1	1	1		1	
	Hoonah		1	1	1	1	1	1	
	Pelican		1	1	1	1		1	
	Yakutat		2	2	2	2		3	
Skagway-Yakutat-Angoon Census Area Total			4	5	5	6	1	8	
Valdez-Cordova Census Area	Cordova	1	4	5	5	4		5	
	Valdez		1	2	2	2		3	
	Whittier		1	2	2	1		2	
Valdez-Cordova Census Area Total		1	6	9	9	7		10	
Wrangell-Petersburg Census Area	Kake			1	1	1	1	1	
	Petersburg		3	4	4	5	5	8	2
	Wrangell		1	2	2	2	2	2	1
Wrangell-Petersburg Census Area Total			4	7	7	8	8	11	3
Alaska Total		**18**	**58**	**65**	**71**	**71**	**39**	**101**	**26**
Washington	Seattle	1	1	1	1	1	1		
Total Shore Plants All Areas		**19**	**59**	**66**	**72**	**72**	**40**	**101**	**26**
Combined Total Floaters and Shore Plants		**23**	**63**	**68**	**76**	**72**	**47**	**114**	**35**

Source: AKFIN data set 2003

Table 2.3-10. Count of Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels[1/] Fishing in Areas Affected by Any Alternative by Grouped Community of Operation of Processor, 2001

Geographical Area	Pollock	Pacific Cod	Other Groundfish	# of Unique GF Processors	Halibut	Crab	Salmon	Herring
Floating Processors								
Alaska								
Aleutians East Borough	1[2/]	1		1				
Aleutians West Census Area	1	1	1	1				
Alaska Total	**2**	**2**	**1**	**2**				
Washington	2	2	1	2		7	13	9
Total Floaters	**4**	**4**	**2**	**4**		**7**	**13**	**9**
Shoreplants								
Alaska								
Aleutians East Borough	3	4	3	4	3	3	4	2
Aleutians West Census Area	4	9	7	10	9	6	1	2
Kenai Peninsula Borough	2	9	7	9	12	1	17	1
Kodiak Island Borough	7	10	10	10	8	8	9	6
Other Alaska	1	8	12	12	16	9	35	9
Sitka Borough		4	5	5	2	3	6	3
Skagway-Yakutat-Angoon Census Area		4	5	5	6	1	8	
Valdez-Cordova Census Area	1	6	9	9	7		10	
Wrangell-Petersburg Census Area		4	7	7	8	8	11	3
Total Alaska	**18**	**58**	**65**	**71**	**71**	**39**	**101**	**26**
Washington	1	1	1	1	1	1		
Total Shore Plants	**19**	**59**	**66**	**72**	**72**	**40**	**101**	**26**
Combined Total Floaters and Shore Plan	**23**	**63**	**68**	**76**	**72**	**47**	**114**	**35**

1/ Scallop values cannot be disclosed for any area and have therefore been dropped from this table.

2/ Shaded cells suppressed in accompanying value tables to preserve confidentiality.

Source: AKFIN data set 2003

Table 2.3-11. Ex-Vessel Value Delivered to Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels Fishing in Areas Affected by Any Alternative by Grouped Community of Operation of Processor, 2001

Geographical Area	Pollock	Pacific Cod	Other Groundfish	Total Groundfish	Halibut	Crab	Salmon	Herring
Floating Processors								
Alaska								
Aleutians East Borough	2/	2/	2/	2/	$0	$0	$0	$0
Aleutians West Census Area	2/	2/	2/	2/	$0	$0	$0	$0
Alaska Total	**2/**	**2/**	**2/**	**2/**	**$0**	**$0**	**$0**	**$0**
Washington	2/	2/	2/	2/	$0	$16,467,638	$15,041,899	$3,576,631
Total Floaters	**$13,831,364**	**$1,595,375**	2/	**$15,434,299**	**$0**	**$16,467,638**	**$15,041,899**	**$3,576,631**
Shore Plants 1/								
Alaska								
Aleutians East Borough	2/	$11,229,854	2/	$62,143,691	2/	2/	$9,251,092	2/
Aleutians West Census Area	$79,802,971	$9,683,360	$3,291,940	$92,778,270	$7,380,745	$46,752,926	2/	*
Kenai Peninsula Borough	2/	2/	$13,812,404	$15,185,659	$10,808,729	2/	$14,047,234	2/
Kodiak Island Borough	$11,094,199	$15,908,021	$10,024,558	$37,026,778	$8,803,810	$5,990,038	$23,488,452	$1,071,085
Other Alaska	2/	2/	$6,582,243	$6,820,909	$5,020,737	$3,602,822	$60,606,494	$2,410,229
Sitka Borough	$0	$34,422	$9,665,029	$9,699,451	2/	2/	$12,128,872	2/
Skagway-Yakutat-Angoon Census Area	$0	$2,936	$5,144,067	$5,147,003	$2,655,550	2/	$8,553,444	$0
Valdez-Cordova Census Area	2/	2/	$3,391,987	$3,964,938	$1,847,526	$0	$29,335,814	$0
Wrangell-Petersburg Census Area	$0	$13,317	$4,554,694	$4,568,011	$3,096,183	$14,050,628	$19,752,714	2/
Total Alaska	**$140,245,063**	**$38,490,152**	**$58,599,494**	**$237,334,709**	**$44,720,932**	**$84,400,439**	**$177,167,917**	**$6,868,815**
Total Shore Plants	**$140,245,063**	**$38,490,152**	**$58,599,494**	**$237,334,709**	**$44,720,932**	**$84,400,439**	**$177,167,917**	**$6,868,815**
Combined Total Floaters and Shore Plants	**$154,076,426**	**$40,085,527**	**$58,607,054**	**$252,769,008**	**$44,720,932**	**$100,868,078**	**$192,209,817**	**$10,445,446**

1/ Washington shoreplants (1 entity) excluded from table to preserve confidentiality.

2/ Values in shaded cells are suppressed to preserve confidentiality.

Source: AKFIN data set 2003

Table 2.3-12. Count of Crab Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Residence of Owner of Vessel, 2001

Geographical Area	Community	Number of Catcher Vessels
Alaska		
Aleutians East Borough	King Cove	2
	Sand Point	3
Aleutians East Borough Total		5
Anchorage Borough	Anchorage	5
Kenai Peninsula Borough	Homer	6
	Kenai	1
	Seldovia	1
Kenai Peninsula Borough Total		8
Kodiak Island Borough	Kodiak	25
Sitka Borough	Sitka	2
Skagway-Yakutat-Angoon Census Area	Yakutat	1
Valdez-Cordova Census Area	Cordova	1
Wrangell-Petersburg Census Area	Petersburg	3
Alaska Total		**50**
Oregon	Newport	11
	Other Oregon	6
Oregon Total		**17**
Washington	Seattle	78
	Other Washington	33
Washington Total		**111**
Other States	California	1
	Hawaii	1
Other States Total		**2**
Grand Total All Areas		**180**

Source: AKFIN data set 2003

Table 2.3-14. Count of Halibut Catcher Vessels Harvesting in Areas Potentially

Table 2.3-13. Ex-Value of Harvest at Risk for Crab Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Geographical Area of Residence of Owner of Vessel, 2001

Geographical Area	Number of Catcher Vessels	Ex-Vessel Value
Alaska		
Aleutians East Borough	5	$139,913
Kenai Peninsula Borough	8	$706,959
Kodiak Island Borough	25	$4,919,598
Other Alaska	12	$1,910,278
Alaska Total	**50**	**$7,676,748**
Washington	111	$19,434,233
Other States	19	$4,150,657
Grand Total	**180**	**$31,261,638**

Source: AKFIN data set 2003

Table 2.3-14. Count of Halibut Catcher Vessels Harvesting in Areas Potentially

Table 2.3-14. Count of Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Residence of Owner of Vessel, 2001

Geographical Area	Community	Number of Catcher Vessels
Alaska		
Aleutians East Borough	False Pass	1
	King Cover	3
	Sand Point	13
Aleutians East Borough Total		17
Aleutians West Census Area	Atka	1
	Unalaska	1
Aleutians West Census Area Total		2
Anchorage Borough	Anchorage	12
Juneau Borough	Juneau	18
	Douglas	2
Juneau Borough Total		20
Kenai Peninsula Borough	Homer	44
	Seward	8
	Anchor Point	5
	Seldovia	2
	Clam Gulch	1
	Fritz Creek	1
	Halibut Cover	1
	Kasilof	1
	Kenai	1
	Nikiski	1
	Nikolaevsk	1
Kenai Peninsula Borough Total		66
Ketchikan Gateway Borough	Ketchikan	14
	Ward Cove	1
Ketchikan Gateway Borough Total		15
Kodiak Borough	Kodiak	90
	Port Lions	2
	Old Harbor	1
	Ouzinkie	1
Kodiak Borough Total		94
Lake and Peninsula Borough	Chignik	1
	Chignik Lagoon	1
Lake and Peninsula Borough Total		2
Matanuska-Susitna Borough	Wasilla	3
	Willow	2
	Palmer	1
Matanuska-Susitna Borough Total		6
Pribilof Islands Census Area	Saint George Island	8

Table 2.3-14. Count of Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Residence of Owner of Vessel, 2001 (continued)

Geographical Area	Community	Number of Catcher Vessels
Prince of Wales Census Area	Craig	7
	Klawock	1
	Meyers Chuck	1
Prince of Wales Census Area Total		9
Sitka Borough	Sitka	41
	Port Alexander	8
Sitka Borough Total		49
Skagway-Yakutat-Angoon Census Area	Pelican	3
	Gustavus	2
	Hoonah	2
	Yakutat	1
Skagway-Yakutat-Angoon Census Area		8
Valdez-Cordova Census Area	Cordova	7
Wrangell-Petersburg Census Area	Kake	1
	Petersburg	38
	Wrangell	4
Wrangell-Petersburg Census Area Total		43
Alaska Total		**358**
Oregon	Woodburn	7
	Newport	6
	Warrenton	4
	Astoria	2
	Depoe Bay	2
	Ashland	1
	Brookings	1
	Cloverdale	1
	Mapleton	1
	Molalla	1
	North Bend	1
	Oregon City	1
	Seal Rock	1
	Seaside	1
	Westfir	1
Oregon Total		**31**
Washington	Seattle	25
	Anacortes	11
	Port Townsend	7
	Edmonds	5
	Bellingham	4
	Snohomish	3

Table 2.3-14. Count of Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Community of Residence of Owner of Vessel, 2001 (continued)

Geographical Area	Community	Number of Catcher Vessels
	Bainbridge Island	2
	Friday Harbor	2
	Gig Harbor	2
	Kirkland	2
	Poulsbo	2
	Shoreline	2
	Vashon	2
	Woodinville	2
	Bainbridge Island	1
	Burlington	1
	Camano Island	1
	Chimacum	1
	Ellensburg	1
	Enumclaw	1
	Everett	1
	Fox Island	1
	Granite Falls	1
	Kalama	1
	Kingston	1
	Lynden	1
	Mill Creek	1
	Montesano	1
	Mt Vernon	1
	Port Angeles	1
	Port Hadlock	1
	Prosser	1
	Salkum	1
	Seaview	1
	Tacoma	1
	Westport	
Washington Total		**92**
Other States	Fort Bragg, CA	2
	Richmond, CA	1
	San Pedro, CA	1
	Santa Barbara, CA	1
	Trinidad, CA	1
	Kailua-Kona, HI	1
	Post Falls, ID	1
	Scotia, NY	1
Other States Total		**9**
Unknown		1
Grand Total		**491**

Source: AKFIN data set 2003

Table 2.3-15. Ex-Vessel Value of Harvest at Risk for Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Any Alternative by Geographical Area of Residence of Owner of Vessel, 2001

Geographical Area	Number of Catcher Vessels	Ex-Vessel Value
Alaska		
Aleutians East Borough	17	$747,500
Kenai Peninsula Borough	66	$5,280,348
Kodiak Borough	94	$8,808,770
Sitka Borough	49	$1,744,714
Other Alaska	132	$4,471,217
Alaska Total	**358**	**$21,052,549**
Oregon	31	$3,199,964
Washington	92	$12,393,897
Other States	9	$1,637,008
Grand Total	**491**	**$38,283,418**

Source: AKFIN data set 2003

Table 2.3-14. Count of Halibut Catcher Vessels Harvesting in Areas Potentially

Table 3.1-1. Values Per Metric Ton of Groundfish Species in Alaska by Gear and Species Group

Area	Species Group	Gear	Value (per mt)	Area	Species Group	Gear	Value (per mt)
BSAI	AKPL	TWL	$502	BSAI	PCOD	POT	$1,255
BSAI	AKPL	POT	$313	BSAI	PCOD	HAL	$1,251
BSAI	AKPL	HAL	$313	GOA	PCOD	TWL	$1,176
GOA	AKPL	TWL	$313	GOA	PCOD	POT	$1,289
GOA	AKPL	POT	$313	GOA	PCOD	HAL	$1,162
GOA	AKPL	HAL	$313	GOA	PELS	TWL	$507
BSAI	ATKA	TWL	$995	GOA	PELS	POT	$907
BSAI	ATKA	POT	$1,009	GOA	PELS	HAL	$1,102
BSAI	ATKA	HAL	$1,028	BSAI	PLCK	TWL	$735
GOA	ATKA	TWL	$888	BSAI	PLCK	POT	$494
GOA	ATKA	POT	$888	BSAI	PLCK	HAL	$748
GOA	ATKA	HAL	$888	GOA	PLCK	TWL	$550
BSAI	ARTH	TWL	$505	GOA	PLCK	POT	$571
BSAI	ARTH	POT	$308	GOA	PLCK	HAL	$496
BSAI	ARTH	HAL	$502	BSAI	POP	TWL	$492
GOA	ARTH	TWL	$504	BSAI	POP	HAL	$485
GOA	ARTH	POT	$502	GOA	POP	TWL	$486
GOA	ARTH	HAL	$500	GOA	POP	POT	$486
GOA	DEEP	TWL	$1,105	GOA	POP	HAL	$485
GOA	DEEP	POT	$900	GOA	REXS	TWL	$2,365
GOA	DEEP	HAL	$694	BSAI	RSOL	TWL	$1,185
GOA	DEMS	TWL	$1,600	BSAI	RSOL	POT	$618
GOA	DEMS	POT	$1,600	BSAI	RSOL	HAL	$656
GOA	DEMS	HAL	$1,600	BSAI	SABL	TWL	$4,922
BSAI	FSOL	TWL	$1,000	BSAI	SABL	POT	$4,906
BSAI	FSOL	POT	$794	BSAI	SABL	HAL	$4,965
BSAI	FSOL	HAL	$926	GOA	SABL	TWL	$4,893
GOA	FSOL	TWL	$956	GOA	SABL	POT	$4,922
GOA	FSOL	POT	$956	GOA	SABL	HAL	$4,951
GOA	FSOL	HAL	$956	GOA	SHAL	TWL	$673
BSAI	GTRB	TWL	$694	GOA	SHAL	POT	$673
BSAI	GTRB	POT	$523	GOA	SHAL	HAL	$673
BSAI	GTRB	HAL	$762	BSAI	SKATE	TWL	$321
BSAI	NRCK	TWL	$404	BSAI	SKATE	POT	$321
BSAI	NRCK	HAL	$441	BSAI	SKATE	HAL	$321
GOA	NRCK	TWL	$377	BSAI	SQUD	TWL	$112
GOA	NRCK	POT	$377	BSAI	SQUD	POT	$112
GOA	NRCK	HAL	$377	BSAI	SQUD	HAL	$112
BSAI	OFLT	TWL	$2,312	GOA	SQUD	TWL	$112
BSAI	OFLT	POT	$2,381	GOA	SQUD	POT	$112
BSAI	OFLT	HAL	$1,230	GOA	SQUD	HAL	$112
BSAI	ORCK	TWL	$531	BSAI	SRRE	TWL	$1,651
BSAI	ORCK	POT	$405	BSAI	SRRE	POT	$1,310
BSAI	ORCK	HAL	$570	BSAI	SRRE	HAL	$2,167
GOA	ORCK	TWL	$405	GOA	SRRE	TWL	$1,999
GOA	ORCK	HAL	$405	GOA	SRRE	HAL	$2,327
BSAI	OTHR	TWL	$848	BSAI	THDS	TWL	$3,184
BSAI	OTHR	POT	$603	BSAI	THDS	HAL	$3,330
BSAI	OTHR	HAL	$837	GOA	THDS	TWL	$1,774
GOA	OTHR	TWL	$832	GOA	THDS	HAL	$3,371
GOA	OTHR	POT	$790	BSAI	YSOL	TWL	$540
GOA	OTHR	HAL	$747	BSAI	YSOL	POT	$411
BSAI	PCOD	TWL	$1,257	BSAI	YSOL	HAL	$539

Species Group:
AKPL = Alaska Pleice
ATKA = Atka mackerel
ARTH = Arrowtooth flounder
DEEP = Deepwater flatfish
DEMS = Demersal shelf rockfish
FSOL = Flathead sole
GTRB = Greenland turbot
NRCK = Northern rockfish
OFLT = Other flatfish
OTHR = Other
PCOD = Pacific cod
PELS = Pelagic shelf rockfish
PLCK = Pollock
POP = Pacific ocean perch
REXS = Rex sole
RSOL = Rock sole
SABL = Sablefish
SHAL = Shallow water flatfish
SKATE = Skate
SQUD = Squid
SRRE = Shortraker and rougheye rockfish
THDS = Thornyhead rockfish
YSOL = Yellowfin sole

Gear: TWL = Trawl
POT = Pot
HAL = Hook and line

Source: Terry Hiatt, NMFS

Table 3.2-1. Summary of Benefits and Costs for Alternative 1

Benefit or Cost Category	Alternative 1 Status Quo
EFH Passive Use Value	No additional protection measures beyond those currently in place for EFH
EFH Use Values	Continued commercial fishery exploitation in EFH areas.
Revenue At Risk	No revenues at risk for EFH protection measures
Product Quality	No change from current management impacts on product quality
Operating Costs	Operating costs as currently affected by fishery management measures
Safety	No change in safety costs from current condition
Impacts on Related Fisheries	No additional impacts on related fisheries
Costs to Consumers	No additional costs to consumers
Management and Enforcement	No additional management or enforcement costs
Impacts on Dependent Communities	No additional impacts on dependent communities

Table 3.3-1. Summary of Benefits and Costs for Alternative 2

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 2 GOA NPT SLOPE ROCKFISH 11 SELECTED CLOSURE AREAS
EFH Passive Use Value	No additional protection measures beyond those currently in place for EFH	Protects 10,228 km^2 of seabed from NPT targeting slope rockfish complex.
EFH Use Values	Continued commercial fishery exploitation in EFH areas.	It is not known whether protection of EFH under this alternative would result in sustained or increased production and yield of any FMP species. The other use values of EFH under this alternative are unknown.
Revenue At Risk	No revenues at risk for EFH protection measures	EFH protection measures place $900,000 or 9.6% of status quo gross revenue at risk in 2001, mainly in the catcher processor fleet in the CG and WG. Some or all of the revenue at risk may be mitigated in adjacent open areas using NPT gear.
Product Quality	No change from current management impacts on product quality	May have minimal impact on product quality since nearby open areas are adjacent to closed areas.
Operating Costs	Operating costs as currently impacted by fishery management measures	May have minimal impact on operating costs since nearby open areas are adjacent to closed areas.
Safety	No change in safety costs from current condition	May have some impact on safety costs since nearby open areas are adjacent to closed areas.
Impacts on Related Fisheries	No additional impacts on related fisheries	May have minimal impact on related fisheries since effort may likely be redeployed into adjacent areas concurrently fished by NPT.
Costs to Consumers	No additional costs to consumers	May have minimal cost to consumers since gross revenue at risk may be mitigated and additional operational costs may be low.
Management and Enforcement	No additional management or enforcement costs	Catcher vessel and catcher processor vessels using NPT gear and targeting slope rockfish may need VMS or 100% observer coverage. Additional management and research costs may occur.
Impacts on Dependent Communities	No additional impacts on dependent communities	Some adverse impacts may accrue to Washington based catcher-processors, but overall impacts to dependent communities are expected to be insignificant.

Table 3.3-2. Distributional Revenue at Risk (millions of dollars) for Alternative 2 1/

Revenue at Risk Category	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessesl**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	<$0.01	<$0.01	7.8%	$0.62	$0.02	3.6%	$0.62	$0.02	3.6%
Central Gulf	$2.33	$0.03	1.2%	$5.62	$0.62	10.9%	$7.95	$0.64	8.1%
Western Gulf	$0.00	<$0.01	0.0%	$0.79	$0.23	28.9%	$0.79	$0.23	28.9%
Total GOA	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
BS	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
AI	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
All Alaska	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
Fishery									
Groundfish	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	<$0.01	0.0%	$0.00	$0.00	0.0%	$0.00	<$0.01	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA									
Arrowtooth Flounder	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Deep Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - bottom	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.3-2. Distributional Revenue at Risk (millions of dollars) for Alternative 2 [1/] (continued)

Revenue at Risk Category	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessesl**			**Catcher-Processors**			**Total**		
BS									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.3-2. Distributional Revenue at Risk (millions of dollars) for Alternative 2 [1/] (continued)

Revenue at Risk Category	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk	Alternative 2 - Status Quo	Alternative 2 - Revenue at Risk	Alternative 2 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vesselsl**			**Catcher-Processors**			**Total**		
Alaska									
Arrowtooth Flounder	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Deep Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - bottom	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher Vessels Are Ex-vessel Values and Catcher-Processors Are First Wholesale Value (millions of dollars, based on 2001).

NA = not applicable

Table 3.3-3. Summary First Wholesale Value for Groundfish, Halibut, and Crab of Catcher Vessel Landed Catch to Inshore Processors Under Status Quo and At Risk Due to EFH Mitigation Measures by Area in 2001

	Alt 2			Alt 3			Alt 4		
Area	**At Risk**	**Status Quo**	**%**	**At Risk**	**Status Quo**	**%**	**At Risk**	**Status Quo**	**%**
AI	$0	$0	0%	$0	$0	0%	$3,334	$3,077,678	0%
EBS High	$0	$0	0%	$0	0	0%	$3,394	$13,316,351	0%
EBS Low	$0	$0	0%	$0	0	0%	$3	$2,738	0%
CG	$148,579	$10,783,228	1%	$1,733,031	$10,787,013	16%	$148,579	$10,783,228	1%
EG	$0	$0	0%	$0	$0	0%	$0	$0	0%
WG	$0	$0	0%	$0	$0	0%	$0	$0	0%
GOA	$148,579	$10,783,228	1%	$1,733,031	$10,787,013	16%	$148,579	$10,783,228	1%
Total High	$148,579	$10,783,228	1%	$1,733,031	$10,787,013	16%	$155,307	$27,177,256	1%
Total Low	$148,579	$10,783,228	1%	$1,733,031	$10,787,013	16%	$151,916	$13,863,643	1%

	Alt 5A			Alt 5B			Alt 5C (Preferred)		
Area	**At Risk**	**Status Quo**	**%**	**At Risk**	**Status Quo**	**%**	**At Risk**	**Status Quo**	**%**
AI	$1,981	$2,824,987	0%	$725,940	$3,078,704	24%	$435,564	$3,078,704	14%
EBS High	$3,232	$13,313,583	0%	$3,232	$13,313,583	0%	$0	$13,313,583	0%
EBS Low	$23	$13,313,583	0%	$23	$13,313,583	0%	$0	$13,313,583	0%
CG	$1,853,183	$34,465,926	5%	$1,853,183	$34,465,926	5%	$197,147	$34,465,926	1%
EG	$445,852	$1,881,123	24%	$445,852	$1,881,123	24%	$148,617	$1,881,123	8%
WG	$980,865	$6,102,547	16%	$980,865	$6,102,547	16%	$81,739	$6,102,547	1%
GOA	$3,279,900	$42,449,597	8%	$3,279,900	$42,449,597	8%	$427,503	$42,449,597	1%
Total High	$3,285,113	$58,588,167	6%	$4,009,072	$58,841,883	7%	$863,067	$58,841,883	1%
Total Low	$3,281,904	$58,588,167	6%	$4,005,862	$58,841,883	7%	$863,067	$58,841,883	1%

	Alt 6		
Area	**At Risk**	**Status Quo**	**%**
AI	$7,970,798	$35,040,695	23%
EBS High	$71,197,126	$514,539,012	14%
EBS Low	$71,197,126	$514,539,012	14%
CG	$33,868,538	$143,616,442	24%
EG	$8,640,572	$86,551,837	10%
WG	$11,097,484	$31,088,869	36%
GOA	$53,606,593	$261,257,147	21%
Total High	$132,774,517	$810,836,854	16%
Total Low	$132,774,517	$810,836,854	16%

Note: Alternative 6 includes values for groundfish, halibut, and crab. Coral Garden impacts are not included in Alternatives 5B or 5C; see text in Sections 3.7 and 3.8.

Table 3.4-1. Summary of Benefits and Costs for Alternative 3

Benefit or Cost Category	Alternative 1 - Status Quo	Alternative 3 - GOA NPT Slope Rockfish Slope from 200 to 1000 m
EFH Passive Use Value	No additional protection measures beyond those currently in place for EFH	Protects 29,059 km^2 of seabed from NPT targeting slope rockfish complex.
EFH Use Values	Continued commercial fishery exploitation in EFH areas.	It is not known whether protection of EFH under this alternative would result in sustained or increased production and yield of any FMP species. The other use values of EFH under this alternative are unknown.
Revenue At Risk	No revenues at risk for EFH protection measures	EFH protection measures place $2.65 million or 28.3% of $9.36 million in status quo gross revenue at risk in 2001. Both the CV and CP fleet in the CG and the CP fleet in the WG are impacted. Some or all of the revenue at risk may be mitigated in adjacent open areas (shallower than 200 m depth) and with PTR gear. Some revenue at risk may transfer from smaller CV to larger CV and CP fleet components.
Product Quality	No change from current management impacts on product quality	May have some impact on product quality in CV fleet due to longer running time to open areas.
Operating Costs	Operating costs as currently impacted by fishery management measures	There may be an increase in operating costs in both CV and CP fleets targeting slope RF in the CG and the CP fleet in the WG.
Safety	No change in safety costs from current condition	Some impact on safety costs due to increased effort to mitigate revenue at risk in the CG and WG.
Impacts on Related Fisheries	No additional impacts on related fisheries	Additional NPT effort targeting Slope RF in waters shallower than 200 m may increase gear conflicts with HAL and Pot fisheries.
Costs to Consumers	No additional costs to consumers	May have minimal increased costs to consumers since some or all of the gross revenue at risk may be mitigated and some increase in operational costs may be reflected in an increased price of products to consumers.
Management and Enforcement	No additional management or enforcement costs	Catcher vessel and catcher processor vessels using NPT gear and targeting slope rockfish may require VMS or 100% observer coverage. There may be additional management and research costs.
Impacts on Dependent Communities	No additional impacts on dependent communities	Due to GOA fishery effects, smaller Kodiak owned CVs may lose some rockfish share to larger CVs and C/Ps, and Kodiak and Washington owned C/Ps as a sector may be adversely affected, but overall impacts to dependent communities are expected to be insignificant.

Table 3.4-2. Distributional Revenue at Risk (millions of dollars) for Alternative 3[1/]

Revenue at Risk Category	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	<$0.01	<$0.01	28.0%	$0.62	$0.21	33.3%	$0.62	$0.21	33.3%
Central Gulf	$2.33	$0.43	18.6%	$5.62	$1.80	31.9%	$7.95	$2.23	28.0%
Western Gulf	$0.00	$0.00	0.0%	$0.79	$0.22	27.3%	$0.79	$0.22	27.3%
Total GOA	$2.33	$0.43	18.6%	$7.04	$2.22	31.5%	$9.36	$2.65	28.3%
BS	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
AI	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
All Alaska	$2.33	$0.43	18.6%	$7.04	$2.22	31.5%	$9.36	$2.65	28.3%
Fishery									
Groundfish	$2.33	$0.43	18.6%	$7.04	$2.22	31.5%	$9.36	$2.65	28.3%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$2.33	$0.43	18.6%	$7.04	$2.22	31.5%	$9.36	$2.65	28.3%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA									
Arrowtooth Flounder	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Deep Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - bottom	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$2.33	$0.43	18.6%	$7.04	$2.22	31.5%	$9.36	$2.65	28.3%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.4-2. Distributional Revenue at Risk (millions of dollars) for Alternative 3[1/] (continued)

Revenue at Risk Category	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
BS									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.4-2. Distributional Revenue at Risk (millions of dollars) for Alternative 3[1/] (continued)

Revenue at Risk Category	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk	Alternative 3 - Status Quo	Alternative 3 - Revenue at Risk	Alternative 3 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Alaska									
Arrowtooth Flounder	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Deep Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - bottom	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$2.33	$0.43	18.6%	$7.04	$2.22	31.5%	$9.36	$2.65	28.3%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher Vessels Are Ex-vessel Values and Catcher Processors Are First Wholesale Value (millions of dollars, based on 2001).

Table 3.5-1. Summary of Benefits and Costs for Alternative 4

Benefit or Cost Category	Alternative 1 - Status Quo	Alternative 4 - GOA NPT Slope Rockfish 11 Designated Areas BS NPT 25% Rotating Closures AI NPT Designated Areas
EFH Passive Use Value	No additional protection measures beyond those currently in place for EFH	Protects a total of 81,097 km^2 of EFH, including 22, 883 km^2 in the AI, 47,986 km^2 in the BS, and 10,228 km^2 in the GOA. Restricts NPT for all species in designated areas of the BS and AI and NPT for slope RF in designated areas of the GOA.
EFH Use Values	Continued commercial fishery exploitation in EFH areas.	It is not known whether protection of EFH under this alternative would result in sustained or increased production and yield of any FMP species. The other use values of EFH under this alternative are unknown.
Revenue At Risk	No revenues at risk for EFH protection measures	EFH protection measures place \$3.53 to \$6.11 million or 2.2% to 3.8% of the \$156.86 to \$162.79 million status quo gross revenue at risk (value dependent upon BS rotational area). GOA revenue at risk is \$0.90 million or 9.6% of slope rockfish NPT status quo of \$9.4 million. BS revenue at risk is \$1.8 to \$4.4 million or 2.0% to 4.5% of \$90.92 to \$96.74 million status quo. AI revenue at risk is \$0.82 million or 1.4% of \$56.70 million status quo. Main revenue at risk impact is for CPs at \$0.86 million or 12.3% status quo at risk in the GOA, \$1.82 million to \$4.40 million or 2.0% to 4.8% at risk in BS, and \$0.8 or 1.5% at risk in the AI. Main fisheries affected are NPT for slope rockfish in the GOA, flathead sole in BS and rockfish in the AI.
Product Quality	No change from current management impacts on product quality	May have some impact on product quality in CV fleet due to longer running time to open areas.
Operating Costs	Operating costs as currently impacted by fishery management measures	May be likely to increase operating costs in the CP and CV fleets in all areas.
Safety	No change in safety costs from current condition	May be likely to affect safety costs due to increased effort to mitigate revenue at risk.
Impacts on Related Fisheries	No additional impacts on related fisheries	Redeployment of NPT gear fishing effort in the BS and AI may impact fisheries using HAP and POT.
Costs to Consumers	No additional costs to consumers	May have minimal increased costs to consumers since some or all of the gross revenue at risk may be mitigated and some increase in operational costs may increase the price of products.
Management and Enforcement	No additional management or enforcement costs	Catcher vessel and catcher processor vessels using NPT gear and targeting slope rockfish in the GOA and all species in the BSAI may need VMS or 100% observer coverage. There may be additional management and research costs.
Impacts on Dependent Communities	No additional impacts on dependent communities	GOA related community impacts would be similar to Alt 3. BSAI fishery related community impacts would be negligible. Overall, impacts to dependent communities are expected to be insignificant.

Table 3.5-2. Distributional Revenue at Risk (millions of dollars) for Alternative 4[1/]

Revenue at Risk Category	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	<$0.01	<$0.01	7.8%	$0.62	$0.02	3.6%	$0.62	$0.02	3.6%
Central Gulf	$2.33	$0.03	1.2%	$5.62	$0.62	10.9%	$7.95	$0.64	8.1%
Western Gulf	$0.00	<$0.01	0.0%	$0.79	$0.23	28.9%	$0.79	$0.23	28.9%
Total GOA	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
BS	$0.00-$5.82	<$0.01	0.0%	$90.34-$90.92	$1.82-$4.40	2.0%-4.8%	$90.92-$96.74	$1.82-$4.40	2.0%-4.5%
AI	$1.33	<$0.01	0.1%	$55.38	$0.82	1.5%	$56.70	$0.82	1.4%
All Alaska	$3.54-$9.48	$0.03-$0.03	0.8%-0.3%	$152.75-$153.33	$3.50-$6.08	2.3%-4.0%	$156.86-$162.79	$3.53-$6.11	2.2%-3.8%
Fishery									
Groundfish	$3.54-$9.48	$0.03-$0.03	0.8%-0.3%	$152.75-$153.33	$3.50-$6.08	2.3%-4.0%	$156.86-$162.79	$3.53-$6.11	2.2%-3.8%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$3.54-$9.47	$0.03-$0.03	0.8%-0.3%	$152.75-$153.33	$3.50-$6.08	2.3%-4.0%	$156.86-$162.79	$3.53-$6.11	2.2%-3.8%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA									
Arrowtooth Flounder	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Deep Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Other	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - bottom	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rockfish	$2.33	$0.03	1.2%	$7.03	$0.87	12.3%	$9.36	$0.90	9.6%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.5-2. Distributional Revenue at Risk (millions of dollars) for Alternative 4[1/] (continued)

Revenue at Risk Category	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
BS									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$3.36-$3.38	$0.01-$0.08	0.3%-2.4%	$3.36-$3.38	$0.01-$0.08	0.3%-2.4%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$14.46	$1.23-$3.34	8.5%-23.1%	$14.46	$1.23-$3.34	8.5%-23.1%
Greenland Turbot	$0.00	$0.00	0.0%	$0.56-$1.12	$0.12-$0.12	0.7%-10.9%	$0.56-$1.12	$0.12-$0.12	0.7%-10.9%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.04	12.9%-20.7%	$0.17-$0.18	$0.02-$0.04	12.9%-20.7%
Other Flatfish	$0.00	$0.00	0.0%	$4.16-$4.16	$0.01-$0.03	0.0%-0.7%	$4.16-$4.16	$0.01-$0.03	0.0%-0.7%
Pacific Cod	$0.00-$5.82	$0.00	0.0%	$8.50	$0.14-$0.73	1.6%-8.6%	$8.50-$14.33	$0.14-$0.73	1.6%-5.1%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$23.62-$23.62	$0.03-$0.15	0.1%-0.6%	$23.62-$23.62	$0.03-$0.15	0.1%-0.6%
Rockfish	$0.00	$0.00	0.0%	$0.05-$0.16	$0.01-$0.03	17.9%-20.6%	$0.05-$0.16	$0.01-$0.03	17.9%-20.6%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34-$35.34	<$0.01	0.0%-0.1%	$35.34-$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$0.03	$0.01	39.6%	$0.03	$0.01	39.6%
Atka Mackerel	$0.00	$0.00	0.0%	$41.16	$0.08	0.2%	$41.16	$0.08	0.2%
Flathead Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	55.0%	<$0.01	<$0.01	55.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.38	$0.19	51.1%	$0.38	$0.19	51.1%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.6%	<$0.01	<$0.01	0.6%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$1.32	<$0.01	0.1%	$8.28	$0.02	0.2%	$9.60	$0.02	0.2%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.13	$0.06	42.0%	$0.13	$0.06	42.0%
Rockfish	$0.00	$0.00	0.0%	$5.40	$0.46	8.6%	$5.40	$0.46	8.6%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.5-2. Distributional Revenue at Risk (millions of dollars) for Alternative 4[1/] (continued)

Revenue at Risk Category	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk	Alternative 4 - Status Quo	Alternative 4 - Revenue at Risk	Alternative 4 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Alaska									
Arrowtooth Flounder	$0.00	$0.00	0.0%	$3.39-$3.42	$0.02-$0.10	0.7%-2.8%	$3.39-$3.42	$0.02-$0.10	0.7%-2.8%
Atka Mackerel	$0.00	$0.00	0.0%	$41.16	$0.08-$0.08	0.2%-0.2%	$41.16	$0.08-$0.08	0.2%-0.2%
Deep Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$14.47	$1.23-$3.35	8.5%-23.1%	$14.47	$1.23-$3.35	8.5%-23.1%
Greenland Turbot	$0.00	$0.00	0.0%	$0.94-$1.49	$0.20-$0.31	20.9%-21.0%	$0.94-$1.50	$0.20-$0.31	20.9%-20.9%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.04	12.8%-20.6%	$0.17-$0.18	$0.02-$0.04	12.8%-20.6%
Other Flatfish	$0.00	$0.00	0.0%	$4.16-$4.16	$0.01-$0.03	0.0%-0.7%	$4.16-$4.16	$0.01-$0.03	0.0%-0.7%
Pacific Cod	$1.21-$7.14	<$0.01	0.1%-0.0%	$16.78	$0.15-$0.74	0.9%-4.4%	$17.99-$23.92	$0.15-$0.75	0.9%-3.1%
Pollock - bottom	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$23.75-$23.75	$0.09-$0.20	0.4%-0.9%	$23.75-$23.75	$0.09-$0.20	0.4%-0.9%
Rockfish	$2.33-$2.33	$0.03-$0.03	1.2%-1.2%	$12.48-$12.58	$1.33-$1.36	10.7%-10.8%	$14.80-$14.91	$1.36-$1.39	9.2%-9.3%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34-$35.34	<$0.01	0.0%-0.1%	$35.34-$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher Vessels Are Ex-vessel Values and Catcher-Processors Are First Wholesale Value (millions of dollars, based on 2001).

Table 3.6-1. Summary of Benefits and Costs for Alternative 5A

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 5A GOA NPT SLOPE ROCKFISH SLOPE FROM 200 TO 1000 M GOA NPT ALL SPECIES 10 AREAS BS NPT ALL SPECIES 33% ROTATION AI NPT DESIGNATED AREAS
EFH Passive Use Value	No additional protection measures beyond those currently in place for EFH	Protects a total of 128,114 km^2 of EFH, including 32, 235 km^2 in the AI, 63,975 km^2 in the BS, and 31,904 km^2 in the GOA. Restricts NPT for all species in designated areas of the BS and AI and NPT for slope RF along the slope (200 to 1,000 m) and for all species in designated areas of the GOA.
EFH Use Values	Continued commercial fishery exploitation in EFH areas.	It is not known whether protection of EFH under this alternative will result in sustained or increased production and yield of any FMP species. The other use values of EFH under this alternative are unknown.
Revenue At Risk	No revenues at risk for EFH protection measures	EFH protection measures place $7.92 million to $10.90 million or 4.4% to 6.0% of the $180.66 to $181.30 million status quo gross revenue at risk (value dependent upon BS rotational area). GOA revenue at risk is $3.60 million or 13.0% of the status quo of $27.69 million. BS revenue at risk is $2.63 to $5.61 million or 2.7% to 5.8% of $96.27 to $96.91 million of status quo revenue. AI revenue at risk of $1.69 million or 3.0% of the $56.70 million status quo revenue. Both the CV and CP fleets have a similar percent of status quo revenue at risk of 4.6% (CV) and 4.4% to 6.2% (CP). The CP revenue at risk ranges from $7.02 million to $10.0 million and the CV fleet revenue at risk is $0.90 million. The CV fleet is affected mainly in the GOA while the CP fleets are affected in all three areas. The main fisheries affected are slope rockfish and Pacific cod in the GOA, flathead sole and Pacific cod in the BS, and rockfish in the AI.
Product Quality	No change from current management impacts on product quality	May have some impact on product quality in CV fleet due to longer running time to open areas.
Operating Costs	Operating costs as currently impacted by fishery management measures	Likelihood of up to a some increase in operating costs in the CV and CP fleets targeting Atka mackerel, Pacific cod and rockfish in the AI, the CP fleet targeting flathead sole and other flatfish in the BS, and the CV and CP fleets targeting rockfish and Pacific cod in the GOA.
Safety	No change in safety costs from current condition	Some impact on safety costs due to increased effort to mitigate revenue at risk, particularly in the AI.
Impacts on Related Fisheries	No additional impacts on related fisheries	Redeployment of NPT gear fishing effort may impact fisheries using HAP and POT.
Costs to Consumers	No additional costs to consumers	There may be increased costs to consumers if not all of the gross revenue at risk can be mitigated and if increases in operational costs and reflected in product prices.
Management and Enforcement	No additional management or enforcement costs	Catcher vessel and catcher processor vessels using NPT gear and targeting slope rockfish in the GOA and all species in the BSAI may require VMS or 100% observer coverage. There may be additional management and research costs.
Impacts on Dependent Communities	No additional impacts on dependent communities	Smaller CVs from King Cove, Sand Point, and Kodiak would likely experience adverse impacts, and these impacts, especially in conjunction with potential impacts to shoreside processors in smaller WG area communities, may be felt at the community level in King Cove and Sand Point. Adverse impacts to C/Ps would be concentrated exclusively in Kodiak and Washington and are expected to be insiginifcant at the community level.

Table 3.6-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5A [1/]

Revenue at Risk Category	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	$0.31	$0.06	20.8%	$0.45	$0.18	39.3%	$0.76	$0.24	31.8%
Central Gulf	$9.76	$0.47	4.9%	$10.93	$2.07	18.9%	$20.69	$2.55	12.3%
Western Gulf	$2.24	$0.36	16.0%	$4.00	$0.45	11.3%	$6.25	$0.81	13.0%
Total GOA	$12.31	$0.90	7.3%	$15.38	$2.70	17.6%	$27.69	$3.60	13.0%
BS	$5.82	<$0.01	0.0%-0.0%	$90.45-$91.08	$2.63-$5.61	2.9%-6.2%	$96.27-$96.91	$2.63-$5.61	2.7%-5.8%
AI	$1.32	<$0.01	0.1%	$55.38	$1.69	3.1%	$56.70	$1.69	3.0%
All Alaska	$19.45	$0.90-$0.90	4.6%-4.6%	$161.21-$161.84	$7.02-$10.00	4.4%-6.2%	$180.66-$181.30	$7.92-$10.90	4.4%-6.0%
Fishery									
Groundfish	$19.45	$0.90-$0.90	4.6%-4.6%	$161.21-$161.84	$7.02-$10.00	4.4%-6.2%	$180.66-$181.30	$7.92-$10.90	4.4%-6.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$19.45	$0.90-$0.90	4.6%-4.6%	$161.21-$161.84	$7.02-$10.00	4.4%-6.2%	$180.66-$181.30	$7.92-$10.90	4.4%-6.0%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA									
Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$3.08	<$0.01	0.1%	$3.08	<$0.01	0.1%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$0.79	<$0.01	1.1%	$0.79	<$0.01	1.1%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Pacific Cod	$7.34	$0.38	5.1%	$0.32	<$0.01	0.3%	$7.66	$0.38	4.9%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Rockfish	$2.33	$0.44	18.8%	$7.04	$2.38	33.8%	$9.36	$2.82	30.1%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.6-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5A 1/ (continued)

Revenue at Risk Category	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
BS									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%
Greenland Turbot	$0.00	$0.00	0.0%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$5.82	<$0.01	0.0%-0.0%	$8.50	$0.19-$0.98	2.2%-11.5%	$14.33	$0.19-$0.98	1.3%-6.8%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%
Rockfish	$0.00	$0.00	0.0%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.0%-0.1%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$0.03	$0.01	39.3%	$0.03	$0.01	39.3%
Atka Mackerel	$0.00	$0.00	0.0%	$41.16	$0.20	0.5%	$41.16	$0.20	0.5%
Flathead Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	54.5%	<$0.01	<$0.01	54.5%
Greenland Turbot	$0.00	$0.00	0.0%	$0.38	$0.19	51.0%	$0.38	$0.19	51.0%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.6%	<$0.01	<$0.01	0.6%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$1.32	<$0.01	0.1%	$8.28	$0.13	1.6%	$9.59	$0.13	1.4%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.13	$0.06	42.8%	$0.13	$0.06	42.8%
Rockfish	$0.00	$0.00	0.0%	$5.40	$1.09	20.2%	$5.40	$1.09	20.2%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.6-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5A [1/] (continued)

Revenue at Risk Category	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk	Alternative 5A - Status Quo	Alternative 5A - Revenue at Risk	Alternative 5A - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Alaska									
Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$6.49-$6.50	$0.03-$0.11	0.5%-1.7%	$6.49-$6.50	$0.03-$0.11	0.5%-1.7%
Atka Mackerel	$0.00	$0.00	0.0%	$41.16	$0.20	0.5%	$41.16	$0.20	0.5%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$15.25-$15.25	$1.71-$4.24	11.2%-27.8%	$15.25-$15.25	$1.71-$4.24	11.2%-27.8%
Greenland Turbot	$0.00	$0.00	0.0%	$0.88-$1.49	$0.19-$0.32	21.2%-22.1%	$0.88-$1.49	$0.19-$0.32	21.2%-22.1%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.8%	$0.17-$0.18	$0.02-$0.05	11.6%-27.8%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$14.48	$0.38-$0.38	2.6%-2.6%	$17.10	$0.32-$1.11	1.9%-6.5%	$31.58	$0.70-$1.49	2.2%-4.7%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	$23.75-$23.75	$0.12-$0.22	0.5%-0.9%	$23.75-$23.75	$0.12-$0.22	0.5%-0.9%
Rockfish	$2.33	$0.44	18.8%	$12.11-$12.11	$3.49-$3.52	28.8%-29.1%	$14.44-$14.44	$3.93-$3.96	27.2%-27.4%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.00%-0.00%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher vessels are ex-vessel values and catcher-processors are first wholesale value (millions of dollars, based on 2001).

Table 3.7-1. Summary of Benefits and Costs for Alternative 5B

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 5B GOA NPT SLOPE ROCKFISH SLOPE FROM 200 TO 1,000 M GOA NPT ALL SPECIES 10 AREAS BS NPT ALL SPECIES 33% ROTATION AI NPT DESIGNATED AREAS BY CPUE AND HABITAT AI ALL BOTTOM CONTACT GEAR IN SIX CORAL GARDENS
EFH Non-use Value	No change	This alternative would protect 160,865 to 172,568 km^2 of EFH—(64,986 to 76,689 km^2 in AI + 63,975 km^2 in BS + 31,904 km^2 in GOA). It would restrict NPT for all species in designated areas of BSAI and NPT for slope RF along the slope (200 to 1,000 m) and for all species in designated areas of GOA. It establishes open and closed areas for NPT fisheries. Under Options 1 and 2, AI NPT fisheries could be further restricted based on coral/sponge bycatch rates and would reduce TACs in some NPT fisheries by weight historically caught in closed areas. Under Option 2, fishing with all bottom-contact gear would be prohibited in six designated coral gardens in the AI.
EFH Use Values	Continued commercial fishery exploitation, at present levels, in EFH areas	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species. All other EFH use values under this alternative are unknown.
Revenue At Risk	No attributable EFH revenues at risk	EFH would place $7.46 million to $15.93 million (4.1 to 8.8% of the $179.77 million to $180.41 million status quo) gross revenue at risk (value dependent upon BS rotational area and AI option chosen). GOA revenue at risk would be $3.60 million (13.0 of $27.69 million status quo). BS revenue at risk would be $2.63 million to $5.61 million (2.7 to 5.8% of $96.27 million to $96.91 million status quo). AI revenue at risk due to NPT restrictions would be $6.71 million (12.0% of the $55.81 million status quo revenue) under Option 1, $2.99 million (5.4% of status quo revenue) under Option 2, and $1.23 million (2.2% of status quo revenue) under Option 3. Under Option 2, the six coral garden areas would place an additional $234,000 in groundfish revenue at risk, up to 4.4% of the halibut HAL harvest in the AI IPHC area 4B and 0.3% of catch in king and Tanner crab POT fisheries in the AI. BSAI revenue lost to TAC reduction could total $15.16 million which would be more than the revenue at risk in these areas under Option 1. AI revenue lost to TAC reduction could total $3.83 million under Option 2. C/P revenue at risk could range from $6.53 million to $14.72 million dependent upon BS rotational area and AI option chosen. CV revenue at risk would range from $0.93 million to $1.21 million dependent upon BS rotational area and AI option chosen. The CV fleet would be impacted in the GOA and AI, while C/Ps would be impacted in all three areas. The main fisheries affected would be slope rockfish and Pacific cod in GOA; flathead sole and Pacific cod in BS; and Atka mackerel, Pacific cod, and rockfish in AI.
Product Quality	No change	This alternative might have an adverse impact on product quality. The CV fleet might have increased running time to and from open areas.
Operating Costs	No change	This alternative would have probable increases in CV and C/P operating costs targeting Atka mackerel, Pacific cod, and rockfish in AI, C/Ps targeting flathead sole and other flatfish in BS, CVs and C/Ps targeting rockfish and Pacific cod in GOA. In AI, 100% observer coverage requirement would increase costs for 30% coverage vessels.
Safety	No change	This alternative would have the potential for some adverse safety impacts due to expected increased effort to mitigate revenue at risk, particularly in AI.
Impacts on Related Fisheries	No additional impacts on related fisheries	Redeployment of NPT effort in the BS and AI might adversely impact fisheries using HAL and POT, through damage, loss, or displacement.
Costs to Consumers	No change	This alternative would have expected adverse impacts on consumers from AI NPT fishery restrictions. Some production would be lost due to TAC reductions under AI Options 1 and 2. Operational cost increases might result in higher consumer prices and/or limited supply. Consumer prices for other fishery products from other EFH impacted areas might increase, as well, if catch at risk were not recovered, or operational cost increases could be passed along to the consumer.
Management and Enforcement	No additional management or enforcement costs	CVs and C/Ps using NPT gear and targeting slope rockfish in the GOA, and all targeting species in the BSAI, might be required to have VMS or 100% observer coverage. In the AI, 100% observer coverage would increase management costs. In the AI, a required research and monitoring program would result in increase costs.
Impacts on Dependent Communities	No additional impacts on dependent communities	GOA and BS fishery related community impacts to King Cove, Sand Point, and Kodiak would be similar to Alternative 5A. Additional AI CV and C/P related impacts would accrue to Kodiak and Washington communities, but would probably be insignificant at the community level. Additional shoreside processing impacts might be seen at Unalaska/Dutch Harbor, but would probably be insignificant.

Table 3.7-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 1 [1/]

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	$0.31	$0.06	20.8%	$0.45	$0.18	39.3%	$0.76	$0.24	31.8%
Central Gulf	$9.76	$0.47	4.9%	$10.93	$2.07	18.9%	$20.69	$2.55	12.3%
Western Gulf	$2.24	$0.36	16.0%	$4.00	$0.45	11.3%	$6.25	$0.81	13.0%
Total GOA	$12.31	$0.90	7.3%	$15.38	$2.70	17.6%	$27.69	$3.60	13.0%
BS	$5.82	<$0.01	0.0%-0.0%	$90.45-$91.08	$2.63-$5.61	2.9%-6.2%	$96.27-$96.91	$2.63-$5.61	2.7%-5.8%
AI	$1.32	$0.31	23.6%	$54.49	$6.40	11.7%	$55.81	$6.71	12.0%
All Alaska	$19.45	$1.21-$1.21	6.2%-6.2%	$160.32-$160.95	$11.73-$14.72	7.3%-9.1%	$179.77-$180.41	$12.94-$15.93	7.2%-8.8%
Fishery									
Groundfish	$19.45	$1.21-$1.21	6.2%-6.2%	$160.32-$160.95	$11.73-$14.72	7.3%-9.1%	$179.77-$180.41	$12.94-$15.93	7.2%-8.8%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$19.45	$1.21-$1.21	6.2%-6.2%	$160.32-$160.95	$11.73-$14.72	7.3%-9.1%	$179.77-$180.41	$12.94-$15.93	7.2%-8.8%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$3.08	<$0.01	0.1%	$3.08	<$0.01	0.1%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$0.79	<$0.01	1.1%	$0.79	<$0.01	1.1%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Pacific Cod	$7.34	$0.38	5.1%	$0.32	<$0.01	0.3%	$7.66	$0.38	4.9%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Rockfish	$2.33	$0.44	18.8%	$7.04	$2.38	33.8%	$9.36	$2.82	30.1%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.7-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 1 [1/] (continued)

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
BS Arrowtooth Flnd.	$0.00	$0.00	0.0%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%
Greenland Turbot	$0.00	$0.00	0.0%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$5.82	<$0.01	0.0%-0.0%	$8.50	$0.19-$0.98	2.2%-11.5%	$14.33	$0.19-$0.98	1.3%-6.8%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%
Rockfish	$0.00	$0.00	0.0%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.0%-0.1%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI Arrowtooth Flnd.	$0.00	$0.00	0.0%	<$0.01	<$0.01	11.1%	<$0.01	<$0.01	11.1%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$3.61	8.8%	$41.01	$3.61	8.8%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.03	<$0.01	18.8%	$0.03	<$0.01	18.8%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	7.4%	<$0.01	<$0.01	7.4%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$1.32	$0.31	23.6%	$8.29	$1.33	16.1%	$9.61	$1.64	17.1%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.08	<$0.01	11.7%	$0.08	<$0.01	11.7%
Rockfish	$0.00	$0.00	0.0%	$5.08	$1.45	28.5%	$5.08	$1.45	28.5%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.7-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 1 [1/] (continued)

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Alaska Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$6.47-$6.48	$0.02-$0.10	0.3%-1.5%	$6.47-$6.48	$0.02-$0.10	0.3%-1.5%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$3.61	8.8%	$41.01	$3.61	8.8%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$15.24-$15.25	$1.71-$4.24	11.2%-27.8%	$15.24-$15.25	$1.71-$4.24	11.2%-27.8%
Greenland Turbot	$0.00	$0.00	0.0%	$0.53-$1.15	$0.13-$0.13	1.5%-11.4%	$0.53-$1.15	$0.13-$0.13	1.5%-11.4%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.7%	$0.17-$0.18	$0.02-$0.05	11.6%-27.7%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$14.48	$0.69-$0.69	4.7%-4.8%	$17.12	$1.52-$2.31	8.9%-13.5%	$31.60	$2.21-$3.00	7.0%-9.5%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	$23.70-$23.70	$0.08-$0.17	0.3%-0.7%	$23.70-$23.70	$0.08-$0.17	0.3%-0.7%
Rockfish	$2.33	$0.44	18.8%	$12.27-$12.27	$3.84-$3.87	31.3%-31.5%	$14.60-$14.60	$4.28-$4.31	29.3%-29.5%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.00%-0.00%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher vessels are ex-vessel values and catcher-processors are first wholesale value (millions of dollars, based on 2001).

Table 3.7-3. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 2 (excluding AI coral gardens impacts [2/]) [1/]

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	$0.31	$0.06	20.8%	$0.45	$0.18	39.3%	$0.76	$0.24	31.8%
Central Gulf	$9.76	$0.47	4.9%	$10.93	$2.07	18.9%	$20.69	$2.55	12.3%
Western Gulf	$2.24	$0.36	16.0%	$4.00	$0.45	11.3%	$6.25	$0.81	13.0%
Total GOA	$12.31	$0.90	7.3%	$15.38	$2.70	17.6%	$27.69	$3.60	13.0%
BS	$5.82	<$0.01	0.0%-0.0%	$90.45-$91.08	$2.63-$5.61	2.9%-6.2%	$96.27-$96.91	$2.63-$5.61	2.7%-5.8%
AI	$1.32	$0.05	3.9%	$54.49	$2.94	5.4%	$55.81	$2.99	5.4%
All Alaska	$19.45	$0.95-$0.95	4.9%-4.9%	$160.32-$160.95	$8.27-$11.25	5.2%-7.0%	$179.77-$180.41	$9.22-$12.20	5.1%-6.8%
Fishery									
Groundfish	$19.45	$0.95-$0.95	4.9%-4.9%	$160.32-$160.95	$8.27-$11.25	5.2%-7.0%	$179.77-$180.41	$9.22-$12.20	5.1%-6.8%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$19.45	$0.95-$0.95	4.9%-4.9%	$160.32-$160.95	$8.27-$11.25	5.2%-7.0%	$179.77-$180.41	$9.22-$12.20	5.1%-6.8%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$3.08	<$0.01	0.1%	$3.08	<$0.01	0.1%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$0.79	<$0.01	1.1%	$0.79	<$0.01	1.1%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Pacific Cod	$7.34	$0.38	5.1%	$0.32	<$0.01	0.3%	$7.66	$0.38	4.9%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Rockfish	$2.33	$0.44	18.8%	$7.04	$2.38	33.8%	$9.36	$2.82	30.1%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.7-3. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 2 (excluding AI coral gardens impacts [2/]) [1/](continued)

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
BS Arrowtooth Flnd.	$0.00	$0.00	0.0%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%
Greenland Turbot	$0.00	$0.00	0.0%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$5.82	<$0.01	0.0%	$8.50	$0.19-$0.98	2.2%-11.5%	$14.33	$0.19-$0.98	1.3%-6.8%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%
Rockfish	$0.00	$0.00	0.0%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.0%-0.1%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI Arrowtooth Flnd.	$0.00	$0.00	0.0%	<$0.01	<$0.01	11.1%	<$0.01	<$0.01	11.1%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$1.59	3.9%	$41.01	$1.59	3.9%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.03	<$0.01	0.4%	$0.03	<$0.01	18.8%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	7.4%	<$0.01	<$0.01	7.4%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$1.32	$0.05	3.9%	$8.29	$0.43	5.2%	$9.61	$0.48	5.0%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.08	<$0.01	11.7%	$0.08	<$0.01	11.7%
Rockfish	$0.00	$0.00	0.0%	$5.08	$1.19	23.5%	$5.08	$1.19	23.5%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.7-3. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 2 (excluding AI coral gardens impacts [2/]) [1/] (continued)

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Alaska									
Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$6.47-$6.48	$0.02-$0.10	0.3%-1.5%	$6.47-$6.48	$0.02-$0.10	0.3%-1.5%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$1.59	3.9%	$41.01	$1.59	3.9%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$15.24-$15.25	$1.71-$4.24	11.2%-27.8%	$15.24-$15.25	$1.71-$4.24	11.2%-27.8%
Greenland Turbot	$0.00	$0.00	0.0%	$0.53-$1.15	$0.13-$0.13	1.5%-11.4%	$0.53-$1.15	$0.13-$0.13	1.5%-11.4%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.7%	$0.17-$0.18	$0.02-$0.05	11.6%-27.7%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$14.48	$0.44-$0.45	3.0%-3.1%	$17.12	$0.62-$1.41	0.4%-8.2%	$31.60	$1.05-$1.84	3.3%-5.8%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	$23.70-$23.70	$0.08-$0.17	0.3%-0.7%	$23.70-$23.70	$0.08-$0.17	0.3%-0.7%
Rockfish	$2.33	$0.44	18.8%	$12.27-$12.27	$3.58-$3.61	29.4%	$14.60-$14.60	$4.02-$4.05	27.5%-27.7%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.00%-0.00%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher vessels are ex-vessel values and catcher-processors are first wholesale value (millions of dollars, based on 2001).

2/ Impacts on revenue and catch at risk from the AI Coral Garden areas are excluded from the table and covered in the RIR text.

Table 3.7-4. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 3 [1/]

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	$0.31	$0.06	20.8%	$0.45	$0.18	39.3%	$0.76	$0.24	31.8%
Central Gulf	$9.76	$0.47	4.9%	$10.93	$2.07	18.9%	$20.69	$2.55	12.3%
Western Gulf	$2.24	$0.36	16.0%	$4.00	$0.45	11.3%	$6.25	$0.81	13.0%
Total GOA	$12.31	$0.90	7.3%	$15.38	$2.70	17.6%	$27.69	$3.60	13.0%
BS	$5.82	<$0.01	0.0%-0.0%	$90.45-$91.08	$2.63-$5.61	2.9%-6.2%	$96.27-$96.91	$2.63-$5.61	2.7%-5.8%
AI	$1.32	$0.03	2.2%	$54.49	$1.20	2.2%	$55.81	$1.23	2.2%
All Alaska	$19.45	$0.93-$0.93	4.8%-4.8%	$160.32-$160.95	$6.53-$9.51	4.1%-5.9%	$179.77-$180.41	$7.46-$10.44	4.1%-5.8%
Fishery									
Groundfish	$19.45	$0.93-$0.93	4.8%-4.8%	$160.32-$160.95	$6.53-$9.51	4.1%-5.9%	$179.77-$180.41	$7.46-$10.44	4.1%-5.8%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$19.45	$0.93-$0.93	4.8%-4.8%	$160.32-$160.95	$6.53-$9.51	4.1%-5.9%	$179.77-$180.41	$7.46-$10.44	4.1%-5.8%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$3.08	<$0.01	0.1%	$3.08	<$0.01	0.1%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$0.79	<$0.01	1.1%	$0.79	<$0.01	1.1%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Pacific Cod	$7.34	$0.38	5.1%	$0.32	<$0.01	0.3%	$7.66	$0.38	4.9%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	0.0%	<$0.01	<$0.01	0.0%
Rockfish	$2.33	$0.44	18.8%	$7.04	$2.38	33.8%	$9.36	$2.82	30.1%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.7-4. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 3 [1/] (continued)

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
BS Arrowtooth Flnd.	$0.00	$0.00	0.0%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%	$3.38-$3.38	$0.02-$0.09	0.5%-2.8%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%	$14.46-$14.46	$1.70-$4.23	11.8%-29.3%
Greenland Turbot	$0.00	$0.00	0.0%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%	$0.50-$1.12	$0.12-$0.13	0.5%-11.2%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%	$0.17-$0.18	$0.02-$0.05	11.6%-27.9%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$5.82	<$0.01	0.0%	$8.50	$0.19-$0.98	2.2%-11.5%	$14.33	$0.19-$0.98	1.3%-6.8%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%	$23.62-$23.62	$0.07-$0.16	0.3%-0.7%
Rockfish	$0.00	$0.00	0.0%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%	$0.16-$0.16	$0.01-$0.04	7.2%-27.2%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.0%-0.1%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI Arrowtooth Flnd.	$0.00	$0.00	0.0%	<$0.01	<$0.01	11.1%	<$0.01	<$0.01	11.1%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$0.62	1.5%	$41.01	$0.62	1.5%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.03	<$0.01	0.4%	$0.03	<$0.01	18.8%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	7.4%	<$0.01	<$0.01	7.4%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$1.32	$0.03	2.3%	$8.29	$0.32	3.9%	$9.61	$0.35	3.6%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.08	<$0.01	11.7%	$0.08	<$0.01	11.7%
Rockfish	$0.00	$0.00	0.0%	$5.08	$0.26	5.1%	$5.08	$0.26	5.1%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.7-4. Distributional Revenue at Risk (millions of dollars) for Alternative 5B, Option 3 [1/] (continued)

Revenue at Risk Category	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk	Alternative 5B - Status Quo	Alternative 5B - Revenue at Risk	Alternative 5B - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Alaska									
Arrowtooth Flounder	<$0.01	<$0.01	0.0%	$6.47-$6.48	$0.02-$0.10	0.3%-1.5%	$6.47-$6.48	$0.02-$0.10	0.3%-1.5%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$0.62	1.5%	$41.01	$0.62	1.5%
Deep Water Flatfish	$0.33	$0.01	3.4%	<$0.01	<$0.01	2.2%	$0.33	$0.01	3.4%
Flathead Sole	<$0.01	<$0.01	0.0%	$15.24-$15.25	$1.71-$4.24	11.2%-27.8%	$15.24-$15.25	$1.71-$4.24	11.2%-27.8%
Greenland Turbot	$0.00	$0.00	0.0%	$0.53-$1.15	$0.13-$0.13	1.5%-11.4%	$0.53-$1.15	$0.13-$0.13	1.5%-11.4%
Other	$0.00	$0.00	0.0%	$0.17-$0.18	$0.02-$0.05	11.6%-27.7%	$0.17-$0.18	$0.02-$0.05	11.6%-27.7%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	<$0.01	0.2%-0.6%	$4.32	<$0.01	0.2%-0.6%
Pacific Cod	$14.48	$0.41-$0.41	2.8%-2.8%	$17.12	$0.51-$1.30	3.0%-7.6%	$31.60	$0.92-$1.71	2.9%-5.4%
Pollock - bottom	$0.80	$0.07	9.1%	$0.00	$0.00	0.0%	$0.80	$0.07	9.1%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.3%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	$23.70-$23.70	$0.08-$0.17	0.3%-0.7%	$23.70-$23.70	$0.08-$0.17	0.3%-0.7%
Rockfish	$2.33	$0.44	18.8%	$12.27-$12.27	$2.65-$2.68	21.6%-21.8%	$14.60-$14.60	$3.09-$3.12	21.2%-22.4%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	<$0.01	0.00%-0.00%	$35.34	<$0.01	0.0%-0.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher vessels are ex-vessel values and catcher-processors are first wholesale value (millions of dollars, based on 2001).

Table 3.8-1. Summary of Benefits and Costs for Alternative 5C (Preferred Alternative)

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 5C (PREFERRED ALTERNATIVE) GOA NPT ALL SPECIES 10 DESIGNATED AREAS AI NPT DESIGNATED AREAS BY CPUE AND HABITAT AI ALL BOTTOM CONTACT GEAR IN SIX CORAL GARDENS
EFH Non-use Value	No change	This alternative would protect 74,250 km^2 of EFH (7,157 km^2 in GOA + 67,093 km^2 in AI). It would restrict NPT for all species in 10 designated areas of the GOA slope (200 to 1,000 m) and for all species in designated areas of AI. It would prohibit use of all bottom contact gear in 380 km^2 in six designated coral garden areas of the AI.
EFH Use Values	Continued commercial fishery exploitation at present levels in EFH areas	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species. All other EFH use values under this alternative are unknown.
Revenue At Risk	No attributable EFH revenues at risk	EFH NPT protection measures would place $2.39 million or 1.3% of the $180.41 million status quo gross revenue at risk. GOA revenue at risk would be $1.17 million or 4.2% of the status quo of $27.69 million. GOA affected fisheries would include CV NPT targeting Pacific cod and C/P NPT fisheries targeting Pacific cod, rockfish, and rex sole. AI revenue at risk would be $1.23 million or 2.2% of the $55.81 million status quo revenue. The C/P revenue at risk would be $2.0 million or 1.2% of the $160.95 million status quo gross revenue. CV revenue at risk would be $0.4 million or 2.0% of the $19.45 million status quo gross revenue. NPT restrictions in the AI would affect CV fisheries targeting Pacific cod and C/P fisheries targeting Atka mackerel, Pacific cod, and rockfish. AI coral garden area closure to bottom contact gear would place an additional $234,000 of groundfish revenue at risk, up to 4.4% of AI HAL halibut catch at risk, and 0.3% of POT catch of AI king and Tanner crab.
Product Quality	No change	This alternative might have an adverse impact on product quality. The CV fleet might have increased running time to and from open areas.
Operating Costs	No change	This alternative would have probable increases in CV and C/P operating costs targeting Atka mackerel, Pacific cod, and rockfish in the AI, and CVs and C/Ps targeting rockfish and Pacific cod in GOA. In the AI, 100% observer coverage requirement would increase costs for 30% coverage vessels. In the GOA, 100% VMS requirement for bottom contact gear vessels would impose additional costs, particularly on smaller vessels.
Safety	No change	This alternative would create the potential for some adverse safety impacts due to expected increased effort to mitigate revenue at risk, particularly in AI.
Impacts on Related Fisheries	No additional impacts on related fisheries	Redeployment of NPT effort in the AI might adversely impact fisheries using HAL and POT through damage, loss, or displacement.
Costs to Consumers	No change	This alternative would have expected adverse impacts on consumers from AI NPT fishery restrictions. Operational cost increases might result in higher consumer prices and/or limited supply. Consumer prices for other fishery products from other EFH impacted areas might increase, as well, if catch at risk were not recovered, or operational cost increases could be passed along to the consumer.
Management and Enforcement	No additional management or enforcement costs	CVs and C/Ps using bottom contact gear in the GOA might be required to have VMS or 100% observer coverage for EFH and HAPC regulation enforcement. In the AI, 100% observer coverage would increase management costs.
Impacts on Dependent Communities	No additional impacts on dependent communities	GOA fishery related community impacts to King Cove, Sand Point, and Kodiak would be similar to Alternative 5A. Additional AI CV and C/P related impacts would accrue to Kodiak and Washington communities, but would probably be insignificant at the community level. Additional shoreside processing impacts might be seen at Unalaska/Dutch Harbor, but would probably be insignificant.

Table 3.8-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5C, Preferred Alternative (excluding AI coral gardens impacts [2/]) [1/]

Revenue at Risk Category	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk
Fleet Component		**Catcher Vessels**			**Catcher-Processors**			**Total**	
Geographic									
Eastern Gulf	$0.31	$0.02	6.1%	$0.45	$0.02	3.5%	$0.76	$0.03	4.6%
Central Gulf	$9.76	$0.05	0.5%	$10.93	$0.51	4.7%	$20.69	$0.56	2.7%
Western Gulf	$2.24	$0.30	13.4%	$4.00	$0.27	6.7%	$6.25	$0.57	9.1%
Total GOA	$12.31	$0.37	3.0%	$15.38	$0.80	5.2%	$27.69	$1.17	4.2%
BS	$5.82	$0.00	0.0%	$91.08	$0.00	0.0%	$96.91	$0.00	0.0%
AI	$1.32	$0.03	2.2%	$54.49	$1.20	2.2%	$55.81	$1.23	2.2%
All Alaska	$19.45	$0.40	2.0%	$160.95	$2.00	1.2%	$180.41	$2.39	1.3%
Fishery									
Groundfish	$19.45	$0.40	2.0%	$160.95	$2.00	1.2%	$180.41	$2.39	1.3%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gear									
NPT	$19.45	$0.40	2.0%	$160.95	$2.00	1.2%	$180.41	$2.39	1.3%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
HAL	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
POT	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Target Fishery									
GOA Arrowtooth Flounder	<$0.01	$0.00	0.0%	$3.08	$0.00	0.1%	$3.08	<$0.01	0.0%
Deep Water Flatfish	$0.33	$0.02	6.8%	<$0.01	$0.00	0.0%	$0.33	<$0.01	0.0%
Flathead Sole	<$0.01	$0.00	0.0%	$0.79	$0.01	0.8%	$0.79	<$0.01	0.0%
Other	$0.00	$0.00	0.0%	<$0.01	$0.00	0.0%	<$0.01	<$0.01	0.0%
Pacific Cod	$7.34	$0.32	4.4%	$0.32	$0.00	0.2%	$7.66	$0.32	4.2%
Pollock - bottom	$0.80	$0.00	0.0%	$0.00	$0.00	0.0%	$0.80	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.2%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	<$0.01	$0.00	0.0%	<$0.01	$0.00	0.0%
Rockfish	$2.33	$0.02	1.0%	$7.04	$0.50	7.0%	$9.36	$0.52	5.5%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	<0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.8-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5C, Preferred Alternative (excluding AI coral gardens impacts) (continued)

Revenue at Risk Category	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
BS Arrowtooth Flnd.	$0.00	N/A	N/A	$3.38	N/A	N/A	$3.38	N/A	N/A
Atka Mackerel	$0.00	N/A	N/A	$0.00	N/A	N/A	$0.00	N/A	N/A
Flathead Sole	$0.00	N/A	N/A	$14.46	N/A	N/A	$14.46	N/A	N/A
Greenland Turbot	$0.00	N/A	N/A	$1.12	N/A	N/A	$1.12	N/A	N/A
Other	$0.00	N/A	N/A	$0.18	N/A	N/A	$0.18	N/A	N/A
Other Flatfish	$0.00	N/A	N/A	$4.32	N/A	N/A	$4.32	N/A	N/A
Pacific Cod	$5.82	N/A	N/A	$8.50	N/A	N/A	$14.32	N/A	N/A
Pollock--midwater	$0.00	N/A	N/A	$0.00	N/A	N/A	$0.00	N/A	N/A
Rock Sole	$0.00	N/A	N/A	$23.62	N/A	N/A	$23.62	N/A	N/A
Rockfish	$0.00	N/A	N/A	$0.16	N/A	N/A	$0.16	N/A	N/A
Sablefish	$0.00	N/A	N/A	$0.00	N/A	N/A	$0.00	N/A	N/A
Yellowfin Sole	$0.00	N/A	N/A	$35.34	N/A	N/A	$35.34	N/A	N/A
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AI Arrowtooth Flnd.	$0.00	$0.00	0.0%	<$0.01	<$0.01	11.1%	<$0.01	<$0.01	11.1%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$0.62	1.5%	$41.01	$0.62	1.5%
Flathead Sole	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Greenland Turbot	$0.00	$0.00	0.0%	$0.03	<$0.01	0.4%	$0.03	<$0.01	18.8%
Other	$0.00	$0.00	0.0%	<$0.01	<$0.01	7.4%	<$0.01	<$0.01	7.4%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$1.32	$0.03	2.3%	$8.29	$0.32	3.9%	$9.61	$0.35	3.6%
Pollock--midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rock Sole	$0.00	$0.00	0.0%	$0.08	<$0.01	11.7%	$0.08	<$0.01	11.7%
Rockfish	$0.00	$0.00	0.0%	$5.08	$0.26	5.1%	$5.08	$0.26	5.1%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3.8-2. Distributional Revenue at Risk (millions of dollars) for Alternative 5C, Preferred Alternative (excluding AI coral gardens impacts) (continued)

Revenue at Risk Category	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk	Alternative 5C - Status Quo	Alternative 5C - Revenue at Risk	Alternative 5C - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Alaska									
Arrowtooth Flounder	<$0.01	$0.00	0.0%	$6.48	<$0.01	<0.1%	$6.48	<$0.01	<0.1%
Atka Mackerel	$0.00	$0.00	0.0%	$41.01	$0.62	1.5%	$41.01	$0.62	1.5%
Deep Water Flatfish	$0.33	$0.02	6.8%	<$0.01	$0.00	0.0%	$0.33	$0.02	6.0%
Flathead Sole	<$0.01	$0.00	0.0%	$15.25	$0.01	<0.1%	$15.25	$0.01	0.1%
Greenland Turbot	$0.00	$0.00	0.0%	$1.15	<$0.01	<0.1%	$1.15	<$0.01	0.1%
Other	$0.00	$0.00	0.0%	$0.18	<$0.01	<0.1%	$0.18	<$0.01	<0.1%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	$0.00	0.0%	$4.32	$0.00	0.0%
Pacific Cod	$14.48	$0.35	2.4%	$17.12	$0.32	1.8%	$31.60	$0.67	2.1%
Pollock - bottom	$0.80	$0.00	0.0%	$0.00	$0.00	0.0%	$0.80	$0.00	0.0%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.00	$0.00	0.0%	$4.15	$0.30	7.2%	$4.15	$0.30	7.3%
Rock Sole	$0.00	$0.00	0.0%	$23.70	<$0.01	<0.1%	$23.70	<$0.01	<0.1%
Rockfish	$2.33	$0.02	1.0%	$12.27	$0.76	6.2%	$14.60	$0.78	5.3%
Sablefish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Shallow Water Flatfish	$1.51	<$0.01	<0.1%	$0.00	$0.00	0.0%	$1.51	<$0.01	0.1%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.34	$0.00	0.0%	$35.34	$0.00	0.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1/ Catcher vessels are ex-vessel values and catcher-processors are first wholesale value (millions of dollars, based on 2001).

2/ Impacts on revenue and catch at risk from the AI Coral Garden areas are excluded from the table and covered in the RIR text.

Table 3.8-3. Comparison of Costs of Adding VMS to GOA Vessels Falling in Different Size Classes

Variable	All Vessels	Less Than or Equal to			Unknown
		32 Feet	30 Feet	25 Feet	
Count of vessels	928 (install on 635)	84 (install on 76)	28 (install on 28)	15 (install on 15)	11 (install on 11)
Average installation cost in a vessel adding it	$1,550	$1,550	$1,550	$1,550	$1,550
Average annual transmission costs all vessels	$527	$372	$252	$203	$581
Average annual repair costs for a vessel adding VMS	$47/$93	$93	$93	$93	$93
Average 2003 revenues all vessels	$580,000	$103,000	$17,000	$5,000	$20,000
2003 median	$196,000				
Total installation costs for vessels adding it	$984,000	$118,000	$43,000	$23,000	$17,000
Total annual transmission costs all vessels	$489,000	$31,000	$7,000	$3,000	$6,000
Total annual repair costs all vessels	$34,000	$7,800	$2,600	$1,400	$1,000
Total 2003 gross revenues from all sources	**$538,191,000**	**$8,689,000**	**$476,000**	**$73,000**	**$219,000**

Notes: The “all vessels” and “less than or equal to” categories include vessels that already have VMS. Eight vessels in the less than or equal to 32 feet category already have VMS. Gross revenues estimates include gross revenues from all sources in federally and State of Alaska managed fisheries off of Alaska, including fisheries not using bottom-contact gear. Repair costs were estimated at $47 for vessels over 32 feet and at $93 for others. Breakdowns may also result in losses due to lost fishing time. These have not been monetized.

Table 3.9-1. Summary of Benefits and Costs for Alternative 6

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 6 CLOSURE TO ALL BOTTOM TENDING GEAR IN 20% OF FISHABLE WATERS
EFH Non-Use Value	No change	This alternative would protect 218,750 km^2 of EFH (20,729 km^2 in the AI + 136,031 km^2 in the BS + 61,991 km^2 in the GOA). It would restrict NPT for all species in designated areas of the BSAI. In the GOA, NPT for slope RF along the slope (200 to 1,000 m) and all species in designated areas would be restricted. It would prohibit NPT fisheries in the AI based on coral/sponge bycatch rates. It would Reduce TACs in NPT fisheries by weight historically caught in closed areas.
EFH Use Values	Continued commercial fishery exploitation, at present levels, in EFH areas.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species. All other EFH use values under this alternative are unknown.
Revenue At Risk	No revenues at risk	EFH protection measures would place $237.20 million (18.9% of $1.26 billion status quo gross revenue) at risk. GOA revenue at risk would be $46.52 million (22.0% of status quo of $211.48 million). BS revenue at risk would be $177.54 million (19.0% of $934.36 million status quo). AI revenue at risk would be $13.14 million (11.8% of $111.30 million status quo). Groundfish fisheries would incur the largest revenue at risk impact at $163.76 million (16.0% of status quo), followed by halibut at $38.34 million (34.2% of status quo), crab at $34.11 million (29.4% of status quo), then scallops at $0.98 million (29.1% of status quo revenue). In the GOA, these would be, in order, halibut fisheries at $32.12 million, sablefish fisheries at $6.66 million, Pacific cod fisheries at $2.63 million, and rockfish fishery at $2.29 million. In the BS, the pollock fishery would have revenues at risk of $104.04 million, crab fisheries $28.45 million, and Pacific cod $23.83 million at risk. In the AI, the crab fishery would have $5.3 million at risk, halibut fishery $2.69 million, and Pacific cod $2.32 million at risk.
Product Quality	No change	There would likely be some adverse impact on product quality in the CV fleet due to longer running time between open areas and shoreside processors.
Operating Costs	No change	There would be a strong likelihood of some increase in operating costs of CVs and C/Ps targeting Atka mackerel, Pacific cod and rockfish in the AI, C/Ps targeting flathead sole and other flatfish in the BS, CVs and C/Ps targeting rockfish and Pacific cod in the GOA. In the AI, 100% observer requirement would increase costs for current 30% coverage vessels.
Safety	No change	There might be an impact on safety costs due to increased effort to mitigate revenue at risk in all areas.
Impacts on Related Fisheries	No change	Redeployment of NPT effort in the BS and AI might adversely impact fisheries using HAL and POT, through damage, loss, or displacement.
Costs to Consumers	No additional costs to consumers	There would be a high probability of adverse impacts on consumers. There would be a likely significant loss of aggregate production due to substantial reductions in fishable open areas. Operational cost increases might be prohibitive for some operations and/or sectors. Loss of production would result in higher consumer prices and/or limited supplies. There would be a potential for loss of market share, with associated welfare losses for U.S. consumers.
Management and Enforcement	No additional management or enforcement costs	Catcher vessel and catcher processor vessels using bottom-contact fishing gear for all species might be required to have VMS or 100% observer coverage. Additional management costs may be inferred.
Impacts on Dependent Communities	No additional impacts on dependent communities	Significant dependent community impacts would result from Alternative 6. Groundfish CV related community impacts would be largely concentrated in King Cove, Sand Point, Kodiak, and Homer. Halibut CV impacts would be felt in many communities of various sizes throughout the GOA and BSAI regions, but would likely be most adverse in the comparatively small communities of Sand Point and St. George. Crab fleet associated impacts would be most prominent in Kodiak, although some of the smaller community fleets might also feel effects. Seattle CVs would experience the greatest level of impact of any community fleet, but effects would be insignificant at the community level. C/P impacts would be concentrated largely in Kodiak and Washington communities. Shoreside processor impacts would be concentrated largely in Unalaska, St. Paul, and Kodiak, although other communities would be affected. Overall, multi-sector impacts that might be significant at the community level would occur in Kodiak, Sand Point, King Cove, St. George, and St. Paul. Other communities with substantial, but likely less than significant, impacts would be Homer, Seward, Sitka, Petersburg, Unalaska, and Seattle. Additional impacts related specifically to small vessel fleets due to substantial nearby closures would be likely for a number of communities. Based on 2001 data, St. George is the most obvious example, but similar (if less intense) effects would likely be felt in St. Paul, the Chigniks, and Port Alexander. A number of other communities would experience indirect impacts through permanent local closures serving to make any future small vessel fisheries development difficult, if not impossible.

Table 3.9-2. Distributional Revenue at Risk (millions of dollars) for Alternative 6[1/]

Revenue at Risk Category	Alternative 6 - Status Quo	Alternative 6 - Revenue at Risk	Alternative 6 - % of Status Quo Revenue at Risk	Alternative 6 - Status Quo	Alternative 6 - Revenue at Risk	Alternative 6 - % of Status Quo Revenue at Risk	Alternative 6 - Status Quo	Alternative 6 - Revenue at Risk	Alternative 6 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Geographic									
Eastern Gulf	$69.21	$6.62	9.6%	$3.05	$0.94	31.0%	$72.26	$7.56	10.5%
Central Gulf	$88.21	$24.88	28.2%	$17.72	$4.35	24.5%	$105.92	$29.23	27.6%
Western Gulf	$21.03	$8.48	40.3%	$12.26	$1.25	10.2%	$33.30	$9.73	29.2%
Total GOA	$178.45	$39.98	22.4%	$33.03	$6.54	19.8%	$211.48	$46.52	22.0%
BS	$191.81	$39.49	20.6%	$742.55	$138.05	18.6%	$934.36	$177.54	19.0%
AI	$28.41	$6.83	24.0%	$82.89	$6.31	7.6%	$111.30	$13.14	11.8%
All Alaska	$398.67	$86.30	21.6%	$858.47	$150.89	17.6%	$1,257.14	$237.20	18.9%
Fishery									
Groundfish	$180.60	$16.76	9.3%	$845.01	$147.00	17.4%	$1,025.60	$163.76	16.0%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	$112.04	$38.28	34.2%	$0.12	$0.06	48.0%	$112.16	$38.34	34.2%
Crab	$106.03	$31.26	29.5%	$9.97	$2.85	28.6%	$116.00	$34.11	29.4%
Scallop	$0.00	$0.00	0.0%	$3.37	$0.98	29.1%	$3.37	$0.98	29.1%
Gear									
EG									
HAL	$55.84	$6.58	11.8%	$1.48	$0.28	19.2%	$57.32	$6.86	12.0%
JIG	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
NPT	$0.29	$0.04	12.9%	$0.00	$0.00	0.0%	$0.29	$0.04	12.9%
POT	$13.08	<$0.01	<0.1%	$0.00	$0.00	0.0%	$13.08	<$0.01	<0.1%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
DRG	$0.00	$0.00	0.0%	$1.57	$0.66	42.0%	$1.57	$0.66	42.0%
CG									
HAL	$73.51	$23.01	31.3%	$2.85	$0.45	15.8%	$76.35	$23.46	30.7%
JIG	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
NPT	$10.66	$1.31	12.3%	$13.48	$3.54	26.3%	$24.14	$4.85	15.2%
POT	$4.04	$0.56	13.9%	$0.39	$0.11	27.3%	$4.44	$0.67	15.1%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
DRG	$0.00	$0.00	0.0%	$0.99	$0.25	25.3%	$0.99	$0.25	25.3%
WG									
HAL	$17.16	$8.02	46.7%	$6.85	$0.86	12.5%	$24.01	$8.88	37.0%
JIG	$0.12	<$0.01	<0.1%	$0.00	$0.00	0.0%	$0.12	<$0.01	<0.1%
NPT	$2.17	$0.25	11.3%	$4.47	$0.33	7.4%	$6.64	$0.58	8.7%
POT	$1.59	$0.22	14.0%	$0.76	$0.03	3.8%	$2.35	$0.25	10.7%
PTR	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
DRG	$0.00	$0.00	0.0%	$0.18	$0.03	16.7%	$0.18	$0.03	16.7%
BS									
HAL	$11.06	$3.58	32.3%	$115.28	$21.73	18.9%	$126.34	$25.31	20.0%
JIG	$0.03	<$0.01	8.5%	$0.00	$0.00	0.0%	$0.03	<$0.01	8.5%
NPT	$5.82	$0.17	2.9%	$90.49	$17.60	19.4%	$96.34	$20.03	20.8%
POT	$81.43	$27.82	34.2%	$11.04	$2.61	23.7%	$92.47	$28.16	30.5%
PTR	$93.44	$7.92	8.5%	$525.16	$96.11	18.3%	$618.60	$104.04	16.8%
DRG	$0.00	$0.00	0.0%	$0.58	$0.00	0.0%	$0.58	$0.00	0.0%
AI								$177.54	
HAL	$10.35	$3.03	0.0%	$22.71	$0.49	2.1%	$33.06	$3.51	10.6%
JIG	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
NPT	$1.32	<$0.01	<0.1%	$55.38	$3.97	7.2%	$56.70	$3.98	7.0%
POT	$16.74	$3.80	22.7%	$4.28	$1.76	41.0%	$21.02	$5.56	26.4%
PTR	$0.00	$0.00	0.0%	$0.45	$0.04	10.0%	$0.45	$0.04	10.0%
DRG	$0.00	$0.00	0.0%	$0.06	$0.05	83.3%	$0.06	$0.05	83.3%

Table 3.9-2. Distributional Revenue at Risk (millions of dollars) for Alternative 6$^{1/}$ (continued)

Revenue at Risk Category	Alternative 6 - Status Quo	Alternative 6 - Revenue at Risk	Alternative 6 - % of Status Quo Revenue at Risk	Alternative 6 - Status Quo	Alternative 6 - Revenue at Risk	Alternative 6 - % of Status Quo Revenue at Risk	Alternative 6 - Status Quo	Alternative 6 - Revenue at Risk	Alternative 6 - % of Status Quo Revenue at Risk
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
Target Fishery									
GOA									
Arrowtooth Flounder	$0.12	$0.01	9.8%	$3.37	$0.44	13.2%	$3.48	$0.46	13.1%
Deep Water Flatfish	$0.32	$0.06	18.1%	<$0.01	<$0.01	86.8%	$0.32	$0.06	18.5%
Flathead Sole	$0.13	<$0.01	0.2%	$0.77	$0.04	5.5%	$0.90	$0.04	4.7%
Other	$0.09	$0.02	20.5%	<$0.01	<$0.01	<0.1%	$0.10	$0.02	19.5%
Pacific Cod	$15.34	$1.68	10.9%	$7.09	$0.96	13.5%	$22.43	$2.63	11.7%
Pollock - bottom	$0.88	<$0.01	0.2%	$0.00	$0.00	0.0%	$0.88	<$0.01	0.2%
Pollock - midwater	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Rex Sole	$0.01	<$0.01	1.2%	$5.02	$0.87	17.3%	$5.03	$0.87	17.3%
Rock Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	<0.1%	<$0.01	<$0.01	<0.1%
Rockfish	$4.25	$0.46	10.9%	$6.41	$1.83	28.5%	$10.67	$2.29	21.5%
Sablefish	$45.87	$5.29	11.5%	$7.35	$1.37	18.7%	$53.21	$6.66	12.5%
Shallow Water Flatfish	$1.60	$0.04	2.2%	$0.09	<$0.01	<0.1%	$1.69	$0.04	2.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	$94.50	$32.07	33.9%	$0.12	$0.06	48.0%	$94.62	$32.12	33.9%
Crab	$15.34	$0.37	2.4%	$0.00	$0.00	0.0%	$15.34	$0.37	2.4%
Scallop	$0.00	$0.00	0.0%	$2.74	$0.94	34.3%	$2.74	$0.94	34.3%
BS									
Arrowtooth Flnd.	$0.00	$0.00	0.0%	$3.40	$0.08	2.3%	$3.40	$0.08	2.3%
Atka Mackerel	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Flathead Sole	$0.00	$0.00	0.0%	$14.46	$1.84	12.7%	$14.46	$1.84	12.7%
Greenland Turbot	$0.06	<$0.01	0.2%	$2.55	$0.79	31.1%	$2.61	$0.79	30.4%
Other	$0.00	$0.00	0.0%	$0.54	$0.07	13.6%	$0.54	$0.07	13.6%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	$1.73	40.1%	$4.32	$1.73	40.1%
Pacific Cod	$12.66	$0.62	4.9%	$126.14	$23.22	18.4%	$138.80	$23.83	17.2%
Pollock--midwater	$93.44	$7.92	8.5%	$525.16	$96.11	18.3%	$618.60	$104.04	16.8%
Rock Sole	$0.00	$0.00	0.0%	$23.62	$2.42	10.2%	$23.62	$2.42	10.2%
Rockfish	$0.00	$0.00	0.0%	$0.03	<$0.01	11.8%	$0.04	<$0.01	12.6%
Sablefish	$1.42	$0.07	5.2%	$0.05	<$0.01	11.8%	$1.48	$0.08	5.6%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.39	$10.65	30.1%	$35.39	$10.65	30.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	$9.80	$3.53	36.0%	$0.00	$0.00	0.0%	$9.80	$3.53	36.0%
Crab	$74.42	$27.35	36.7%	$6.27	$1.10	17.6%	$80.70	$28.45	35.3%
Scallop	$0.00	$0.00	0.0%	$0.58	<$0.01	0.0%	$0.58	<$0.01	0.0%

Table 3.9-2. Distributional Revenue at Risk (millions of dollars) for Alternative 6[1/] (continued)

Revenue at Risk Category	**Alternative 6 - Status Quo**	**Alternative 6 - Revenue at Risk**	**Alternative 6 - % of Status Quo Revenue at Risk**	**Alternative 6 - Status Quo**	**Alternative 6 - Revenue at Risk**	**Alternative 6 - % of Status Quo Revenue at Risk**	**Alternative 6 - Status Quo**	**Alternative 6 - Revenue at Risk**	**Alternative 6 - % of Status Quo Revenue at Risk**
Fleet Component	**Catcher Vessels**			**Catcher-Processors**			**Total**		
AI Arrowtooth Flnd.	<$0.01	<$0.01	<0.1%	$0.04	$0.01	32.50%	$0.04	$0.01	32.40%
Atka Mackerel	$0.00	$0.00	0.00%	$41.18	$0.89	2.20%	$41.18	$0.89	2.20%
Flathead Sole	$0.00	$0.00	0.0%	<$0.01	<$0.01	54.0%	<$0.01	<$0.01	54.0%
Greenland Turbot	$0.01	<$0.01	11.3%	$0.41	$0.22	53.9%	$0.42	$0.22	52.9%
Other	<$0.01	<$0.01	36.4%	$0.20	$0.03	17.2%	$0.20	$0.04	17.5%
Other Flatfish	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%	$0.00	$0.00	0.0%
Pacific Cod	$1.44	<$0.01	0.4%	$29.92	$2.32	7.7%	$31.35	$2.32	7.4%
Pollock--midwater	$0.00	$0.00	0.0%	$0.06	<$0.01	16.4%	$0.06	<$0.01	16.4%
Rock Sole	$0.00	$0.00	0.0%	$0.36	$0.04	10.5%	$0.36	$0.04	10.5%
Rockfish	$0.00	$0.00	0.0%	$0.13	$0.06	42.2%	$0.13	$0.06	42.2%
Sablefish	$0.02	<$0.01	10.9%	$5.47	$0.77	14.1%	$5.49	$0.78	14.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	$7.74	$2.69	34.7%	$0.00	$0.00	0.0%	$7.74	$2.69	34.7%
Crab	$16.27	$3.55	21.8%	$3.69	$1.75	47.3%	$19.96	$5.30	26.5%
Scallop	$0.00	$0.00	0.0%	$0.06	$0.05	83.3%	$0.06	$0.05	83.3%
Alaska Arrowtooth Flounder	$0.12	$0.01	9.8%	$6.81	$0.54	7.9%	$6.93	$0.55	7.9%
Atka Mackerel	$0.00	$0.00	0.0%	$41.18	$0.89	2.2%	$41.18	$0.89	2.2%
Deep Water Flatfish	$0.32	$0.06	18.1%	<$0.01	<$0.01	86.8%	$0.32	$0.06	18.5%
Flathead Sole	$0.13	<$0.01	0.2%	$15.24	$1.89	12.4%	$15.37	$1.89	12.3%
Greenland Turbot	$0.07	<$0.01	1.8%	$2.96	$1.01	34.2%	$3.03	$1.01	33.5%
Other	$0.09	$0.02	21.0%	$0.75	$0.11	14.5%	$0.84	$0.13	15.2%
Other Flatfish	$0.00	$0.00	0.0%	$4.32	$1.73	40.1%	$4.32	$1.73	40.1%
Pacific Cod	$29.44	$2.30	7.8%	$163.15	$26.49	16.2%	$192.59	$28.79	15.0%
Pollock - bottom	$2.54	$0.61	24.2%	$23.96	$5.14	21.4%	$26.50	$5.75	21.7%
Pollock - midwater	$91.77	$7.31	8.0%	$501.61	$91.02	18.1%	$593.38	$98.33	16.6%
Rex Sole	$0.01	<$0.01	1.2%	$5.02	$0.87	17.3%	$5.03	$0.87	17.3%
Rock Sole	$0.00	$0.00	0.0%	$23.75	$2.47	10.4%	$23.75	$2.47	10.4%
Rockfish	$4.28	$0.46	10.9%	$11.91	$2.60	21.9%	$16.19	$3.07	19.0%
Sablefish	$50.22	$5.94	11.8%	$8.70	$1.53	17.5%	$58.92	$7.47	12.7%
Shallow Water Flatfish	$1.60	$0.04	2.2%	$0.09	<$0.01	<0.1%	$1.69	$0.04	2.1%
Yellowfin Sole	$0.00	$0.00	0.0%	$35.39	$10.65	30.1%	$35.39	$10.65	30.1%
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	$112.04	$38.28	34.2%	$0.12	$0.06	48.0%	$112.16	$38.34	34.2%
Crab	$106.03	$31.26	29.5%	$9.97	$2.85	28.6%	$116.00	$34.11	29.4%
Scallop	$0.00	$0.00	0.0%	$3.37	$0.98	29.1%	$3.37	$0.98	29.1%

1/ Catcher vessels are ex-vessel values and catcher-processors are first wholesale value (millions of dollars, based on 2001).

Table 3.9-3. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Community of Residence of Owner of Vessel for Selected Fisheries Groups, 2001

Geographical Area	Community	Number of Unique Catcher Vessels	Pollock	Pacific Cod	Other Groundfish	Halibut	Crab	Salmon
Alaska								
Aleutians East Borough	False Pass	1	0	1	1	1	0	0
	King Cove	10	6	10	2	3	10	8
	Sand Point	12	10	12	6	6	10	10
Aleutians East Borough Total		23	16	23	9	10	20	18
Anchorage Borough	Anchorage	14	5	11	10	12	5	5
	Girdwood	1	1	1	1	1	0	1
Anchorage Borough Total		15	6	12	11	13	5	6
Juneau Borough	Douglas	1	0	1	1	1	0	0
	Juneau	7	0	0	7	7	1	2
Juneau Borough Total		8	0	1	8	8	1	2
Kenai Peninsula Borough	Anchor Point	3	2	3	3	3	0	3
	Fritz Creek	1	0	1	1	1	0	1
	Halibut Cove	1	0	0	1	1	0	0
	Homer	36	15	29	33	33	1	19
	Kenai	1	0	1	1	1	0	0
	Nikolaevsk	1	1	1	1	1	0	1
	Seldovia	2	0	2	2	2	0	0
	Seward	6	0	2	6	6	1	3
Kenai Peninsula Borough Total		51	18	39	48	48	2	27
Ketchikan Gateway Borough	Ketchikan	12	0	5	12	12	0	7
Kodiak Island Borough	Kodiak	71	26	66	54	54	39	15
	Larsen Bay	2	0	2	2	0	1	1
	Old Harbor	5	0	5	1	1	2	5
	Port Lions	2	0	2	1	2	0	1
Kodiak Island Borough Total		80	26	75	58	57	42	22
Matanuska-Susitna Borough	Palmer	1	0	0	1	1	0	0
	Wasilla	2	0	1	2	2	0	1
	Willow	2	2	2	2	2	0	2
Matanuska-Susitna Borough Total		5	2	3	5	5	0	3
Prince of Wales-Outer Ketchikan Census Area	Craig	6	0	1	6	6	0	5
	Klawock	1	0	1	1	1	0	1
	Meyers Chuck	1	0	1	1	1	0	1
	Thorne Bay	1	0	0	1	0	0	0
Pr of Wales-Outer Ketch CA Total		9	0	3	9	8	0	7
Sitka Borough	Sitka	40	0	23	40	36	5	23
Skagway-Yakutat-Angoon Census Area	Angoon	1	0	1	1	1	0	1
	Gustavus	1	0	1	1	1	0	0
	Hoonah	2	0	1	2	2	1	2
	Pelican	3	0	2	3	3	1	0
Skagway-Yakutat-Angoon CA Total		7	0	5	7	7	2	3
Valdez-Cordova Census Area	Cordova	6	1	1	6	6	2	1
Wrangell-Petersburg Census Area	Kake	1	0	1	1	1	1	1
	Petersburg	28	1	12	28	28	18	20
	Port Alexander	5	0	2	5	5	1	2
	Wrangell	4	0	0	4	4	0	1
Wrangell-Petersburg Census Area Total		38	1	15	38	38	20	24
ZOther Alaska	Delta Junction	2	2	2	2	2	0	2
	Haines	1	0	1	1	1	0	1
	Unalaska	3	1	3	2	1	1	1
Other Alaska Total		6	3	6	5	4	1	4
Alaska Grand Total		300	73	211	256	252	100	147
Oregon	Astoria	2	1	1	2	1	0	0
	Brookings	1	1	1	1	0	0	0
	Cloverdale	1	1	1	1	1	0	0
	Coos Bay	1	1	1	1	0	0	0
	Depoe Bay	2	1	2	1	1	1	0
	Florence	2	2	2	2	0	1	0
	Mapleton	1	0	1	1	1	0	0
	Newport	18	16	17	18	4	6	0
	Port Orford	1	1	1	1	0	0	0
	Portland	1	0	1	1	0	1	0

Table 3.9-3. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Community of Residence of Owner of Vessel for Selected Fisheries Groups, 2001 (continued)

Geographical Area	Community	Number of Unique Catcher Vessels	Pollock	Pacific Cod	Other Groundfish	Halibut	Crab	Salmon
	Reedsport	1	0	0	1	1	0	0
	Seal Rock	1	0	1	1	1	1	1
	Seaside	1	0	0	1	1	0	0
	Siletz	2	2	2	2	0	2	1
	Sisters	2	0	2	2	2	2	0
	South Beach	1	1	1	1	0	0	0
	Warrenton	2	1	2	2	2	0	0
	Westfir	1	0	0	1	1	0	0
	Woodburn	3	0	2	2	3	0	2
Oregon Total		44	28	38	42	19	14	4
Washington	Aberdeen	2	1	2	2	1	0	0
	Anacortes	8	2	3	8	6	0	1
	Bainbridge Island	1	0	0	1	1	0	0
	Bellingham	5	2	4	5	4	2	1
	Blaine	3	3	3	3	1	0	0
	Burlington	1	0	1	1	1	0	1
	Camano Island	2	0	1	1	1	1	0
	Camas	1	1	1	1	0	1	0
	Chimacum	1	0	0	1	1	0	1
	Chinook	1	0	1	1	1	0	0
	East Wenatchee	1	1	1	1	1	0	0
	Edmonds	7	2	3	7	5	1	4
	Ellensburg	1	0	0	1	1	0	0
	Everett	1	0	1	1	1	0	0
	Federal Way	1	0	1	0	0	1	0
	Fox Island	1	1	1	1	1	0	0
	Friday Harbor	1	0	1	1	1	0	0
	Gig Harbor	2	0	1	2	2	0	0
	Granite Falls	1	0	1	1	1	0	0
	Issaquah	1	1	1	1	0	1	0
	Kalama	1	0	1	0	1	0	1
	Kingston	2	1	1	2	1	0	0
	Kirkland	1	0	1	1	1	0	0
	Long Beach	1	0	0	1	1	0	0
	Lynden	1	1	1	1	1	0	0
	Mill Creek	1	0	1	1	1	0	0
	Montesano	1	0	1	1	1	0	0
	Mount Vernon	1	0	0	1	1	0	1
	Olympia	1	0	0	1	1	0	0
	Port Angeles	1	0	0	1	1	0	1
	Port Hadlock	1	0	0	1	1	0	1
	Port Townsend	4	0	2	3	4	0	2
	Poulsbo	2	0	1	2	1	1	1
	Prosser	1	0	1	1	1	0	1
	Reardan	1	1	1	1	1	0	1
	Renton	1	0	1	0	0	1	0
	Seattle	71	50	56	68	20	23	5
	Seaview	1	0	1	0	1	0	0
	Shoreline	3	3	3	3	2	1	0
	Snohomish	1	0	0	1	1	0	0
	South Bend	1	1	1	1	0	0	0
	Squrmamish	1	1	1	1	0	0	0
	Sultan	1	0	0	1	1	0	0
	Vashon	2	0	1	2	2	0	0
	Woodinville	2	0	0	2	2	0	0
Washington Total		146	72	102	137	77	33	22
Other States	Fort Bragg	2	0	1	2	2	0	0
	Half Moon Bay	2	2	2	2	0	0	0
	Hayfork	1	1	1	0	0	0	0
	Kailua Kona	2	1	2	2	2	2	2
	Kamuela	1	0	1	0	1	0	1
	Lemmon	1	0	1	0	0	0	0

Table 3.9-3. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Community of Residence of Owner of Vessel for Selected Fisheries Groups, 2001 (continued)

Geographical Area	Community	Number of Unique Catcher Vessels	Pollock	Pacific Cod	Other Groundfish	Halibut	Crab	Salmon
	Magnolia Springs	1	0	1	0	0	1	0
	Midvale	1	0	0	1	1	0	0
	Mooresville	1	1	1	1	1	0	1
	Post Falls	1	0	1	1	1	0	0
	Richmond	1	1	1	1	1	1	0
	San Pedro	1	0	1	1	1	1	0
	Santa Barbara	1	1	1	1	1	1	0
	Trinidad	1	0	1	0	1	1	0
Total Other States		17	7	15	12	12	7	4
Grand Total All Regions		**507**	**180**	**366**	**447**	**360**	**154**	**177**

Source: AKFIN data set 2003

Table 3.9-4. Count of Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Geographical Area of Residence of Owner of Vessel for Selected Fisheries Groups, 2001

Geographical Area	Number of Unique Catcher Vessels	Pollock	Pacific Cod	Other Groundfish	Halibut	Crab	Salmon
Alaska							
Aleutians East Borough	23	16	23	9	10	20	18
Anchorage Borough	15	6	12	11	13	5	6
Juneau Borough	8	0	1	8	8	1	2
Kenai Peninsula Borough	51	18	39	48	48	2	27
Ketchikan Gateway Borough	12	0	5	12	12	0	7
Kodiak Island Borough	80	26	75	58	57	42	22
Matanuska-Susitna Borough	5	2	3	5	5	0	3
Prince of Wales-Outer Ketchikan Census Area	9	0	3	9	8	0	7
Sitka Borough	40	0	23	40	36	5	23
Skagway-Yakutat-Angoon Census Area	7	0	5	7	7	2	3
Valdez-Cordova Census Area	6	1	1	6	6	2	1
Wrangell-Petersburg Census Area	38	1	15	38	38	20	24
Other Alaska	6	3	6	5	4	1	4
Total Alaska	300	73	211	256	252	100	147
Oregon	44	28	38	42	19	14	4
Washington	146	72	102	137	77	33	22
Other States	17	7	15	12	12	7	4
Grand Total All Areas	**507**	**180**	**366**	**447**	**360**	**154**	**177**

Note: Shaded cells suppressed in accompanying value tables to preserve confidentiality.

Columns will sum to total given, but rows will not due to removal of scallop and herring vessels to protect confidentiality.

Source: AKFIN data set 2003

Table 3.9-5. Value of Harvest for Groundfish Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Geographical Area of Residence of Owner of Vessel for Selected Fisheries Groups, 2001

Geographical Area	Number of Unique Catcher Vessels	Pollock	Pacific Cod	Other Groundfish	Halibut	Crab	Salmon	Total Ex-Vessel Value
Alaska								
Aleutians East Borough	23	$2,329,111	$2,573,423	$17,404	$988,468	$341,416	$909,354	$6,870,674
Anchorage Borough	15	$1,106,064	$940,729	$530,171	$1,417,408	$1,520,214	$300,381	$5,113,989
Juneau Borough	8	$0	*	$271,243	$1,568,145	*	*	$1,347,123
Kenai Peninsula Borough	51	$214,326	$1,187,996	$3,287,973	$8,512,716	*	$741,134	$10,290,647
Ketchikan Gateway Borough	12	$0	$411	$722,930	$834,514	$0	$1,071,004	$2,417,259
Kodiak Island Borough	80	$4,615,125	$5,093,343	$4,502,912	$13,623,258	$2,629,983	$2,562,885	$26,582,033
Matanuska-Susitna Borough	5	*	*	$201,885	$323,254	$0	*	$556,816
Prince of Wales-Outer Ketchikan Ce	9	*	*	$272,675	$279,897	$0	$427,433	$1,081,361
Sitka Borough	40	$0	$21,464	$6,577,440	$4,225,671	$250,926	$1,676,210	$10,885,615
Skagway-Yakutat-Angoon Census A	7	$0	$316	$1,022,049	$598,794	*	*	$1,636,078
Valdez-Cordova Census Area	6	*	*	$452,731	$1,144,092	*	*	$1,431,624
Wrangell-Petersburg Census Area	38	*	$161,995	$5,268,949	$4,516,635	$1,160,119	$3,009,116	$12,377,002
Other Alaska	6	*	$203,767	$555,791	$418,207	*	$106,572	$1,082,559
Total Alaska	300	$8,268,413	$10,330,509	$23,684,151	$38,451,059	$6,766,691	$11,413,241	$81,672,780
Oregon	44	$15,961,491	$6,590,484	$3,284,771	$5,310,879	$2,946,473	$35,286	$31,502,892
Washington	146	$113,109,600	$8,628,283	$17,484,653	$24,106,187	$5,788,888	$1,726,743	$158,922,660
Other States	17	$4,609,447	$1,085,622	$2,457,096	$4,067,636	$805,237	$489,000	$11,502,391
Grand Total All Areas	**507**	**$141,948,951**	**$26,634,897**	**$46,910,671**	**$71,935,761**	**$16,307,288**	**$13,664,270**	**$283,600,723**

Note: Value in cells marked with an * suppressed to preserve confidentiality

Columns will sum to total given, but rows will not due to removal of scallop and herring vessels to protect confidentiality.

Source: AKFIN data set 2003

Table 3.9-6. Count of Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Community of Residence of Owner of Vessel, 2001

Geographical Area	Community	Number of Catcher Vessels
Alaska		
Aleutians East Borough	False Pass	1
	King Cove	3
	Sand Point	13
Aleutians East Borough Total		17
Aleutians West Census Area	Atka	1
	Unalaska	1
Aleutians West Census Area Total		2
Anchorage Borough	Anchorage	12
Juneau Borough	Juneau	18
	Douglas	2
Juneau Borough Total		20
Kenai Peninsula Borough	Homer	44
	Seward	8
	Anchor Point	5
	Seldovia	2
	Clam Gulch	1
	Fritz Creek	1
	Halibut Cove	1
	Kasilof	1
	Kenai	1
	Nikiski	1
	Nokolaevsk	1
Kenai Peninsula Borough Total		66
Ketchikan Gateway Borough	Ketchikan	14
	Ward Cove	1
Ketchikan Gateway Borough Total		15
Kodiak Borough	Kodiak	90
	Port Lions	2
	Old Harbor	1
	Ouzinkie	1
Kodiak Borough Total		94
Lake and Peninsula Borough	Chignik	1
	Chignik Lagoon	1
Lake and Peninsula Borough Total		2
Matanuska-Susitna Borough	Wasilla	3
	Willow	2
	Palmer	1
Matanuska-Susitna Borough Total		6
Pribilof Islands Census Area	Saint George Island	8
Prince of Wales Census Area	Craig	7
	Klawock	1
	Meyers Chuck	1
Prince of Wales Census Area Total		9
Sitka Borough	Sitka	41
	Port Alexander	8
Sitka Borough Total		49

Table 3.9-6. Count of Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Community of Residence of Owner of Vessel, 2001 (continued)

Geographical Area	Community	Number of Catcher Vessels
Skagway-Yakutat-Angoon Census Area	Pelican	3
	Gustavus	2
	Hoonah	2
	Yakutat	1
Skagway-Yakutat-Angoon Census Area Total		8
Valdez-Cordova Census Area	Cordova	7
Wrangell-Petersburg Census Area	Kake	1
	Petersburg	38
	Wrangell	4
Wrangell-Petersburg Census Area Total		43
Alaska Total		**358**
Oregon	Woodburn	7
	Newport	6
	Warrenton	4
	Astoria	2
	Depoe Bay	2
	Ashland	1
	Brookings	1
	Cloverdale	1
	Mapleton	1
	Molalla	1
	North Bend	1
	Oregon City	1
	Seal Rock	1
	Seaside	1
	Westfir	1
Oregon Total		**31**
Washington	Seattle	25
	Anacortes	11
	Port Townsend	7
	Edmonds	5
	Bellingham	4
	Snohomish	3
	Bainbridge Island	2
	Friday Harbor	2
	Gig Harbor	2
	Kirkland	2
	Poulsbo	2
	Shoreline	2
	Vashon	2
	Woodinville	2
	Bainbridge Island	1
	Burlington	1
	Camano Island	1
	Chimacum	1
	Ellensburg	1
	Enumclaw	1
	Everett	1
	Fox Island	1
	Granite Falls	1
	Kalama	1
	Kingston	1

Table 3.9-6. Count of Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Community of Residence of Owner of Vessel, 2001 (continued)

Geographical Area	Community	Number of Catcher Vessels
	Lynden	1
	Mill Creek	1
	Montesano	1
	Mount Vernon	1
	Port Angeles	1
	Port Hadlock	1
	Prosser	1
	Salkum	1
	Seaview	1
	Tacoma	1
	Westport	
Washington Total		**92**
Other States	Fort Bragg, CA	2
	Richmond, CA	1
	San Pedro, CA	1
	Santa Barbara, CA	1
	Trinidad, CA	1
	Kailua-Kona, HI	1
	Post Falls, ID	1
	Scotia, NY	1
Other States Total		**9**
Unknown		1
Grand Total		**491**

Source: AKFIN data set 2003

Table 3.9-7. Value of Harvest for Halibut Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Geographical Area of Residence of Owner of Vessel, 2001

Geographical Area	Number of Catcher Vessels	Ex-Vessel Value
Alaska		
Aleutians East Borough	17	$747,500
Kenai Peninsula Borough	66	$5,280,348
Kodiak Borough	94	$8,808,770
Sitka Borough	49	$1,744,714
Other Alaska	132	$4,471,217
Alaska Total	**358**	**$21,052,549**
Oregon	31	$3,199,964
Washington	92	$12,393,897
Other States	9	$1,637,008
Grand Total	**491**	**$38,283,418**

Source: AKFIN data set 2003

Table 3.9-8. Count of Crab Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Community of Residence of Owner of Vessel, 2001

Geographical Area	Community	Number of Catcher Vessels
Alaska		
Aleutians East Borough	King Cove	2
	Sand Point	3
Aleutians East Borough Total		5
Anchorage Borough	Anchorage	5
Kenai Peninsula Borough	Homer	6
	Kenai	1
	Seldovia	1
Kenai Peninsula Borough Total		8
Kodiak Island Borough	Kodiak	25
Sitka Borough	Sitka	2
Skagway-Yakutat-Angoon Census Area	Yakutat	1
Valdez-Cordova Census Area	Cordova	1
Wrangell-Petersburg Census Area	Petersburg	3
Alaska Total		**50**
Oregon	Newport	11
	Other Oregon	6
Oregon Total		**17**
Washington	Seattle	78
	Other Washington	33
Washington Total		**111**
Other States	California	1
	Hawaii	1
Other States Total		**2**
Grand Total All Areas		**180**

Source: AKFIN data set 2003

Table 3.9-9. Value of Harvest for Crab Catcher Vessels Harvesting in Areas Potentially Affected by Alternative 6 by Geographical Area of Residence of Owner of Vessel, 2001

Geographical Area	Number of Catcher Vessels	Ex-Vessel Value
Alaska		
Aleutians East Borough	5	$139,913
Kenai Peninsula Borough	8	$706,959
Kodiak Island Borough	25	$4,919,598
Other Alaska	12	$1,910,278
Alaska Total	**50**	**$7,676,748**
Washington	111	$19,434,233
Other States	19	$4,150,657
Grand Total	**180**	**$31,261,638**

Source: AKFIN data set 2003

Table 3.9-10. Count of Mobile Groundfish Processors (motherships and catcher-processors) Operating in Areas (or processing catch from areas) Affected by Alternative 6 by Community of Ownership, 2001

Geographical Area	Community	Pollock	Pacific Cod	Other Groundfish	# of Unique GF Processors
MOTHERSHIPS					
Washington	Seattle	4	4	2	4
CATCHER-PROCESSORS					
Alaska					
Aleutians West Census Area	Unalaska	2	2	2	2
Kodiak Island Borough	Kodiak	1	2	1	2
Oher Alaska	Anchorage	1	1	1	1
	Homer			1	1
	Petersburg	3	3	3	3
	Seward			1	1
	Sitka			1	1
Other Alaska Total		4	4	7	7
Unknown	Unknown	1	1	1	1
Alaska Total		**8**	**9**	**11**	**12**
Washington	Anacortes	1	1	1	1
	Bellevue	1	1	1	1
	Bellingham	2	2	2	2
	Edmonds	3	3	3	3
	Mill Creek	1	1	1	1
	Redmond	1	1	1	1
	Renton	1	1		1
	Seattle	53	54	52	54
	Woodinville	1	1	1	1
Washington Total		**64**	**65**	**62**	**65**
Other States	Richmond, CA	1	1	1	1
	Rockland, ME	3	3	3	3
Total Other States		**4**	**4**	**4**	**4**
Total All Areas		**76**	**78**	**77**	**81**
Mothership and Catcher-Processor Combined Total		**80**	**82**	**79**	**85**

Halibut, Crab, Scallop, and Herring counts are zero for all areas.
Source: AKFIN data set 2003

Table 3.9-11. Count of Mobile Groundfish Processors (motherships and catcher-processors) Operating in Areas (or processing catch from areas) Affected by Alternative 6 by Grouped Area of Ownership, 2001

Geographical Area	Pollock	Pacific Cod	Other Groundfish	# of Unique GF Processors
MOTHERSHIPS				
Washington	4	4	2	4
CATCHER-PROCESSORS				
Alaska				
Aleutians West Census Area	2	2	2	2
Kodiak Island Borough	1	2	1	2
Other Alaska	4	4	7	7
Unknown	1	1	1	1
Alaska Total	8	9	11	12
Washington	64	65	62	65
Other States	4	4	4	4
Total Catcher Processors	76	78	77	81
Total Motherships and Catcher-Processors	**80**	**82**	**79**	**85**

Shaded cells suppressed in accompanying value tables to preserve confidentiality.

Source: AKFIN data set 2003

Table 3.9-12. First Wholesale Value of Mobile Groundfish Processors (motherships and catcher-processors) Operating in Areas (or processing catch from areas) Affected by Alternative 6 by Grouped Area of Ownership, 2001

Geographical Area	Pollock	Pacific Cod	Other Groundfish	Total Groundfish
MOTHERSHIPS				
Washington	$122,030,329	*	*	$123,690,790
CATCHER-PROCESSORS				
Alaska	*	*	*	*
Aleutians West Census Area	*	*	*	*
Kodiak Island Borough	$289,345	$11,606,787	$2,246,046	$14,142,177
Other Alaska	*	*	*	*
Unknown				
Alaska Total	$442,919	$22,930,223	$3,618,231	$26,991,373
Washington	$625,385,384	$111,672,471	$110,582,146	$847,640,000
Other States	$2,277,019	$5,732,493	$6,260,976	$14,270,487
Total Catcher-Processors	$628,105,322	$140,335,186	$120,461,352	$888,901,860
Total Motherships and Catcher-Processors	**$750,135,650**	**$141,987,378**	**$120,469,621**	**$1,012,592,650**

*****Values in cells marked with * are suppressed to reserve confidentiality.

Source: AKFIN data set 2003

Table 3.9-13. Count of Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels Fishing in Areas Affected by Alternative 6 by Community of Operation of Processor, 2001

Geographical Area	Community	Pollock	Pacific Cod	Other Groundfish	# of Unique GF Processors	Halibut	Crab	Scallops	Salmon	Herring
FLOATING PROCESSORS										
Alaska										
Aleutians East Borough	Akutan	1	1		1					
Aleutians West Census Area	Unalaska	1	1	1	1					
Alaska Total		2	2	1	2					
Washington	Arlington								2	
	Seattle	2	2	1	2		6		7	7
	Sequim								1	
Washington Total		2	2	1	2		6		10	7
Total All Areas		4	4	2	4		6		10	7
SHORE PLANTS										
Alaska										
Aleutians East Borough	Akutan	1	1	1	1	1	1			1
	King Cove	1	2	1	2	1	1		2	1
	Port Miller								1	
	Sand Point	1	1	1	1	1	1		1	
Aleutians East Borough Total		3	4	3	4	3	3		4	2
Aleutians West Census Area	Atka			1	1	1				
	Saint Paul Island	1	1		1	1	1			
	Unalaska	3	7	5	7	6	5			2
Aleutians West Census Area Total		4	8	6	9	8	6			2
Anchorage Borough	Anchorage		2	2	2	3	1		3	
Bristol Bay Borough	Naknek								3	2
Dillingham Census Area	Ekuk								1	1
Haines Borough	Haines								1	
Juneau Borough	Juneau	1	3	3	3	3	4		4	1
Kenai Peninsula Borough	Anchor Point					1			1	
	Homer		2	2	2	2			1	
	Kasilof								1	
	Kenai		1	1	1	3			6	
	Ninilchik	1	1	1	1	1	1		1	
	Seward	1	3	3	3	3			2	
	Soldotna					1			1	1
Kenai Peninsula Borough Total		2	7	7	7	11	1		13	1
Ketchikan Gateway Borough	Ketchikan		2	2	2	2	1		5	3
Kodiak Island Borough	Kodiak	7	9	9	9	7	8	1	8	5
	Moser Bay		1	1	1	1			1	1
Kodiak Island Borough Total		7	10	10	10	8	8	1	9	6
Lake and Peninsula Borough	Chignik		1	1	1	1			2	
	Egegik					1			1	1

Table 3.9-13. Count of Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels Fishing in Areas Affected by Alternative 6 by Community of Operation of Processor, 2001 (continued)

Geographical Area	Community	Pollock	Pacific Cod	Other Groundfish	# of Unique GF Processors	Halibut	Crab	Scallops	Salmon	Herring
Lake and Peninsula Borough Total			1	1	1	2			3	1
Prince of Wales-Outer Ketchikan Census Area	Craig								1	
Sitka Borough	Sitka		3	4	4	2	3		4	3
Skagway-Yakutat-Angoon Census Area	Excursion Inlet					1			1	
	Hoonah		1	1	1	1	1		1	
	Pelican		1	1	1	1			1	
	Yakutat		2	2	2	2		1	2	
Skagway-Yakutat-Angoon Census Area Total			4	4	4	5	1	1	5	
Valdez-Cordova Census Area	Cordova	1	4	5	5	4			5	
	Valdez		1	2	2	2			3	
	Whittier		1	1	1	1			1	
Valdez-Cordova Census Area Total		1	6	8	8	7			9	
Wrangell-Petersburg Census Area	Kake			1	1	1	1		1	
	Petersburg		2	3	3	3	3		6	2
	Wrangell		1	2	2	2	2		2	1
Wrangell-Petersburg Census Area			3	6	6	6	6		9	3
Alaska Total		18	53	56	60	60	34	2	74	25
Washington	Seattle	1	1	1	1	1	1			
Total Shore Plants All Areas		19	54	57	61	61	35	2	74	25
Grand Total Floaters + Shore Plants		**23**	**58**	**59**	**65**	**61**	**41**	**2**	**84**	**32**

Source: AKFIN data set 2003

Table 3.9-14. Count of Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels Fishing in Areas Affected by Alternative 6 by Grouped Community of Operation of Processor, 2001

Geographical Area	Pollock	Pacific Cod	Other Groundfish	Total Groundfish	Halibut	Crab	Salmon	Herring
FLOATING PROCESSORS								
Alaska								
Aleutians East Borough	1	1		1				
Aleutians West Census Area	1	1	1	1				
Alaska Total	2	2	1	2				
Washington	2	2	1	2		6	10	7
Total Floaters	4	4	2	4		6	10	7
SHORE PLANTS								
Alaska								
Aleutians East Borough	3	4	3	4	3	3	4	2
Aleutians West Census Area	4	8	6	9	8	6		2
Kenai Peninsula Borough	2	7	7	7	11	1	13	1
Kodiak Island Borough	7	10	10	10	8	8	9	6
Other Alaska	1	8	8	8	10	6	21	8
Sitka Borough		3	4	4	2	3	4	3
Skagway-Yakutat-Angoon Census Area		4	4	4	5	1	5	
Valdez-Cordova Census Area	1	6	8	8	7		9	
Wrangell-Petersburg Census Area		3	6	6	6	6	9	3
Alaska Total	18	53	56	60	60	34	74	25
Total Shore Plants	18	53	56	60	60	34	73	24
Combined Total Floaters + Shore Plants	**22**	**57**	**58**	**65**	**60**	**40**	**83**	**31**

Note: Shaded cells suppressed in accompanying value tables to preserve confidentiality.

Washington shoreplants (1 entity) excluded from table due to confidentiality problems.

Scallop values cannot be disclosed for any area and have therefore been dropped from this table.

Source: AKFIN data set 2003

Table 3.9-15. Ex-Vessel Value Delivered to Shoreside Groundfish Processors (floating processors and shore plants) Processing Catch from Vessels Fishing in Areas Affected by Alternative 6 by Grouped Community of Operation of Processor, 2001

Geographical Area	Pollock	Pacific Cod	Other Groundfish	Total Groundfish	Halibut	Crab	Salmon	Herring
FLOATING PROCESSORS								
Alaska								
Aleutians East Borough	*	*	*	*	$0	$0	$0	$0
Aleutians West Census Area	*	*	*	*	$0	$0	$0	$0
Alaska Total	*	*	*	*	$0	$0	$0	$0
Washington	*	*	*	*	$0	$15,286,767	$13,654,339	$2,824,546
Total Floaters	$13,831,364	$1,595,375	*	$15,434,299	$0	$15,286,767	$13,654,339	$2,824,546
SHORE PLANTS								
Alaska								
Aleutians East Borough	*	$11,229,854	*	$62,143,691	*	*	$9,251,092	*
Aleutians West Census Area	$79,802,971	$9,682,987	$3,291,921	$92,777,879	$12,089,780	$46,752,926	$0	*
Kenai Peninsula Borough	*	*	$13,812,404	$15,021,723	$22,003,074	*	$12,840,152	*
Kodiak Island Borough	$11,094,199	$15,908,021	$10,024,558	$37,026,778	$17,658,996	$5,990,038	$23,488,452	$1,071,085
Other Alaska	*	*	$6,522,702	$6,761,369	$9,457,399	$3,599,917	$53,325,250	$2,300,801
Sitka Borough	$0	*	*	$9,678,960	*	*	$12,080,219	*
Skagway-Yakutat-Angoon Census Area	$0	$2,936	$5,143,846	$5,146,782	$5,342,372	*	$8,447,545	$0
Valdez-Cordova Census Area	*	*	$3,391,147	$3,964,098	$3,715,335	$0	$29,331,981	$0
Wrangell-Petersburg Census Area	$0	$12,393	$4,551,063	$4,563,456	$6,755,460	$14,047,333	$19,734,165	*
Alaska Total	$140,245,063	$38,310,641	$58,529,034	$237,084,737	$87,241,188	$84,394,239	$168,498,856	$6,759,387
Total Shoreplants	$140,245,451	$39,943,778	$59,814,776	$240,004,004	$89,488,632	$85,086,886	$168,498,856	$6,759,387
Combined Total Floaters + Shore Plants	**$154,076,815**	**$41,539,153**	**$59,822,335**	**$255,438,303**	**$89,488,632**	**$100,373,653**	**$182,153,195**	**$9,583,933**

Note: The single Washington shore plants was excluded from table due to confidentiality problems.

Values in cells marked with * are suppressed to preserve confidentiality.

Source: AKFIN data set 2003

Table 3.9-16. Count of Existing Specialty or Niche Shoreside Processors and Those Affected by Alternative 6

	Fishery							
Processor Type	**Pollock**	**Pacific Cod**	**Other Groundfish**	**Number of Unique Groundfish Processors**	**Halibut**	**Crab**	**Salmon**	**Herring**
Count of Specialty Processors by Type of Processor and Fishery, 2001 (Existing Conditions)								
Catcher/Shoreside Processors	1	7	9	12	5	5	15	
Catcher/Seller	1	7	8	10	6	8	11	5
Catcher/Exporter	2	28	11	36	15	17	3	
EEZ Operator	1	1	1	1	2	2	1	
TOTAL	**5**	**43**	**29**	**59**	**28**	**32**	**30**	**5**
Count of Specialty Processors, by Type of Processor and Fishery, Potentially Affected by Alternative 6 (based on 2001 activity)								
Catcher/Shoreside Processors	1	1	2	2	1	2	2	
Catcher/Seller	1	6	8	9	6	3	8	3
Catcher/Exporter	2	8	1	8	1	1		
EEZ Operator	1	1	1	1	2	2	1	
TOTAL	**5**	**16**	**12**	**20**	**10**	**8**	**11**	**3**

Source: AKFIN data set 2003

Table 3.9-17. Alaska Coastal Communities with Alternative 6 Closure Areas within 20 Miles and Percentage of Area Closed

COMMUNITY	Percentage of Maximum Available Area Closed	Area Open Under Alternative 6 (mi^2)	Area Closed Under Alternative 6 (mi^2)	Maximum Available Area within 20 Miles Under Existing Conditions (mi^2)
Nelson Lagoon	98.65%	11	834	845
Saint George	97.11%	35	1,187	1,222
Port Heiden	88.58%	65	502	566
Nikolski	73.62%	276	770	1,046
Akhiok	71.72%	194	492	686
Toksook Bay	48.82%	349	333	682
Larsen Bay	36.91%	223	130	353
Tununak	36.73%	534	310	844
Chenega Bay	34.52%	490	259	749
Mekoryuk	22.97%	584	174	758
Port Alexander	20.96%	780	207	987
Saint Paul	19.17%	979	232	1,212
Ivanoff Bay	18.72%	343	79	422
Port Lions	18.60%	322	74	396
Cold Bay	13.02%	576	86	663
Chignik	12.95%	518	77	595
Attu (not a civilian community)	10.70%	887	106	994
False Pass	10.36%	515	60	575
King Cove	7.88%	635	54	689
Karluk	3.76%	702	27	729
Yakutat	3.41%	834	29	863
Old Harbor	1.04%	453	5	458
Pilot Point	0.93%	377	4	380
Perryville	0.48%	543	3	545
Women's Bay	0.17%	487	1	488
Chignik Lagoon	0.13%	374	0	375

Notes:

Communities listed are within 5 miles of a portion of the coastline that is within 20 miles of an EFH Alt 6 closure area. Named places with no residential population are excluded.

Maximum available area within 20 miles (existing conditions) is the square miles of ocean within 20 miles of community, excluding existing SSL closure areas. Caveat: Some of the ocean areas within 20 miles of the community as the crow flies may not be accessible to small boats in practical terms (e.g., waters on the opposite side of a narrow peninsula). This should be taken as a rough measure.

Area closed under Alternative 6 is the amount of area within the maximum available area within 20 miles that would be included in an EFH Alternative 6 closure area.

Percentage of maximum available area closed is the percentage resulting from area closed divided by maximum available area.

This table includes communities with and without current commercial fishery participation.

Table 3.9-18. Alaska Coastal Communities with Alternative 6 Closure Areas within 20 Miles and Percentage of Area Closed by Region

COMMUNITY	Percentage of Maximum Available Area Closed	Area Open Under Alternative 6 (mi^2)	Area Closed Under Alternative 6 (mi^2)	Maximum Available Area within 20 Miles (Existing Conditions)
Aleutians East Borough				
Nelson Lagoon	98.65%	11	834	845
Cold Bay	13.02%	576	86	663
False Pass	10.36%	515	60	575
King Cove	7.88%	635	54	689
Aleutians West Census Area				
Saint George	97.11%	35	1,187	1,222
Nikolski	73.62%	276	770	1,046
Saint Paul	19.17%	979	232	1,212
Attu (not a civilian community)	10.70%	887	106	994
Kodiak Island Borough				
Akhiok	71.72%	194	492	686
Larsen Bay	36.91%	223	130	353
Port Lions	18.60%	322	74	396
Karluk	3.76%	702	27	729
Old Harbor	1.04%	453	5	458
Women's Bay	0.17%	487	1	488
Lake and Peninsula Borough				
Port Heiden	88.58%	65	502	566
Ivanoff Bay	18.72%	343	79	422
Chignik	12.95%	518	77	595
Pilot Point	0.93%	377	4	380
Perryville	0.48%	543	3	545
Chignik Lagoon	0.13%	374	0	375
Y-K Delta Area				
Toksook Bay	48.82%	349	333	682
Tununak	36.73%	534	310	844
Mekoryuk	22.97%	584	174	758
Prince William Sound Area				
Chenega Bay	34.52%	490	259	749
Southeast Alaska Area				
Port Alexander	20.96%	780	207	987
Yakutat	3.41%	834	29	863

Notes:

Communities listed are within 5 miles of a portion of the coastline that is within 20 miles of an EFH Alt 6 closure area. Named places with no residential population are excluded.

Maximum available area within 20 miles (existing conditions) is the square miles of ocean within 20 miles of community, excluding existing SSL closure areas. Caveat: Some of the ocean areas within 20 miles of the community as the crow flies may not be accessible to small boats in practical terms (e.g., waters on the opposite side of a narrow peninsula). This should be taken as a rough measure.

Area closed under Alternative 6 is the amount of area within the maximum available area within 20 miles that would be included in an EFH Alternative 6 closure area.

Percentage of maximum available area closed is the percentage resulting from area closed divided by maximum available area.

This table includes communities with and without current commercial fishery participation.

Table 3.9-19. Halibut Small Vessel (<60') Fleet Data for Communities with Alternative 6 Closure Areas within 20 Miles, 2001

Community	Number of Permit Holders	Number of Permits Fished	Total Pounds Landed	Estimated Gross Earnings
Chignik Lagoon	2	2	[1]	[1]
False Pass	2	2	[1]	[1]
King Cove	9	9	149,401	$278,062
Mekoryuk	43	30	113,053	$159,666
Old Harbor	1	0	0	$0
Pilot Point	1	0	0	$0
Port Alexander	16	13	126,273	$253,347
Port Lions	8	5	15,080	$30,214
St. George	11	9	[1]	[1]
St. Paul	28	24	967,495	$1,688,090
Toksook Bay	40	32	57,342	$73,112
Tununak	21	17	26,271	$33,496
Yakutat	28	25	101,474	$210,976
Total	**210**	**168**	**1,556,389**	**$2,726,963**

[1] Cell value suppressed to preserve confidentiality.

Source: CFEC

Table 3.9-20. Area and Halibut Landing Statistics, Communities with Alternative 6 Closure Areas within 20 Miles, 2001

	GIS Analysis Data			NMFS-RAM Halibut Port		AKFIN Halibut Landings	
Community	**Stat. Areas (by number) within 20 nm**	**Area Closed within 20 nm (m^2)**	**Percent of Stat. Area Closed**	**Vessel Landings**	**Pounds Landed**	**Vessel Landings**	**Pounds Landed**
CHIGNIK (area)	575603	220,522,056	40.85%	38	478,257	7	96,287
	575604	187,300,294	14.22%			13	200,657
	575634	21,152,206	4.65%			0	0
False Pass	625435	196,910,000	17.90%			1	13,825
	625437	118,658,960	37.50%			0	0
KING COVE	625502	47,675,970	4.33%	69	679,374	2	4,036
	625437	33,762,776	32.03%			0	0
	625436	136,812,056	43.23%			0	0
	625435	768,082	0.21%			1	13,825
Mekoryuk	656002	242,085,466	58.84%			16	6,127
	656001	388,831,292	21.79%			0	0
OLD HARBOR	405600	3,945,210	5.68%			0	0
Pilot Point	585701	44,721,951	2.44%			0	0
	585702	71,700,283	16.26%			0	0
Port Alexander	505630	109,991,862	54.72%			29	702,122
	505832	137,300,000	36.09%			8	82,361
	515530	280,030,000	11.79%			0	0
	515600	4	0.00%			0	0
PORT LIONS	405932	268,140,410	46.30%			0	0
ST. GEORGE IS.	695631	1,429,800,000	42.82%	2	813	6	183,930
	695600	1,949,700,000	65.64%			7	191,276
	695632	337,850,000	92.74%			11	102,155
ST. PAUL IS.	695700	95,798,460	3.23%	136	247,628	0	0
	695701	708,480,000	21.67%			0	0
	695631	92,798,203	85.15%			6	183,930
	705730	21,140,133	0.64%			1	9,393
Toksook Bay	656003	13,470,185	3.27%			0	0
	656001	851,842,585	47.74%			0	0
	656002	223,104,122	82.69%			16	6,127
Tununak	656002	49,840,207	12.11%			16	6,127
	656003	776,753,083	43.53%			0	0
	656001	223,104,122	82.69%			0	0
YAKUTAT	535634	62,433,555	2.77%	199	1,012,014	9	41,793
	535635	91,611,780	22.46%			0	0

Note: Communities in ALL CAPS are designated as ports.

Sources: GIS data derived by NOAA analytic team. NMFS RAM data from <www.fakr.noaa.gov/ram/01ifqporth.htm>. AKFIN data are taken from IFQ reports and are, therefore, non-confidential.

Table 3.9-21. Count of NMFS Halibut Subsistence Permit Holders in Communities with Alternative 6 Closure Areas within 20 Miles (as of 6-18-03)

Rural City	Count
Akhiok	1
Attu (not a civilian community)	0
Chenega Bay	4
Chignik	4
Chignik Lagoon	5
Cold Bay	10
False Pass	6
Ivanoff Bay	0
Karluk	0
King Cove	8
Larsen Bay	3
Mekoryuk	2
Nelson Lagoon	0
Nikolski	2
Old Harbor	24
Perryville	0
Pilot Point	0
Port Alexander	14
Port Heiden	0
Port Lions	10
Saint George	7
Saint Paul	3
Toksook Bay	2
Tununak	0
Women's Bay	0
Yakutat	22
Total	**127**

Note: Subsistence halibut permits were not issued prior to 2003. At present, the number of permits is continually increasing, so data given may quickly be obsolete.

Source: http://www.fakr.noaa.gov/ram/subsistence/halibut.htm

Table 3.10-1. Comparative Summary of Benefits and Costs for Alternatives 1 through 6

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 2 GOA NPT SLOPE ROCKFISH 11 AREAS	ALTERNATIVE 3 GOA NPT SLOPE ROCKFISH ENTIRE SLOPE	ALTERNATIVE 4 GOA NPT SLOPE ROCKFISH 11 AREAS NPT ALL SPECIES IN AREAS OF BSAI	ALTERNATIVE 5A GOA NPT All SPECIES 10 AREAS GOA SLOPE ROCKFISH ENTIRE SLOPE NPT ALL SPECIES IN AREAS OF BSAI	ALTERNATIVE 5B GOA NPT All SPECIES 10 AREAS GOA SLOPE ROCKFISH ENTIRE SLOPE NPT ALL SPECIES IN AREAS OF BSAI AI HABITAT/CPUE BASE CLOSURES	ALTERNATIVE 5C (PREFERRED ALTERNATIVE) GOA NPT All SPECIES 10 AREAS AI NPT ALL SPECIES IN AREAS CORAL GARDENS All BOTTOM CONTACT GEAR	ALTERNATIVE 6 20% CLOSURE TO ALL BOTTOM CONTACT GEAR IN BS, AI, GOA
EFH Passive Use Value (ranking assumes positive correlation between km^2 protected and passive use value)	There would be no change in passive use value (status quo).	This alternative would protect 10,228 km^2 of seabed from NPT targeting slope rockfish complex. It would be a slight potential increase in passive use value compared to Alternative 1.	This alternative would protect 29,059 km^2 of seabed from NPT targeting slope rockfish complex. It would be a somewhat larger potential increase in passive use value compared to Alternatives 1 or 2.	This alternative would protect 81,097 km^2 of EFH (including 22,883 km^2 in AI + 47,986 km^2 in BS + 10,228 km^2 in GOA). It would restrict NPT for all species in designated areas of BSAI and NPT for slope RF in designated areas of GOA. It would be a potential increase in passive use value relative to Alternatives 1, 2, or 3.	This alternative would protect 128,114 km^2 of EFH (including 32,235 km^2 in AI + 63,975 km^2 in BS + 31,904 km^2 in GOA). It would restrict NPT for all species in designated areas of BSAI, and NPT for slope RF along the slope (200 to 1,000 m) and for all species in designated areas of GOA. It would be a potential increase in passive use value relative to Alternatives 1, 2, 3, or 4.	This alternative would protect 160,865 to 172,568 km^2 of EFH (64,986 to 76,689 km^2 in AI depending upon option chosen + 63,975 km^2 in BS + 31,904 km^2 in GOA). Itwould restrict NPT, all species, in designated areas of BSAI, and NPT for slope RF along the slope (200 to 1,000 m) and for all species in designated areas of GOA. It would prohibit NPT use in AI based on coral/sponge bycatch rates under Options 1 and 2. Option 2 in the AI would prohibit all bottom contact gear use in six designated coral garden areas. Would reduce TACs in NPT fisheries by weight historically caught in closed areas under Options 1 and 2. It would be a potential increase in passive use values relative to Alternatives 1, 2, 3, 4, or 5A.	This alternative would protect 74,250 km^2 of EFH (7,157 km^2 in GOA + 67,093 km^2 in AI). It would restrict NPT, all species, in 10 designated areas of the GOA slope (200 to 1,000 m) and for all species in designated areas of AI. It would prohibit use of all bottom contact gear in 380 km^2 in six designated coral garden areas of the AI.	This alternative would protect 218,750 km^2 of EFH 20,729 km^2 in AI + 136,031 km^2 in BS + 61,991 km^2 in GOA). It would restrict NPT, all species, in designated areas of BSAI and NPT for slope RF along slope (200 to 1,000 m) and for all species in designated areas of GOA. It would prohibit NPT use in the AI based on coral/sponge bycatch rates. It would reduce TACs in NPT fisheries by weight historically caught in closed areas. It would be a potential increase in passive use value relative to all other alternatives under consideration, although uncertain, owing to unpredictable status of state waters..
Management and Enforcement	This alternative would continue fishery exploitation at present levels in EFH areas. Based upon best available scientific information, existing habitat conservation measures would probably be sufficient to sustain FMP stocks at present abundance levels. Because some information is not well understood (e.g., linkages between fish productivity rates and habitat; recovery rates of some sessile invertebrates) uncertainties would remain.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species, although EFH provisions in MSA presuppose this outcome. All other EFH use values under this alternative are unknown.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species, although EFH provisions in MSA presuppose this outcome. All other EFH use values under this alternative are unknown.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species, although EFH provisions in MSA presuppose this outcome. All other EFH use values under this alternative are unknown.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species, although EFH provisions in MSA presuppose this outcome. All other EFH use values under this alternative are unknown.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species, although EFH provisions in MSA presuppose this outcome. All other EFH use values under this alternative are unknown.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species, although EFH provisions in MSA presuppose this outcome. All other EFH use values under this alternative are unknown.	It is uncertain whether EFH protection under this alternative would result in sustained/increased yield of any FMP species, although EFH provisions in MSA presuppose this outcome. All other EFH use values under this alternative are unknown.
Revenue At Risk	No EFH attributable revenues would be at risk.	EFH protection measures would place $900 thousand (9.6% of 2001 status quo gross revenue) at risk, mainly in the CG and WG C/P fleet. Some of these revenues at risk may be mitigated, using NPT, in adjacent open areas.	EFH protection measures would place $2.65 million (28.3% of 2001 gross revenues of $9.36 million) at risk. CV and C/P fleets in CG and C/P fleet in WG would be adversely impacted. Some of these revenues at risk may be mitigated, using PTR, in adjacent open areas (shallower than 200 m). Some share of revenue at risk may be transferred from small CV sector to larger CV and C/P fleet components.	EFH protection measures would place from $3.53 to $6.11 million (2.2% to 3.8% of $156.86 to $162.79 million status quo gross revenue) at risk (depending upon EBS rotational area). GOA revenue at risk would be $0.90 million (9.6% of $9.4 million slope rockfish NPT status quo). EBS revenue at risk would be $1.8 million to $4.4 million (2.0 to 4.5% of $90.92 to $96.74 million status quo). AI revenue at risk would be $0.82 million (1.4% of $56.70 million status quo). Main revenue at risk impact would be GOA C/Ps at $0.86 million (12.3% of status quo), EBS C/Ps at $1.82 million to $4.40 million (2.0 to 4.8%), AI C/Ps $0.8 (1.5% of status quo). Main fisheries affected would be GOA slope rockfish NPT, EBS flathead sole, AI rockfish.	EFH protection measures would place $7.92 million to $10.90 million or 4.4 to 6.0% of the $180.66 to $181.30 million status quo gross revenue at risk (value dependent upon EBS rotational area). GOA revenue at risk would be $3.60 million or 13.0% of the status quo of $27.69 million. EBS revenue at risk would be $2.63 million to $5.61 million or 2.7 to 5.8% of $96.27 to $96.91 million of status quo revenue. AI revenue at risk would be $1.69 million or 3.0% of the $56.70 million status quo revenue. Both the CV and C/P fleets would have a similar percent of status quo revenue at risk of 4.6% (CV) and 4.4 to 6.2% (C/P). The C/P revenue at risk would range from $7.02 million to $10.0 million and the CV fleet revenue at risk would be $900 thousand. The CV fleet would be affected mainly in the GOA while the C/P fleets would be affected in all three areas.	EFH protection measures would place $7.46 million to $15.93 million or 4.1 to 8.8% of the $179.77 to $180.41 million status quo gross revenue at risk (value dependent upon BS rotational area and AI option chosen). GOA revenue at risk would be $3.60 million or 13.0% of the status quo of $27.69 million. EBS revenue at risk would be $2.63 million to $5.61 million or 2.7 to 5.8% of $96.27 million to $96.91 million of status quo revenue. AI revenue at risk would be $6.71 million or 12.0% of the $55.81 million status quo revenue under Option 1, $2.99 million at risk or 5.4% of status quo revenue under Option 2, and $1.23 million at risk or 2.2% of status quo revenue under Option 3. BSAI revenue lost to TAC reduction could total $15.16 million or more than the revenue at risk in these areas under Option 1 and $3.83 million in the AI under Option 2. The C/P revenue at risk would range from $6.53 million to $14.72 million, and the CV fleet revenue at risk would range from $0.93 million to $1.21 million dependent upon BS rotational area and AI option chosen. Under Option 2, AI coral	EFH NPT protection measures would place $2.39 million or 1.3% of the $180.41 million status quo gross revenue. GOA revenue at risk would be $1.17 million or 4.2% of the status quo of $27.69 million. AI revenue at risk would be $1.23 million or 2.2% of the $55.81 million status quo revenue. The C/P revenue at risk would be $2.0 million or 1.2% of the $160.95 million status quo gross revenue. CV revenue at risk would be $0.4 million or 2.0% of the $19.45 million status quo gross revenue. AI coral garden area closure to bottom contact gear would place an additional $234,000 of groundfish revenue at risk, up to 4.4% of AI HAL halibut catch at risk, and 0.3% of POT catch of AI king and Tanner crab.	EFH protection measures would place $237.20 million or 18.9% of the $1.26 billion status quo gross revenue at risk. GOA revenue at risk would be $46.52 million or 22.0% of the status quo of $211.48 million. EBS revenue at risk would be $177.54 million or 19.0% of $934.36 million of status quo revenue. AI revenue at risk would be $13.14 million or 11.8% of the $111.30 million status quo revenue. Groundfish fisheries would have the largest revenue at risk with $163.76 million or 16.0% of status quo revenue, followed by the halibut fishery with $38.34 million or 34.2% of status quo revenue, crab fisheries with $34.11 million or 29.4% of status quo revenue, and the scallop fishery with $0.98 million or 29.1% of status quo revenue. Largest effects on revenue at risk in the GOA would be in halibut fisheries at $32.12 million, sablefish fisheries at $6.66 million, Pacific cod fisheries at $2.63 million, and the rockfish fishery at $2.29 million.

Table 3.10-1. Comparative Summary of Benefits and Costs for Alternatives 1 through 6 (continued)

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 2 GOA NPT SLOPE ROCKFISH 11 AREAS	ALTERNATIVE 3 GOA NPT SLOPE ROCKFISH ENTIRE SLOPE	ALTERNATIVE 4 GOA NPT SLOPE ROCKFISH 11 AREAS NPT ALL SPECIES IN AREAS OF BSAI	ALTERNATIVE 5A GOA NPT All SPECIES 10 AREAS GOA SLOPE ROCKFISH ENTIRE SLOPE NPT ALL SPECIES IN AREAS OF BSAI	ALTERNATIVE 5B GOA NPT All SPECIES 10 AREAS GOA SLOPE ROCKFISH ENTIRE SLOPE NPT ALL SPECIES IN AREAS OF BSAI AI HABITAT/CPUE BASE CLOSURES	ALTERNATIVE 5C (PREFERRED ALTERNATIVE) GOA NPT All SPECIES 10 AREAS AI NPT ALL SPECIES IN AREAS CORAL GARDENS All BOTTOM CONTACT GEAR	ALTERNATIVE 6 20% CLOSURE TO ALL BOTTOM CONTACT GEAR IN BS, AI, GOA
Revenue At Risk (continued)					The main fisheries affected would be slope rockfish and Pacific cod in the GOA, flathead sole and Pacific cod in the EBS, and rockfish in AI.	garden area closure to bottom-contact gear would place an additional $234,000 of groundfish revenue at risk, up to 4.4% of AI HAL halibut catch at risk, and 0.3% of the POT catch of AI king and Tanner crab. The CV fleet would be impacted in the GOA and AI while the C/P fleets would be impacted in all three areas. The main fisheries affected would be slope rockfish and Pacific cod in the GOA, flathead sole and Pacific cod in the EBS, and Atka mackerel, Pacific cod, and rockfish in AI.	Both the C/P and CV fleets would be impacted in the GOA and AI. The main fisheries affected would be slope rockfish, rex sole and Pacific cod in the GOA and Atka mackerel, Pacific cod, and rockfish in AI.	In the EBS, the pollock fishery would have $104.04 million of revenue at risk, the crab fisheries $28.45 million, and the Pacific cod fisheries, $23.83 million of revenue at risk. In the AI, the crab fishery would have $5.3 million at risk, halibut fishery $2.69 million and Pacific cod fisheries $2.32 million at risk.
Product Quality	There would be no change.	There would be a minimal impact on product quality. Open areas are immediately adjacent to EFH closed	This alternative might have adverse impact on product quality. CV fleet may have increased running time to and from open areas.	This alternative might have adverse impact on product quality. CV fleet may have increased running time to and from open areas.	This alternative might have adverse impact on product quality. CV fleet may have increased running time to and from open areas.	This alternative might have an adverse impact on product quality. The CV fleet might have increased running time to and from open areas.	This alternative might have an adverse impact on product quality. The CV fleet might have increased running time to and from open areas.	This alternative might have an adverse impact on product quality. The CV fleet might have increased running time to and from open areas.
Operating Costs	There would be no change.	This alternative would be a minimal impact on operating costs. EFH open areas are adjacent to closed areas.	Might be significant increases in operating costs for CG CVs and C/Ps targeting slope RF and WG C/Ps.	Might be significant increases in operating costs for C/Ps and CVs in all areas.	This alternative would be probable increases in CV and C/P operating costs targeting Atka mackerel, Pacific cod, and rockfish in AI, C/Ps targeting flathead sole and other flatfish in EBS, CVs and C/Ps targeting rockfish and Pacific cod in GOA.	This alternative would be probable increases in CV and C/P operating costs targeting Atka mackerel, Pacific cod, and rockfish in AI, C/Ps targeting flathead sole and other flatfish in EBS, CVs and C/Ps targeting rockfish and Pacific cod in GOA. In AI, 100% observer coverage requirement would increase costs for 30% coverage vessels.	This alternative would be probable increases in CV and C/P operating costs targeting Atka mackerel, Pacific cod, and rockfish in AI, C/Ps targeting flathead sole and other flatfish in EBS, CVs and C/Ps targeting rockfish and Pacific cod in GOA. In AI, 100% observer coverage requirement would increase costs for 30% coverage vessels.	This alternative would be probable increases in CV and C/P operating costs targeting Atka mackerel, Pacific cod, and rockfish in AI, C/Ps targeting flathead sole and other flatfish in EBS, CVs and C/Ps targeting rockfish and Pacific cod in GOA. In AI, 100% observer coverage requirement would increase costs for 30% coverage vessels.
Safety Costs	There would be no change.	For this alternative, there would be potentially small adverse impacts on safety. The remaining open areas are adjacent	For this alternative, there would be potential for some adverse safety impacts due to expected increased effort to mitigate revenue at risk in the CG and WG.	For this alternative, there would likely be some adverse impacts on safety due to expected increased effort to mitigate revenue at risk.	For this alternative, there would be potential for adverse safety impacts due to expected increased effort to mitigate revenue at risk, particularly in AI.	For this alternative, there would be potential for adverse safety impacts due to expected increased effort to mitigate revenue at risk, particularly in AI.	For this alternative, there would be potential for adverse safety impacts due to expected increased effort to mitigate revenue at risk, particularly in AI.	For this alternative, there would be potential for adverse safety impacts in all FMP management areas due to expected increased effort to mitigate revenue at risk in all areas.
Impacts on Related Fisheries	There would be no impact.	This alternative would be a minimal impact on related fisheries. Displaced effort would likely be redeployed into adjacent areas, concurrently fished by NPT.	Additional NPT effort targeting DSR in waters shallower than 200 m might increase gear conflicts (damage, losses, and costs) with HAL and POT fisheries.	Redeployment of NPT effort in the EBS and AI might adversely impact fisheries using HAL and POT, through damage, loss, or displacement.	Redeployment of NPT effort in the EBS and AI might adversely impact fisheries using HAL and POT, through damage, loss, or displacement.	Redeployment of NPT effort in the EBS and AI might adversely impact fisheries using HAL and POT, through damage, loss, or displacement.	Redeployment of NPT effort in the EBS and AI might adversely impact fisheries using HAL and POT, through damage, loss, or displacement.	Redeployment of NPT effort in the EBS and AI might adversely impact fisheries using HAL and Pot, through damage, loss, or displacement.
Costs to Consumers	There would be no impact.	This alternative would be a negligible expected cost to consumers. Catch and revenue at risk might be largely mitigated, and additional operational costs might be low.	This alternative would be a minimal expected increased costs to consumers, as some or all of the displaced catch might be mitigated. It would be a potential increased cost to consumers, reflecting operating cost increases, depending on market factors (e.g., elasticities, price and availability of substitutes, etc.).	This alternative would be a minimal expected increased costs to consumers, as some or all of the displaced catch might be mitigated. It would be a potential increased price to consumers, reflecting operating cost increases, depending on market factors (e.g., elasticities, availability, and price of substitutes, etc.).	This alternative would be a greater risk that displaced catch might not be made up. It would be increased probability of adverse impacts on consumers (e.g., increased prices, reduced supplies, more limited range of product forms, lower quality).	This alternative would be expected to have an adverse impact on consumers from AI NPT fishery restrictions under AI Alternative 5B, Options 1 and 2. Some production would be foregone and unrecoverable due to TAC reductions under AI Options 1 and 2. Operational cost increases might result in higher consumer prices and/or limited supplies, depending upon market factors (e.g., demand elasticity, price, and availability of substitutes, etc.).	This alternative would be expected to have an adverse impact on consumers from AI NPT fishery restrictions under AI Alternative 5C. Operational cost increases might result in higher consumer prices and/or limited supplies, depending upon market factors (e.g., demand elasticity, price, and availability of substitutes, etc.).	This alternative would be a high probability of adverse impacts on consumers. It would likely be significant loss of aggregate production due to substantial reductions in fishable open areas. Operational cost increases might be prohibitive for some operations and/or sectors. Loss of production would result in higher consumer prices and/or limited supplies. It would be a potential for loss of market share, with associated welfare losses for U.S. consumers, at all levels of the market.

Table 3.10-1. Comparative Summary of Benefits and Costs for Alternatives 1 through 6 (continued)

BENEFIT OR COST CATEGORY	ALTERNATIVE 1 STATUS QUO	ALTERNATIVE 2 GOA NPT SLOPE ROCKFISH 11 AREAS	ALTERNATIVE 3 GOA NPT SLOPE ROCKFISH ENTIRE SLOPE	ALTERNATIVE 4 GOA NPT SLOPE ROCKFISH 11 AREAS NPT ALL SPECIES IN AREAS OF BSAI	ALTERNATIVE 5A GOA NPT All SPECIES 10 AREAS GOA SLOPE ROCKFISH ENTIRE SLOPE NPT ALL SPECIES IN AREAS OF BSAI	ALTERNATIVE 5B GOA NPT All SPECIES 10 AREAS GOA SLOPE ROCKFISH ENTIRE SLOPE NPT ALL SPECIES IN AREAS OF BSAI AI HABITAT/CPUE BASE CLOSURES	ALTERNATIVE 5C (PREFERRED ALTERNATIVE) GOA NPT All SPECIES 10 AREAS AI NPT ALL SPECIES IN AREAS CORAL GARDENS All BOTTOM CONTACT GEAR	ALTERNATIVE 6 20% CLOSURE TO ALL BOTTOM CONTACT GEAR IN BS, AI, GOA
Management and Enforcement	There would be no impact.	CVs and C/Ps using NPT gear and targeting slope rockfish might have to have VMS or 100% observer coverage. Additional management costs might be inferred.	CVs and C/Ps using NPT gear and targeting slope rockfish might have to have VMS or 100% observer coverage. Additional management costs might be inferred.	CVs and C/Ps using NPT gear and targeting slope rockfish in the GOA, and all species in the BSAI, might have to have VMS or 100% observer coverage. Additional management costs might be inferred.	CVs and C/Ps using NPT gear and targeting slope rockfish in the GOA, and all species in the BSAI, might have to have VMS or 100% observer coverage. Additional management costs might be inferred.	CVs and C/Ps using NPT gear and targeting slope rockfish in the GOA, and all species in the BSAI, might have to have VMS or 100% observer coverage. In AI, 100% observer coverage would increase management costs. In AI, a required research and monitoring program would result in increase costs.	CVs and C/Ps using bottom contact gear in the GOA and AI, might have to have VMS or 100% observer coverage (AI). In AI, 100% observer coverage would increase management costs. In GOA, increased use of VMS would increase management costs, particularly for small entities.	Catcher vessel and catcher-processor vessels using bottom-contact fishing gear for all species might have to have VMS or 100% observer coverage. Additional management costs might be inferred.
Impacts on Dependent Communities	There would be no impact.	Some adverse impacts might accrue to Washington-based C/Ps, but overall impacts to dependent communities would be expected to be insignificant.	Due to GOA fishery effects, smaller Kodiak owned CVs might lose some rockfish share to larger CVs and C/Ps, and Kodiak and Washington owned C/Ps as a sector might be adversely affected, but overall impacts to dependent communities would probably be insignificant.	GOA related community impacts would be similar to Alternative 3. BSAI fishery related community impacts would be negligible. Overall, impacts to dependent communities would probably be insignificant.	Smaller CVs from King Cove, Sand Point, and Kodiak would likely experience adverse impacts, and these impacts, especially in conjunction with potential impacts to shoreside processors in smaller WG area communities, might be felt at the community level in King Cove and Sand Point. Adverse impacts to C/Ps would be concentrated exclusively in Kodiak and Washington and are expected to be insignificant at the community level.	GOA and BS fishery-related community impacts to King Cove, Sand Point, and Kodiak would be similar to Alternative 5A. Additional AI CV and C/P related impacts would accrue to Kodiak and Washington communities, but would probably be insignificant at the community level. Additional shoreside processing impacts might be seen in Unalaska/Dutch Harbor, but would probably be insignificant.	GOA fishery-related community impacts to King Cove, Sand Point, and Kodiak would be similar to Alternative 5A. Additional AI CV and C/P related impacts would accrue to Kodiak and Washington communities, but would probably be insignificant at the community level. Additional shoreside processing impacts might be seen in Unalaska/Dutch Harbor, but would probably be insignificant.	Significant community impacts might result from Alternative 6. Groundfish CV related community impacts would largely be concentrated in King Cove, Sand Point, Kodiak, and Homer; halibut CV impacts in many communities of various sizes throughout GOA and BSAI, but most likely in the small communities of Sand Point and St. George. Expected crab fleet community impacts would be most prominent in Kodiak, but smaller community fleets might also feel effects. Seattle CVs would incur the greatest impact, but effects would be insignificant at the community level. C/P impacts would be concentrated largely in Kodiak and Washington communities. Shoreside processor impacts would be concentrated largely in Unalaska, St. Paul, and Kodiak, although other communities would be affected. Significant multi-sector impacts at the community level would occur in Kodiak, Sand Point, King Cove, St. George, and St. Paul. Many communities relatively more dependent on small boat fleets would incur losses due to closures of adjacent fishing areas.

Table 3.10-2. Total Catcher Vessel and Catcher-Processor Revenue at Risk (millions of dollars) by Alternative and Fleet Component (excluding AI coral gardens impacts[2/])[1/]

Category Fleet Component	Alternative 2	Alternative 3	Alternative 4	Alternative 5A	Alternative 5B, Option 1	Alternative 5B, Option 2	Alternative 5B, Option 3	Alternative 5C, Preferred Alternative	Alternative 6
Geographic									
Eastern Gulf	$0.02	$0.21	$0.02	$0.24	$0.24	$0.24	$0.24	$0.03	$7.56
Central Gulf	$0.64	$2.23	$0.64	$2.55	$2.55	$2.55	$2.55	$0.56	$29.23
Western Gulf	$0.23	$0.22	$0.23	$0.81	$0.81	$0.81	$0.81	$0.57	$9.73
Total GOA	$0.90	$2.65	$0.90	$3.60	$3.60	$3.60	$3.60	$1.17	$46.52
BS	$0.00	$0.00	$1.82-$4.40	$2.63-$5.61	$2.63-$5.61	$2.63-$5.61	$2.63-$5.61	$0.00	$177.54
AI	$0.00	$0.00	$0.82	$1.69	$6.71	$2.99	$1.23	$1.23	$13.14
All Alaska	$0.90	$2.65	$3.53-$6.11	$7.92-$10.90	$12.94-$15.93	$9.22-$12.20	$7.46-$10.44	$2.39	$237.20
Fishery									
Groundfish	$0.90	$2.65	$3.53-$6.11	$7.92-$10.90	$12.94-$15.93	$9.22-$12.20	$7.46-$10.44	$2.39	$163.76
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$38.34
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$34.11
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.98
Gear									
NPT	$0.90	$2.65	$3.53-$6.11	$7.92-$10.90	$12.94-$15.93	$9.22-$12.20	$7.46-$10.44	$2.39	$29.47
PTR	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$104.08
HAL	<$0.01	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$68.02
POT	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$34.64
JIG	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
DRG	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.99
Target History									
GOA Arrowtooth Flounder	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.46
Deep Water Flatfish	$0.00	$0.00	$0.00	$0.01	$0.01	$0.01	$0.01	<$0.01	$0.06
Flathead Sole	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.04
Other	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.02
Pacific Cod	$0.00	$0.00	$0.00	$0.38	$0.38	$0.38	$0.38	$0.32	$2.63
Pollock - bottom	$0.00	$0.00	$0.00	$0.07	$0.07	$0.07	$0.07	$0.00	<$0.01
Pollock - midwater	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Rex Sole	$0.00	$0.00	$0.00	$0.30	$0.30	$0.30	$0.30	$0.30	$0.87
Rock Sole	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	$0.00	<$0.01
Rockfish	$0.90	$2.65	$0.90	$2.82	$2.82	$2.82	$2.82	$0.52	$2.29
Sablefish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$6.66
Shallow Water Flatfish	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.04
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$32.12
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.37
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.94

Table 3.10-2. Total Catcher Vessel and Catcher-Processor Revenue at Risk (millions of dollars) by Alternative and Fleet Component (excluding AI coral gardens impacts[2/])[1/] (continued)

Category	Fleet Component	Alternative 2	Alternative 3	Alternative 4	Alternative 5A	Alternative 5B, Option 1	Alternative 5B, Option 2	Alternative 5B, Option 3	Alternative 5C, Preferred Alternative	Alternative 6
BS	Arrowtooth Flnd.	$0.00	$0.00	$0.01-$0.08	$0.02-$0.09	$0.02-$0.09	$0.02-$0.09	$0.02-$0.09	N/A	$0.08
	Atka Mackerel	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	N/A	$0.00
	Flathead Sole	$0.00	$0.00	$1.23-$3.34	$1.70-$4.23	$1.70-$4.23	$1.70-$4.23	$1.70-$4.23	N/A	$1.84
	Greenland Turbot	$0.00	$0.00	$0.12-$0.12	$0.12-$0.13	$0.12-$0.13	$0.12-$0.13	$0.12-$0.13	N/A	$0.79
	Other	$0.00	$0.00	$0.02-$0.04	$0.02-$0.05	$0.02-$0.05	$0.02-$0.05	$0.02-$0.05	N/A	$0.07
	Other Flatfish	$0.00	$0.00	$0.01-$0.03	<$0.01	<$0.01	<$0.01	<$0.01	N/A	$1.73
	Pacific Cod	$0.00	$0.00	$0.14-$0.73	$0.19-$0.98	$0.19-$0.98	$0.19-$0.98	$0.19-$0.98	N/A	$23.83
	Pollock--midwater	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	N/A	$104.04
	Rock Sole	$0.00	$0.00	$0.03-$0.15	$0.07-$0.16	$0.07-$0.16	$0.07-$0.16	$0.07-$0.16	N/A	$2.42
	Rockfish	$0.00	$0.00	$0.01-$0.03	$0.01-$0.04	$0.01-$0.04	$0.01-$0.04	$0.01-$0.04	N/A	<$0.01
	Sablefish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	N/A	$0.08
	Yellowfin Sole	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	N/A	$10.65
	Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3.53
	Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$28.45
	Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<$0.01
AI	Arrowtooth Flnd.	$0.00	$0.00	$0.01	$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.01
	Atka Mackerel	$0.00	$0.00	$0.08	$0.20	$3.61	$1.59	$0.62	$0.62	$0.89
	Flathead Sole	$0.00	$0.00	<$0.01	<$0.01	$0.00	$0.00	$0.00	$0.00	<$0.01
	Greenland Turbot	$0.00	$0.00	$0.19	$0.19	<$0.01	<$0.01	<$0.01	<$0.01	$0.22
	Other	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.04
	Other Flatfish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Pacific Cod	$0.00	$0.00	$0.02	$0.13	$1.64	$0.48	$0.35	$0.35	$2.32
	Pollock--midwater	$0.00	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	$0.00	<$0.01
	Rock Sole	$0.00	$0.00	$0.06	$0.06	<$0.01	<$0.01	<$0.01	<$0.01	$0.04
	Rockfish	$0.00	$0.00	$0.46	$1.09	$1.45	$1.19	$0.26	$0.26	$0.06
	Sablefish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.78
	Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2.69
	Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$5.30
	Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.05

Table 3.10-2. Total Catcher Vessel and Catcher-Processor Revenue at Risk (millions of dollars) by Alternative and Fleet Component (excluding AI coral gardens impacts [2])[1] (continued)

Category **Fleet Component**	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5A**	**Alternative 5B, Option 1**	**Alternative 5B, Option 2**	**Alternative 5B, Option 3**	**Alternative 5C, Preferred Alternative**	**Alternative 6**
Alaska Arrowtooth Flounder	$0.00	$0.00	$0.02-$0.10	$0.03-$0.11	$0.02-$0.10	$0.02-$0.10	$0.02-$0.10	<0.01	$0.55
Atka Mackerel	$0.00	$0.00	$0.08-$0.08	$0.20	$3.61	$1.59	$0.62	$0.62	$0.89
Deep Water Flatfish	$0.00	$0.00	$0.00	$0.01	$0.01	$0.01	$0.01	$0.02	$0.06
Flathead Sole	$0.00	$0.00	$1.23-$3.35	$1.71-$4.24	$1.71-$4.24	$1.71-$4.24	$1.71-$4.24	$0.01	$1.89
Greenland Turbot	$0.00	$0.00	$0.20-$0.31	$0.19-$0.32	$0.13-$0.13	$0.13-$0.13	$0.13-$0.13	<0.01	$1.01
Other	$0.00	$0.00	$0.02-$0.04	$0.02-$0.05	$0.02-$0.05	$0.02-$0.05	$0.02-$0.05	<0.01	$0.13
Other Flatfish	$0.00	$0.00	$0.01-$0.03	<$0.01	<$0.01	<$0.01	<$0.01	$0.00	$1.73
Pacific Cod	$0.00	$0.00	$0.15-$0.75	$0.70-$1.49	$2.21-$3.00	$1.05-$1.84	$0.92-$1.71	$0.67	$28.79
Pollock - bottom	$0.00	$0.00	$0.00	$0.07	$0.07	$0.07	$0.07	$0.00	$5.75
Pollock - midwater	$0.00	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	$0.00	$98.33
Rex Sole	$0.00	$0.00	$0.00	$0.30	$0.30	$0.30	$0.30	$0.30	$0.87
Rock Sole	$0.00	$0.00	$0.09-$0.20	$0.12-$0.22	$0.08-$0.17	$0.08-$0.17	$0.08-$0.17	<$0.01	$2.47
Rockfish	$0.90	$2.65	$1.36-$1.39	$3.93-$3.96	$4.28-$4.31	$4.02-$4.05	$3.09-$3.12	$0.78	$3.07
Sablefish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$7.47
Shallow Water Flatfish	$0.00	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.04
Yellowfin Sole	$0.00	$0.00	<$0.01	<$0.01	<$0.01	<$0.01	<$0.01	$0.00	$10.65
Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Halibut	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$38.34
Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$34.11
Scallop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.98

[1] Catcher vessels are ex-vessel values and catcher-processors are first wholesale value (millions of dollars, based on 2001 data).

[2] Impacts on revenue and catch at risk from the AI coral garden areas in Alternatives 5B, Option 2, and 5C are excluded from the table and covered in the RIR text.

Table 4.1-1. Comparison of SBA Small Entity Impacts of Adding VMS to GOA Vessels of Differing Size Classes

Variable	All Vessels	Less Than or Equal to 32 Feet	Less Than or Equal to 30 Feet	Less Than or Equal to 25 Feet	Unknown
Count of vessels with VMS	865 (install on 635)	84 (install on 76)	28 (install on 28)	15 (install on 15)	11 (install on 11)
Average installation cost in a vessel adding it	$1,550	$1,550	$1,550	$1,550	$1,550
Average annual transmission costs all vessels	$489	$372	$252	$203	$581
Average annual repair costs for a vessel adding VMS	$47/$93	$93	$93	$93	$93
Average 2003 revenues all vessels	$349,000	$103,000	$17,000	$5,000	$20,000
2003 median	$175,000				
Total installation costs for vessels adding it	$984,000	$118,000	$43,000	$23,000	$17,000
Total annual transmission costs all vessels	$423,000	$31,000	$7,000	$3,000	$6,000
Total annual repair costs all vessels	$34,000	$7,800	$2,600	$1,400	$1,000
Total 2003 gross revenues from all sources	**$302,068,000**	**$8,689,000**	**$476,000**	**$73,000**	**$219,000**

Notes: The “all vessels” and “less than or equal to” categories include vessels that already have VMS. Eight vessels in the less than or equal to 32 feet category already have VMS. Gross revenues estimates include gross revenues from all sources in federally and State of Alaska managed fisheries off of Alaska, including fisheries not using bottom-contact gear. Repair costs were estimated at $47 for vessels over 32 feet and at $93 for others. Breakdowns may also result in losses due to lost fishing time. These have not been monetized.

Appendix D
EFH Text and Map Descriptions for Federally Managed Species of the Alaska Region

Prepared by

National Marine Fisheries Service

April 2005

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ACRONYMS AND ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
AI	Aleutian Islands
AKR	Alaska Region
EBS	Bering Sea
BSAI	Bering Sea and Aleutian Islands
cm	centimeter
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
FMP	Fishery Management Plans
FMU	Fishery Management Unit
GIS	geographical information system
GOA	Gulf of Alaska
nm	nautical mile
m	meters
mm	millimeter
Magnuson-Stevens Act	Magnuson-Stevens Fisheries Conservation and Management Act
NMFS	National Marine Fisheries Service
RACE	Resource Assessment and Conservation Engineering Division

Section I Introduction

This appendix describes essential fish habitat (EFH) for federally managed species in the Alaska region in text, tables, and maps. Material is arranged by alternative, with each alternative containing: a general discussion of objective, methodology, and rationale; summary tables; text descriptions of each species; and maps for each species.

Federal Management Plans

EFH is described with text and maps for each life history stage of those federally managed species listed in the five Fishery Management Plans (FMP) for Alaska. The five FMPs and area covered by the FMP are:

1. Bering Sea and Aleutian Islands (BSAI) Groundfish FMP

   The management area for the federally managed BSAI groundfish fisheries effectively covers all of the Bering Sea (EBS) under U.S. jurisdiction, extending southward to include the waters south of the Aleutian Islands (AI) west of long. 170º W, to the border of the U.S. Exclusive Economic Zone (EEZ). The northern boundary of the EBS is the Bering Strait, defined as a straight line from Cape Prince of Whales to Cape Dezhneva.

2. Gulf of Alaska (GOA) Groundfish FMP

   The management area is the entire U.S. EEZ of the North Pacific Ocean, exclusive of the EBS, between the eastern AI at long. 170º W and Dixon Entrance at long. 132º 40' W. (This area is commonly referred to as the GOA.)

3. Scallop Fisheries off the Coast of Alaska FMP

   The management areas covered under the Scallop FMP includes all federal waters of the GOA and the BSAI area. The GOA is defined as the U.S. EEZ of the North Pacific Ocean, exclusive of the EBS, between the eastern AI at long. 170º W and Dixon Entrance at long. 132º40' W. The BSAI is defined as the EEZ south of the Bering Strait to the Alaska Peninsula and AI and extending south of the AI west of long. 170º W.

4. BSAI King and Tanner Crab FMP

   The management area is those waters of the EEZ lying south of Point Hope (lat. 68º 21' N), east of the USSR convention line of 1867, and extending south of the AI for 200 miles between the convention line and Scotch Cap Light (long. 164º 44.6' W).

5. Salmon Fisheries in the EEZ Off the Coast of Alaska FMP

   The management unit of the salmon FMP consists of all of the EEZ off the coast of Alaska (including parts of the GOA, EBS, Chukchi Sea, and Arctic Ocean), and the salmon fisheries that occur there. Two management areas are established within the fishery management unit, with the border between the two at the longitude of Cape Suckling (long. 143º53'36" W). As long as the International Convention for the High Seas Fisheries of the North Pacific Ocean remains in effect (or is replaced by an equivalent convention), the Council leaves the management of the salmon fisheries west

> of long. 175º E under the control of the International North Pacific Fisheries Commission (or equivalent organization). Otherwise, this plan will govern the salmon fisheries in the EEZ west of long. 175º E as an integral part of the West Area.
>
> The West Area is the area of the EEZ off the coast of Alaska west of the longitude of Cape Suckling (143º53'36" W). It includes the EEZ in the Bering, Chukchi, and Beaufort Seas, as well as the EEZ in the North Pacific Ocean west of Cape Suckling. The East Area is the area of the EEZ off the coast of Alaska east of the longitude of Cape Suckling.

EFH Descriptive Information Levels

EFH is defined in the Magnuson-Stevens Act as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The regulations specify the following requirements for EFH description. "FMPs must describe and identify EFH in text that clearly states the habitats or habitat types determined to be EFH for each life stage of the managed species. FMPs should explain the physical, biological, and chemical characteristics of EFH and, if known, how these characteristics influence the use of EFH by the species/life stage. FMPs must identify the specific geographic location or extent of habitats described as EFH. FMPs must include maps of the geographic locations of EFH or the geographic boundaries within which EFH for each species and life stage is found....[also] FMPs must demonstrate that the best scientific information available was used in the description and identification of EFH, consistent with national standard 2" (50 CFR 600.815(a)(1)(i)).

The EFH Final Rule (50 CFR 600815(a)(1)(iii)) specifies the following approach to gather and organize the data necessary for identifying EFH. Information is to be described using levels of information and all levels should be used to identify EFH, if information exists. The goal of this procedure is to include as many levels of analysis as possible within the constraints of the available data. Councils should strive to obtain data sufficient to describe habitat at the highest level of detail (i.e., Level 4).

> Level 1: Distribution data are available for some or all portions of the geographic range of the species. At this level, only distribution data are available to describe the geographic range of a species (or life stage). Distribution data may be derived from systematic presence/absence sampling and/or may include information on species and life stages collected opportunistically. In the event that distribution data are available only for portions of the geographic area occupied by a particular life stage of a species, habitat use can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior. Habitat use may also be inferred, if appropriate, based on information on a similar species or another life stage.
>
> Level 2: Habitat-related densities of the species are available. At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species or life stage. Because the efficiency of sampling methods is often affected by habitat characteristics, strict quality assurance criteria should be used to ensure that density estimates are comparable among methods and habitats. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.
>
> Level 3: Growth, reproduction, or survival rates within habitats are available. At this level, data are available on habitat-related growth, reproduction, and/or survival by life stage. The habitats

> contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life stage).
>
> Level 4: Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species or life stage to habitat type, quantity, quality, and location. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and the managed species' contribution to a healthy ecosystem.

The regulations specify that Level 1 information, if available, should be used to identify the geographic range of the species at each life stage. If only Level 1 information is available, distribution data should be evaluated (e.g., using a frequency of occurrence or other appropriate analysis) to identify EFH as those habitat areas most commonly used by the species. Levels 2 through 4 information, if available, should be used to identify EFH as the habitats supporting the highest relative abundance; growth, reproduction, or survival rates; and/or production rates within the geographic range of a species.

Existing EFH descriptions (EFH description Alternative 2) include reference to Level 0 and is the only alternative to reference Level 0 information. Level 0 was established by the Alaska Region's (AKR) EFH Team in 1999 to address concerns of how to identify EFH in the data-limited environment the AKR faces. The AKR EFH Team felt the EFH Interim Rule did not adequately provide the level of definition needed for Alaska EFH resources. Further discussion on Level 0 is provided in Sections 2.3.1.2 and D.2.

EFH description Alternatives 3, 4, 5, and 6 do not include Level 0 information and use the level of information definitions (Levels 1 to 4) as defined by the EFH Final Rule, as outlined above. The EFH Final Rule level of information definitions were changed to allow the use of habitat information in data-limited situations, such as inference.

EFH Scientific Information

EFH descriptions are interpretations of the best scientific information. In support of this information, a thorough review of FMP species is contained in Section 3.2.1 Biology, Habitat Usage, and Status of Magnuson-Stevens Act Managed Species and detailed by life history stage in Appendix F: EFH Habitat Assessment Reports.

Another important scientific reference, specific to Pacific salmon, is the Alaska Department of Fish and Game's (ADF&G's) *Catalogue of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a). The catalogue covers the entire State of Alaska and focuses on freshwater and estuarine areas used by anadromous fishes. The catalogue is divided into six regional areas (see Figure D-1). There are limitations to the catalogue, and many areas in Alaska have not been completely surveyed.

EFH Text Descriptions

The EFH Final Rule (50 CFR 600.815(a)(1)(iv)(B)) states: "FMPs must describe EFH in text, including reference to the geographic location or extent of EFH using boundaries such as longitude and latitude, isotherms, isobaths, political boundaries, and major landmarks. If there are differences between the descriptions of EFH in text, maps, and tables, the textual description is ultimately determinative of the limits of EFH....the boundaries of EFH should be static."

The EFH descriptions refer to the boundaries as defined by each Fishery Management Unit (FMU) for each FMP, described on page D-1. FMU boundaries are known geographic locations within the waters of Alaska and reference is included in each species life history text description.

EFH Map Description

EFH guidelines specify FMPs must include maps that display, within the constraints of available information, the geographic location of EFH or the geographic boundaries within which EFH for each species and life stage is found. A geographical information system (GIS) analytical system was used to delineate EFH map descriptions for this analysis. Importantly, EFH descriptive maps are a means to visually present the EFH text description and are complimentary.

EFH Alternative Methodology and Analytical Approach

Each EFH description alternative has a specific methodology and analytical approach to describe EFH. To assess each alternative and evaluate the merits of one particular approach to another, it is important to understand each alternative. At the beginning of each EFH description alternative in Chapter 2, the basic methodology, objective, and rationale for each alternative is provided. Appendix H offers more details about specific GIS analytical approaches used for each EFH description alternative.

The following sections provide a description of alternatives, evaluated in this analysis, for the description and identification of EFH. This EIS includes alternatives for describing EFH for every species and life stage managed under the North Pacific Council's five FMPs for which sufficient information is available. As specified in the EFH regulations, if there is no information on a given species or life stage, and habitat use cannot be inferred from other means, EFH should not be described (50 CFR 600.815(a)(1)(iii)(B)).

Section II EFH Description Alternatives by FMP

D.1 Alternative 1—No EFH Description (No Action)

Under this alternative, the FMPs would be amended to remove any description or identification of EFH.

D.2 Alternative 2 (Status Quo)—Existing EFH General Distribution

Under this alternative, the existing description and identification of EFH contained in the FMPs would remain unchanged. EFH is the general distribution for a species life history stage, if presence/absence information is available. General distribution is used to describe EFH whether higher levels of information exist and are provided under all stock conditions. General distribution is a subset of a species range, encompassing the area that contains about 95 percent of the occurrence for a particular species' life history stage.

In January 1999, these EFH descriptions were made under FMP amendments 55/55/8/5/5. Importantly, *EFH is the text description only* and any mapped areas are only attempts to depict general distribution.

Additionally, the EFH Core Team (a multi-disciplined panel comprised of National Marine Fisheries Service (NMFS) AKR and Alaska Fisheries Science Center staff) decided there was some information for a particular species' life history stage, but not enough to describe EFH using Level 1 information. In these cases, a Level 0 was established to describe EFH for those life history stages where EFH could be inferred from another life history stage or a species with similar habitat characteristics. Further, the

Level 0 was divided into three sub-categories as 0a, 0b, 0c. Level 0 sub-categories are summarized below and are listed in the EFH descriptions for each life stage in Alternative 2.

> Classification of EFH Level 0 used in the AKR EFH determinations based on available information. The classification system used in the AKR for Levels 1 to 4 follows NMFS nationwide guidelines.

Level 0	No systematic sampling has been conducted for this species and life stage; may have been caught opportunistically in small numbers during other research.
Level 0a	Some information on a species' life stage upon which to infer general distribution.
Level 0b	No information on the life stage, but some information on a similar species or adjacent life stage from which to infer general distribution.
Level 0c	No information on the actual species' life stage and no information on a similar species or adjacent life stages, or where complexity of a species stock structure prohibited inference of general distribution.

As discussed earlier, Alternative 2 is the only alternative to reference Level 0 information.

Objective

Existing EFH descriptions were analyzed through an environmental assessment process that met the objectives of the Magnuson-Stevens Act and EFH Interim Final Rule guidelines. Specifically, the objective was to identify EFH for each FMP species, by particular life stage and using best scientific information and technology, as only those waters and substrates necessary to the species.

Methodology

The analysis examined fishery observer data and catch data for BSAI Groundfish, GOA Groundfish, BSAI Crab, and Scallop FMP fisheries (Fritz et al. 1998), NMFS survey records, and, where appropriate, Alaska Department of Fish and Game (ADF&G) survey information to select approximately 95 percent of occurrences; as where one would reasonably (with high probability) expect to find a certain life stage of that species. Where this information exists, the area described by this data is EFH. The EFH areas were reviewed by scientific stock assessment authors for accuracy. EFH maps were hand drawn over a template of the FMP area, either BSAI or GOA. Text descriptions for each FMP by life stage were developed (see the 1999 EFH Environmental Assessment [EA] for more information).

For Salmon FMP species, the analysis is focused on two areas: marine and freshwater. Marine salmon EFH was generally described to include all marine waters from the mean higher high water line to the limits of the EEZ, since scientific information indicates salmon are 1) distributed throughout all marine waters during late juvenile and adult life stages, and 2) found nearshore and along coastal migration corridors as early juvenile life stages out migrate and adult life stages return to and from freshwater areas, respectively. Freshwater areas used by egg, larvae, and returning adult salmon will be described as those areas indexed in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), specifically Pacific salmon species. Freshwater salmon systems are generally defined as those areas above mean higher tide to the upper limits of those freshwater systems supporting salmon and may include contiguous wetland areas, such as those areas hydrologically connected to the main water source via access channels to an adjacent river, stream, lake, pond, etc.

Rationale

Alternative 2 incorporates basic rationales to describe EFH as general distribution. These rationales are found in the 1999 EFH EA Section 6.0, pages 46-48, and are summarized as follows:

- Areas of higher concentration, based on current information, do not adequately address unpredictable annual differences in spatial distributions of a life stage, nor changes due to long-term shifts in oceanographic regimes;
- All habitats occupied by a species contribute to production at some level;
- A stock's long-term productivity is based on both high and low levels of abundance, and the entire general distribution may be required during times of high abundance;
- Observed concentrations or densities do not necessarily reflect all habitat required to maintain healthy stocks within the ecosystem;
- The use of best scientific information available in a risk-averse fashion and employing an ecosystem approach suggests that, unless the information indicates otherwise, the more inclusive general distribution should be used to describe EFH;
- Density knowledge alone (Level 2 information and higher) would be insufficient to determine that habitat encompassed by general distribution is not essential to maintain healthy stocks and ecosystems and sustain productive fisheries; and
- A broad geographic distribution of essential habitats provides the prey species important for growth, maturation, and diversity that may be required in times of changing environmental conditions.

D.2.1 Description of Essential Fish Habitat for the Groundfish Resources of the BSAI Regions

D.2.1.1 EFH Information Levels for BSAI Groundfish

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Pollock	1	1	1	1	2
Pacific cod	0a	0a	0a	1	2
Yellowfin sole	0a	0a	0a	1	2
Greenland turbot	0a	0a	0a	1	2
Arrowtooth flounder	0a	0a	0a	1	2
Rock sole	0a	0a	0a	1	2
Other flatfish	0a	0a	0a	1	2
Flathead sole	0a	0a	0a	1	2
Sablefish	0a	0a	0a	1	2
Pacific ocean perch	-	0a	0a	1	1
Northern rockfish	-	0b	0b	1	1
Shortraker rockfish	-	0b	0a-b	0b	1
Rougheye rockfish	-	0b	0a-b	1	1
Dusky rockfish	-	0b	0b	0a	1
Thornyhead rockfish	0a	0a	0a	0a	1
Atka mackerel	0a	0a	0b	0b	2
Squid	0a	-	0a	0a	0a
Other species					
sculpins	0a	0a	0a	0a	1
skates	0a	-	0a	0a	1
sharks	-	-	0a	0a	0a
octopus	0a	-	0a	0a	0a
squid	0a	-	0a	0a	0a
Forage fish species					
smelts	0a	0a	0a	0a	0a
other forage fish	0	0	0	0	0

D.2.1.2 EFH Text Descriptions for BSAI Groundfish

EFH Definition for BSAI Walleye Pollock

Eggs (duration 14 to 25 days)—Level 1

Pelagic waters of the outer continental shelf and upper slope of the BS from Unimak Island northwest to Zhenchug Canyon. Also in pelagic waters (200 to 400 meters [m] depth) over basin and lower slope areas in the AI and the Aleutian Basin. These are likely areas of upwelling or have gyres. Spawning occurs from February through April.

Larvae (duration 60 days)—Level 1

Epipelagic waters on the inner, middle, and outer continental shelf and upper slope throughout the BS, eastern portions of the Aleutian Basin and throughout the AI. Survival is enhanced where food (copepod nauplii and small euphausiids) is concentrated, such as along semi-permanent fronts (mid-shelf front near the 100-m isobath) in the BS, within ephemeral gyres, and possibly in association with jellyfish.

Juveniles (up to 4 years)—Level 1
Throughout the BS and the AI both pelagically and on-bottom (no known substrate preferences) throughout the inner, middle, and outer shelf regions. At ages 2 and 3 years, pollock are located off-bottom within the water column, principally in the middle and outer shelf regions northwest of the Pribilof Islands. Ranges of juveniles of strong year-classes have varied from throughout the BS (1978 year-class) to almost exclusively north of Zhenchug Canyon (1989 year-class). Feeding areas contain pelagic crustaceans such as copepods and euphausiids.

Adults (4+ years old)—Level 2
Meso-pelagic and semi-demersal habitats (no known substrate preferences) along the middle and outer continental shelf in the BS from the U.S. Russia Convention Line to Unimak Pass and northeast along the Alaska Peninsula and throughout the AI. Adults also exist pelagically over deep Aleutian basin waters. Feeding areas are those that concentrate pelagic crustaceans (e.g., euphausiids) and juvenile fish (primarily juvenile pollock), such as in upwelling regions along the shelf break or fronts on the middle shelf. Known spawning areas in the BS are: north of Unimak Island, along the mid-shelf front (100-m isobath) between Unimak Island and the Pribilof Islands, south of the Pribilof Islands, and possibly at other areas to the north, particularly at heads of submarine canyons. Known spawning areas in the AI are: over deep waters north of Umnak and Unalaska Islands, the region north of the Islands of Four Mountains, through Amukta Pass to Seguam Island, and north of Kanaga and Tanaga Islands. Pollock may prefer waters of 2º to 3ºC for spawning.

EFH Definition for BSAI Pacific Cod

Eggs (duration 15 to 20 days)—Level 0a
Areas of mud and sand on the inner, middle, and outer continental shelf and upper slope throughout the eastern BSAI in winter and spring.

Larvae (duration unknown)—Level 0a
Epipelagic waters throughout the eastern BSAI regions in winter and spring.

Early Juveniles (up to 2 years)—Level 0a
Areas of mud and sand and the water column on the inner and middle continental shelf of the eastern BSAI, particularly those with mysids, euphausiids and shrimp.

Late Juveniles (2 to 4 years)—Level 1
Areas of soft substrate (clay, mud, and sand) and the lower portion of the water column on the inner, middle, and outer continental shelf areas of the eastern BSAI, particularly those with mysids, euphausiids, shrimp, pollock, flatfish, crab, and fishery discards.

Adults (4+ years old)—Level 2
Areas of mud and sand along the inner, middle, and outer continental shelf up to 500 m along with the lower portion of the water column of the eastern BSAI. Spawning occurs from January through May near the bottom across broad areas of the shelf, but predominately along the outer shelf between 100 and 200 m in the BS and throughout the area less than 200 m from the AI. After spawning, the mature population spreads out throughout the shelf in the eastern BSAI, but with concentrations along the outer shelf northwest of the Pribilof Islands and along the outer and middle shelf areas northwest of the Alaskan Peninsula and into Bristol Bay. Feeding areas are those containing pollock, flatfish, and crab.

EFH Definition for BSAI Yellowfin Sole

Eggs (duration unknown)—Level 0_a
Pelagic inshore waters of the southeastern BS shelf from Norton Sound to Bristol Bay in spring and summer.

Larvae (duration 2 to 3 months)—Level 0_a
Pelagic inshore waters of the southeastern BS shelf from Norton Sound to Bristol Bay in spring, summer, and fall.

Early Juveniles (to 5.5 years old)—Level 0_a
Demersal areas (bottom and lower portion of the water column) on the inner, middle, and outer portions of the continental shelf (down to 250 m) and within nearshore bays of the BS.

Late Juveniles (5.5 to 9 years old)—Level 1
Areas of sandy bottom along with the lower portion of the water column within nearshore bays and on the inner, middle and outer portions of the continental shelf (down to 250 m) of the BS south of St. Matthew Island (approximately 61º N) and in Norton Sound. Feeding areas would be those containing polychaetes, bivalves, amphipods, and echiurids.

Adults (9+ years old)—Level 2
Areas of sandy bottom along with the lower portion of the water column on the inner, middle and outer portions of the continental shelf (down to 250 m) of the BS south of St. Matthew Island (approximately 6º N) and in Norton Sound. Areas of known concentrations vary seasonally. Adult spawning areas in summer (May through August) are located along the inner shelf from Cape Constantine to Cape Peirce, throughout Kuskokwim Bay, and north of Nunivak Island. Summer (June through October) feeding concentrations of adults are located along the inner and middle portions of the shelf from Kuskokwim and Bristol Bays south along the Alaskan Peninsula to Amak Island, and northwest to St. Matthew Island. Feeding areas would be those containing polychaetes, bivalves, amphipods, and echiurids. In winter, yellowfin sole adults migrate to deeper waters of the shelf (100 to 200 m) south of 60º N to the Alaskan Peninsula.

EFH Definition for BSAI Greenland Turbot

Eggs (duration unknown)—Level 0_a
Benthypelagic waters of the outer continental shelf and slope in the BS and throughout the AI**.**

Larvae (8 to 9 months)—Level 0_a
Pelagic waters of the outer continental shelf, slope, and adjacent basin in the BS and throughout the AI.

Early Juveniles (to 4 years old)—Level 0_a
Substrate and lower portion of the water column of the inner, middle, and outer portions of the continental shelf and the adjacent upper slope region of the BS and throughout the AI.

Late Juveniles (4 to 5 years old)—Level 1
Substrate (particularly mud and muddy-sand) and lower portion of the water column of the middle and outer continental shelf and adjacent upper and lower slope regions of the BS and throughout the AI. Feeding areas would be those containing euphausiids, polychaetes, and small fish.

Adults (5+ years old)—Level 2
Substrate (particularly mud and muddy-sand) and lower portion of the water column of the outer continental shelf and adjacent upper and lower slope regions of the BS and throughout the AI. Feeding areas would be those containing pollock and small fish.

EFH Definition for BSAI Arrowtooth Flounder

Eggs (duration unknown)—Level 0_a
Pelagic waters of the middle and outer continental shelf and slope in the BS and throughout the AI in winter.

Larvae (duration 2 to 3 months)—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf and adjacent nearshore bays in the BS and throughout the AI.

Early Juveniles (to 2 years old)—Level 0_a
Areas of gravel, sand, and mud and the associated water column of the inner continental shelf and the adjacent nearshore bays in the BS and throughout the AI.

Late Juveniles (2 to 4 years old)—Level 1
Areas of gravel, sand, and mud and the associated water column of the middle and outer continental shelf and adjacent upper slope regions of the BS and throughout the AI. Feeding areas would be those containing euphausiids, crustaceans, and small fish.

Adults (4+ years old)—Level 2
Areas of gravel, sand, and mud and the associated water column of the middle and outer continental shelf and adjacent upper slope regions of the BS and throughout the AI. Summer feeding areas on the middle and outer shelf would be those containing gadids, euphausiids, and other fish. Spawning areas in winter are on the outer shelf and upper slope regions.

EFH Definition for BSAI Rock Sole

Eggs (duration unknown)—Level 0_a
Areas of pebbles and sand on the middle and outer continental shelf in the BS in winter (December through March).

Larvae (duration 2 to 3 months)—Level 0_a
Pelagic waters of the BS over the inner, middle, and outer continental shelf, the slope, and the Aleutian Basin.

Early Juveniles (to 3.5 years old)—Level 0_a
Inner, middle, and outer portions of the continental shelf along with the lower portion of the water column of the BS south of 61° N and in Norton Sound. Feeding areas would be those containing polychaetes, bivalves, amphipods, and crustaceans.

Late Juveniles (3.5 to 8 years old)—Level 1
Areas of pebbles and sand along with the lower portion of the water column within nearshore bays and on the inner, middle, and outer portions of the continental shelf of the BS south of 61° N and in Norton Sound. Feeding areas would be those containing polychaetes, bivalves, amphipods, and crustaceans.

Adults (8+ years old)—Level 2
Areas of pebbles and sand along with the lower portion of the water column on the inner, middle, and outer portions of the continental shelf of the BS south of 61º N and in Norton Sound. Areas of known concentrations vary seasonally and include adult spawning areas in winter and feeding areas in summer (May through October), which include Bristol Bay, portions of outer Kuskokwim Bay, north of the Alaskan Peninsula to Unimak Island, and near the Pribilof Islands. Feeding areas would be those containing polychaetes, bivalves, amphipods, and crustaceans.

EFH Definition for BSAI Other Flatfish—Alaska Plaice

Eggs (duration unknown)—Level 0_a
Pelagic waters of the middle and outer continental shelf of the BS in spring and early summer.

Larvae (duration 2 to 4 months)—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf of the BS in summer and fall.

Early Juveniles (up to 4 years)—Level 0_a
Substrate (particularly areas of sand and mud) and lower portion of the water column on the inner and middle continental shelf of the BS.

Late Juveniles (4 to 7 years)—Level 1
Substrate (particularly areas of sand and mud) and lower portion of the water column on the inner, middle, and outer continental shelf of the BS. Feeding areas will be those containing polychaetes, amphipods, and echiurids. With increasing age, plaice overwinter near the edge of the shelf, and return to the middle and inner shelf for feeding in spring, summer, and fall.

Adults (7+ years)—Level 2
Substrate (particularly areas of sand and mud) and lower portion of the water column on the inner, middle, and outer continental shelf of the BS. Feeding areas will be those containing polychaetes, amphipods, and echiurids. Plaice overwinters near the edge of the shelf in the southeastern BS from the Pribilof islands to Unimak Island and north along the Alaskan Peninsula. Adults also occur across broad areas of the middle and inner shelf in summer and fall.

EFH Definition for BSAI Flathead Sole

Eggs (duration unknown)—Level 0_a
Pelagic waters of the middle and outer portions of the southeastern BS shelf, adjacent slope, and basin waters and throughout the AI in winter and early spring.

Larvae (duration unknown)—Level 0_a
Pelagic waters of the inner, middle, and outer portions of the southeastern BS shelf, adjacent slope, and basin waters and throughout the AI in spring and summer.

Early Juveniles (to 2 years old)—Level 0_a
Bottom substrate and lower water column on the inner, middle, and outer portions of the southeastern BS shelf and throughout the AI.

Late Juveniles (2 to 3 years old)—Level 1
Bottom substrate (particularly sand and mud) and lower portion of the water column on the inner, middle, and outer portions of the southeastern BS shelf south of 61° N and throughout the AI. Feeding areas would be those containing polychaetes, bivalves, ophiuroids, pollock, small tanner crab, and other crustaceans.

Adults (3+ years old)—Level 2
Bottom substrate (particularly sand and mud) and lower portion of the water column on the inner, middle, and outer portions of the southeastern BS shelf south of 61° N and throughout the AI. Feeding areas, primarily on the inner, middle, and outer shelf in spring, summer, and fall, are those containing polychaetes, bivalves, ophiuroids, pollock, small tanner crab, and other crustaceans. Spawning areas in winter and early spring are located primarily on the outer shelf.

EFH Definition for BSAI Sablefish

Eggs (duration 14 to 20 days)—Level 0_a
Pelagic waters of the upper and lower slope, and basin areas from 200 to 3,000 m from late winter to early spring (December through April) in the eastern BSAI.

Larvae (up to 3 months)—Level 0_a
Epipelagic waters of the middle and outer continental shelf, the slope, and basin areas in the eastern BSAI during late spring-early summer months (April through July).

Early Juveniles (up to 2 years)—Level 0_a
Pelagic waters, during the first summer, along the outer, middle, and inner continental shelf of the eastern BSAI and, after the first summer, areas of soft-bottom in nearshore bays and island passages until the end of the second summer.

Late Juveniles (2 to 5 years)—Level 1
Areas of soft bottom deeper than 200 m associated with the continental slope and deep shelf gulleys and fjords (presumably within the lower portion of the water column) of the eastern BSAI. Feeding areas are those containing mesopelagic and benthic fishes, benthic invertebrates, and jellyfish.

Adults (5+ years)—Level 2
Areas of soft bottom deeper than 200 m (presumably within the lower portion of the water column) associated with the continental slope and deep shelf gulleys in the eastern BSAI. Feeding areas would be those containing mesopelagic and benthic fishes, benthic invertebrates, and jellyfish. A large portion of the adult diet is comprised of gadid fishes, mainly pollock.

EFH Definition for BSAI Pacific Ocean Perch

Eggs (internal incubation, ~90 days)—No EFH Definition Determined
Internal fertilization and incubation. Incubation is assumed to occur during the winter months.

Larvae (duration 60 to 180 days)—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas of the BSAI during the spring and summer months.

Early Juveniles (larval stage to 3 years)—Level 0_a
Initially pelagic, then demersal in very rocky areas of the inner continental shelf of the BSAI. Includes the water column.

Late Juveniles (3 to 10 years)—Level 1
Areas of cobble, gravel, mud, and sand along the inner, middle, and outer continental shelf and upper slope areas, shallower than for adults, and the middle and lower portions of the water column of the BSAI regions. Feeding areas are those containing euphausiids.

Adults (10+ years)—Level 1
Areas of cobble, gravel, mud, and sand along the outer continental shelf and upper slope areas and middle and lower portions oft the water column of the BSAI. Feeding areas are those containing euphausiids. Areas of high concentrations tend to vary seasonally and may be related to spawning behavior. In summer, adults inhabit shallower depths (180 to 250 m), and in the fall, they migrate farther offshore (300 to 420 m).

EFH Definition for BSAI Pacific Ocean Perch Complex—Shortraker, and Rougheye Rockfish

Eggs—No EFH Definition Determined
Internal fertilization and incubation.

Larvae (duration unknown)—Level 0_b
Epipelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas of the BSAI during the spring and summer months.

Early Juveniles—Level $0_{a\text{-}b}$
Pelagic waters and substrate on the entire continental shelf of the BSAI regions.

Late Juveniles—Level 0_b and Level 1
Areas shallower than for adults along the continental shelf of the BSAI regions. Juvenile shortraker rockfish have been seen only rarely.

Adults (15+ years)—Level 1
Areas of mud, sand, rock, cobble, and gravel and the lower portion of the water column on the outer continental shelf and upper slope of the BSAI. Fishery concentrations at 100 to 500 m. Feeding areas would be those areas where shrimps, squid, and myctophids occur.

EFH Definition for BSAI Pacific Ocean Perch Complex—Northern Rockfish

Eggs—No EFH Definition Determined
Internal fertilization and incubation.

Larvae—Level 0_b
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas extending to the seaward boundary of the EEZ of the BSAI during the spring and summer months.

Early Juveniles (up to 25 centimeter [cm])—Level 0_b
Pelagic waters and substrate of the inner, middle, and outer continental shelf of the BSAI.

Late Juveniles (greater than 25 cm)—Level 1
Areas of cobble and rock along the shallower regions (relative to adults) of the outer continental shelf of the BSAI.

Adults (13+ years)—Level 1
Areas of cobble and rock along the outer continental slope and upper slope regions and the middle and lower portions of the water column of the BSAI. Areas of relatively shallow banks of the outer continental shelf have been found to have concentrated populations.

EFH Definition for BSAI Other Rockfish—Dusky Rockfish

Eggs—No EFH Definition Determined
Internal fertilization and incubation.

Larvae—Level 0_b
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas extending to the seaward boundary of the EEZ of the BSAI during the spring and summer months.

Early Juveniles (up to 25 cm)—Level 0_b
Pelagic waters of the inner, middle, and outer continental shelf of the BSAI.

Juveniles (greater than 25 cm)—Level 0_a
Areas of cobble, rock, and gravel and the water column along the inner, middle, and outer continental shelf of the BSAI.

Adults (up to 50 years)—Level 1
Areas of cobble, rock, and gravel along the outer continental shelf and upper slope region and the middle and lower portions of the water column of the BSAI. Feeding areas are those containing euphausiids.

EFH Definition for BSAI Other Rockfish—Thornyhead Rockfish

Eggs—Level 0_a
Pelagic waters of the BSAI during the late winter and early spring.

Larvae (duration less than 15 months)—Level 0_a
Pelagic waters of the BSAI.

Juveniles (greater than 15 months)—Level 0_a
Areas of mud, sand, rock, cobble, and gravel and the lower portion of the water column along the middle and outer continental shelf and upper slope of the BSAI.

Adults (12+ years)—Level 1
Areas of mud, sand, rock, cobble, and gravel and the lower portion of the water column along the middle and outer continental shelf and upper and lower slope of the BSAI. Feeding areas are those containing shrimp, fish (cottids), and small crabs.

EFH Definition for BSAI Atka Mackerel

Eggs (duration 1 to 1.5 months)—Level 0_a
Areas of gravel, rock and kelp in shallow water in island passages, nearshore, and on the inner continental shelf in the AI and southeastern BS in areas of swift current in summer.

Larvae (duration 1.5 to 6 months)—Level 0_a
Epipelagic waters of the outer continental shelf of the southeastern BSAI, the Aleutian Basin (to the edge of the EEZ), and in the adjacent North Pacific Ocean (to the edge of the EEZ) in fall and winter.

Juveniles (up to 3 years)—Level 0_b
Unknown habitat association; assumed to settle near areas inhabited by adults, but have not been observed in fishery or surveys.

Adults (3+ years)—Level 2
Areas of gravel, rock, and kelp on the inner, middle, and outer portions of the shelf in the AI and the entire water column to the surface. Areas of gravel and rock on the outer portion of the shelf in the southeast BS and extending nearshore near the Pribilof Islands, including the entire water column. Feeding areas are those containing copepods, euphausiids and meso-pelagic fish (myctophids). Spawning occurs in nearshore (inner shelf and in island passages) rocky areas and in kelp in shallow waters in summer. BSAI Atka mackeral move to offshore deeper areas nearby in winter, and perform diurnal/tidal movements between demersal and pelagic areas.

EFH Definition for BSAI Other Species—Sculpins

Eggs—Level 0_a
All substrates on the inner, middle, and outer continental shelf of the eastern BSAI. Some species deposit eggs in rocky, shallow waters near shore.

Larvae—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf and slope of the eastern BSAI, predominately over the inner and middle shelf.

Juveniles—Level 0_a
Broad range of demersal habitats from intertidal pools, all shelf substrates (mud, sand, gravel, etc.), and rocky areas of the upper slope of the eastern BSAI.

Adults—Level 1
Broad range of demersal habitats from intertidal pools, all shelf substrates (mud, sand, gravel, etc.), and rocky areas of the upper slope of the eastern BSAI.

EFH Definition for BSAI Other Species—Skates

Eggs—Level 0_a
All bottom substrates of the slope and across the shelf throughout the eastern BSAI.

Larvae—No EFH Definition Determined
Not applicable (no larval stage)

Juveniles—Level 0_a
Broad range of substrate types (mud, sand, gravel, and rock) and the water column on the shelf and the upper slope of the eastern BSAI.

Adults—Level 1
Broad range of substrate types (mud, sand, gravel, and rock) and the lower portion of the water column on the shelf and the upper slope of the eastern BSAI.

EFH Definition for BSAI Other Species—Sharks

Eggs—No EFH Definition Determined
Not applicable (most are oviparous)

Larvae—No EFH Definition Determined
Not applicable (no larval stage).

Juveniles and Adults—Level 0_a
All waters and substrate types in the inner, middle, and outer continental shelf and slope of the BSAI.

EFH Definition for BSAI Other Species—Octopus

Eggs—Level 0_a
All bottom substrates of the shelf throughout the eastern BSAI.

Larvae—No EFH Definition Determined
Not applicable (no larval stage).

Juveniles and Adults—Level 0_a
Broad range of substrate types (mostly rock, gravel, and sand) and the lower portion of the water column on the shelf and the upper slope of the eastern BSAI. Feeding areas are those containing crustaceans and molluscs.

EFH Definition for BSAI Squid—Red Squid

Eggs—Level 0_a
Areas of mud and sand on the upper and lower slope throughout the eastern BSAI.

Larvae—No EFH Definition Determined
Not applicable (no larval stage).

Juveniles and Adults—Level 0_a
Pelagic waters of the shelf, slope, and basin to the seaward edge of the EEZ in the eastern BSAI. Feeding areas are those containing euphausiids, shrimp, forage fish, and other cephalopods.

EFH Definition for BSAI Forage Fish Complex—Eulachon

Eggs (duration 30 to 40 days)—Level 0_a
Bottom substrates of sand, gravel, and cobble in rivers from April through June.

Larvae (duration 1 to 2 months)—Level 0_a
Pelagic waters of the inner continental shelf throughout the BS.

Juveniles (to 3 years)—Level 0_a
Pelagic waters of the middle and outer continental shelf and upper slope throughout the BS.

Adults (3+ years)—Level 0_a
Pelagic waters of the middle to outer continental shelf and upper slope throughout the BS for non-spawning fishes (July through April). Feeding areas are those containing euphausiids and copepods. Rivers during spawning (April through June).

EFH Definition for BSAI Forage Fish Complex—Capelin

Eggs (duration 2 to 3 weeks)—Level 0_a
Sand and cobble intertidal beaches down to 10 m deep along the shores of the BS in Bristol Bay, Norton Sound, and along the northern shore of the Alaskan Peninsula from May through August.

Larvae (duration 4 to 8 months)—Level 0_a
Epipelagic waters of the inner and middle continental shelf throughout the BS.

Juveniles (1 to 2 yrs)—Level 0_a
Pelagic waters of the inner and middle continental shelf throughout the BS. Capelin juveniles may be associated with fronts and ice edges in winter.

Adults (2+ years)—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf throughout the BS during their non-spawning cycle (September through April). Populations are associated with fronts and the ice edge formed in winter and with intertidal beaches of sand and cobble down to 10 m deep during spawning (May through August).

EFH Definition for BSAI Forage Fish Complex—Sand Lance

Eggs (3 to 6 weeks)—Level 0_a
Bottom substrate of sand to sandy gravel along the inner continental shelf throughout the BS and the AI.

Larvae (100 to 131 days)—Level 0_a
Pelagic and neustonic waters along the inner continental shelf throughout the BS and the AI.

Juveniles—Level 0_a
Soft bottom substrates (i.e., sand, mud) and the entire water column of the inner and middle continental shelf throughout the BS and the AI. Feeding areas contain zooplankton, calanoid copepods, mysid shrimps crustacean larvae, gammarid amphipods, and chaetognaths.

Adults—Level 0_a
Soft bottom substrates (i.e., sand, mud) and the entire water column of the inner and middle continental shelf throughout the BS and the AI. Feeding areas contain zooplankton, calanoid copepods, mysid shrimps crustacean larvae, gammarid amphipods, and chaetognaths.

EFH Definition for BSAI Forage Fish Complex—Myctophids and Bathylagids

Eggs—Level 0_c—No EFH Definition Determined

No information available at this time.

Larvae—Level 0_c—No EFH Definition Determined

No information available at this time.

Juveniles—Level 0_a

Pelagic waters ranging from near surface to lower portion of the water column of the slope and basin regions throughout the BS, the AI, and to the seaward extent of the EEZ in the EBS and North Pacific Ocean.

Adults—Level 0_a

Pelagic waters ranging from near surface to lower portion of the water column of the slope and basin regions throughout the BS, the AI, and to the seaward extent of the EEZ in the EBS and North Pacific Ocean.

EFH Definition for BSAI Forage Fish Complex—Sand Fish

Eggs—Level 0_a

Egg masses attached to rock in nearshore areas throughout the BS and the AI.

Larvae—Level 0_c—No EFH Definition Determined

No information available at this time.

Juveniles—Level 0_a

Bottom substrates of mud and sand of the inner continental shelf throughout the BS and the AI.

Adults—Level 0_a

Bottom substrates of mud and sand of the inner continental shelf throughout the BS and the AI.

EFH Definition for BSAI Forage Fish Complex—Euphausiids

Eggs—Level 0_a

Neustonic waters throughout the BS, the AI, and to the seaward extent of the EEZ in the EBS and North Pacific Ocean in spring.

Larvae—Level 0_a

Epipelagic waters throughout the BS, the AI, and to the seaward extent of the EEZ in the EBS and North Pacific Ocean in spring.

Juveniles—Level 0_a

Pelagic waters throughout the BS, the AI, and to the seaward extent of the EEZ in the EBS and North Pacific Ocean. Dense populations are associated with upwelling or nutrient-rich areas, such as the edge of the continental shelf, heads of submarine canyons, edges of gullies on the continental shelf, in island passages along the AI, and over submerged seamounts.

Adults—Level 0_a
Pelagic waters throughout the BS, the AI, and to the seaward extent of the EEZ in the EBS and North Pacific Ocean. Dense populations are associated with upwelling or nutrient-rich areas, such as the edge of the continental shelf, heads of submarine canyons, edges of gullies on the continental shelf, in island passages along the AI, and over submerged seamounts.

EFH Definition for BSAI Forage Fish Complex—Pholids and Stichaeids

Eggs—Level 0_c—No EFH Definition Determined
No information available at this time.

Larvae—Level 0_c—No EFH Definition Determined
No information available at this time.

Juveniles—Level 0_a
Intertidal to demersal waters of the inner continental shelf with mud substrate throughout the BS and the AI. Certain species are associated with vegetation such as eelgrass and kelp.

Adults—Level 0_a
Intertidal to demersal waters of the inner continental shelf with mud substrate throughout the BS and the AI. Certain species are associated with vegetation such as eelgrass and kelp.

EFH Definition for BSAI Forage Fish Complex—Gonostomatids

Eggs—Level 0_c—No EFH Definition Determined
No information is available at this time.

Larvae—Level 0_c—No EFH Definition Determined
No information is available at this time.

Juveniles—Level 0_c—No EFH Definition Determined
No information is available at this time.

Adults—Level 0_a
Bathypelagic waters throughout the BS, AI, and to the seaward extent of the EEZ in the EBS and North Pacific Ocean.

D.2.1.3 EFH Map Descriptions for BSAI Groundfish

Figures D-2 through D-21 show EFH distributions under Alternative 2 for the BSAI groundfish species described in Section D.2.1.2.

D.2.2 Description of Essential Fish Habitat for the Groundfish Resources of the GOA Region

D.2.2.1 EFH Information Levels for GOA Groundfish

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Pollock	1	1	1	1	2
Pacific cod	0a	0a	0a	1	2
Shallow water flatfish					
Yellowfin sole	0a	0a	0a	1	2
Rock sole	0a	0a	0a	1	2
Deepwater flatfish	0a	0a	0a	0a	1
Arrowtooth flounder	0a	0a	0a	1	2
Rex sole	0a	0a	0a	0a	1
Flathead sole	0a	0a	0a	1	2
Sablefish	0a	0a	0a	1	2
Pacific ocean perch	-	0a	0a	1	1
Northern rockfish	-	0b	0b	1	1
Shortraker rockfish	-	0b	0a-b	0b	1
Rougheye rockfish	-	0b	0a-b	1	1
Yelloweye rockfish	-	0b	0a	1	1
Pelagic shelf rockfish					
Dusky rockfish	-	0b	0b	0a	1
Thornyhead rockfish	0a	0a	0a	0a	1
Atka mackerel	0a	0a	0a	0a	1
Other species					
sculpins	0a	0a	0a	0a	1
skates	0a	-	0a	0a	1
sharks	-	-	0a	0a	0a
octopus	0a	-	0a	0a	0a
squid	0a	-	0a	0a	0a
Forage Fish species					
smelts	0a	0a	0a	0a	0a
other forage fish	0	0	0	0	0

D.2.2.2 EFH Text Descriptions for GOA Groundfish

EFH Definition for GOA Walleye Pollock

Eggs (duration to 14 days)—Level 1
Pelagic waters along the inner, middle, and outer continental shelf and the upper slope in the GOA from Dixon Entrance to 170º W. Spawning concentrations occur in Shelikof Strait (late March), in the Shumagin Islands (early March), the east side of Kodiak Island, and near Prince William Sound. Oceanographic features that eggs may be associated with are gyres.

Larvae (duration 14 to 60 days)—Level 1
Epipelagic waters of the water column along the middle and outer continental shelf in the GOA from Dixon Entrance to 170º W. Feeding areas are those that contain copepod, naupli, and small euphausiids. Oceanographic features that larvae may be associated with are gyres and fronts.

Juveniles (4 to 4.5 years)—Level 1
Pelagic waters along the inner, mid, and outer continental shelf in the GOA from Dixon Entrance to 170º W. Feeding areas are those that contain pelagic crustaceans, copepods, and euphausiids. Oceanographic features that juveniles may be associated with are fronts and the thermocline.

Adults (4.5+ years)—Level 2
Pelagic waters from 70 to 200 m along the outer continental shelf and basin in the GOA from Dixon Entrance to 170º W. Feeding areas are those that contain pelagic crustaceans and fish. Oceanographic features that adults are associated with are fronts and upwelling. Spawning concentrations occur in Shelikof Strait, in the Shumagin Islands, along the east side of Kodiak Island, and near Prince William Sound in late winter. The greatest abundance occurs in the GOA between 147º W to 170º W at depths less than 300 m.

EFH Definition for GOA Pacific Cod

Eggs (duration 15 to 20 days)—Level 0_a
Areas of mud, sandy mud, muddy sand, and sand along the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W in winter and spring.

Larvae (duration unknown)—Level 0_a
Epipelagic waters of the GOA from Dixon Entrance to 170º W in winter and spring.

Early Juveniles(up to 2 years)—Level 0_a
Areas of mud, sandy mud, muddy sand, and sand along the inner and middle continental shelf and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing small invertebrates (e.g., mysids, euphausiids, and shrimp).

Late Juveniles (2 to 5 years)—Level 1
Areas of mud, sandy mud, muddy sand, and sand along the inner and middle continental shelf and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing pollock, flatfish, and crab.

Adults (5+ years)—Level 2
Areas of mud, sandy mud, muddy sand, and sand along the inner, middle, and outer continental shelf up to 500 m and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing pollock, flatfish, and crab. Spawning occurs from January through May.

EFH Definition for GOA Deep Water Flatfish—Dover Sole

Eggs—Level 0_a
Pelagic waters along the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W during spring and summer.

Larvae (duration up to 2 years)—Level 0_a
Pelagic waters along the inner, middle, and outer continental shelf and upper slope of the GOA from Dixon Entrance to 170º W.

Early Juveniles (up to 3 years)—Level 0_a
Areas of sand and mud along the inner and middle continental slope and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing polychaetes, amphipods, and annelids.

Late Juveniles (3 to 5 years)—Level 0_a
Areas of sand and mud along the inner and middle continental slope and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing polychaetes, amphipods, and annelids.

Adults (5+ years)—Level 1
Areas of sand and mud along the middle to outer continental shelf and upper slope deeper than 300 m and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Winter and spring spawning and summer feeding occur on soft substrates (sand and mud) of the continental shelf and upper slope and a shallower summer distribution occurs mainly on the middle to outer portion of the shelf and upper slope. Feeding areas are those containing polychaetes, amphipods, annelids, and mollusks.

EFH Definition for GOA Shallow Water Complex—Yellowfin Sole

Eggs (duration unknown)—Level 0_a
Pelagic inshore waters of the central and western GOA during summer months.

Larvae (duration 2 to 3 months)—Level 0_a
Pelagic inshore waters and inner continental shelf regions of the central and western GOA during summer and autumn months.

Early Juveniles (to 5.5 years old)—Level 0_a
Demersal areas (bottom and lower portion of the water column) on the inner, middle, and outer portions of the continental shelf (down to 250 m) and within nearshore bays of the central and western GOA.

Late Juveniles (5.5 to 9 years old)—Level 1
Areas of sandy bottom along with the lower portion of the water column within nearshore bays and on the inner, middle, and outer portions of the continental shelf (down to 250 m) of the central and western GOA. Feeding areas would be those containing polychaetes, bivalves, amphipods, and echiurids.

Adults (9+ years old)—Level 2
Areas of sandy bottom along with the lower portion of the water column on the inner, middle, and outer portions of the continental shelf (down to 250 m) of the central and western GOA. Areas of known concentrations vary seasonally (known for the EBS). Adult spawning areas are known for the BS (see EBS EFH definition). Summer (June through October) feeding concentrations of adults occur in the EBS. Feeding areas would be those containing polychaetes, bivalves, amphipods, and echiurids. In winter, yellowfin sole adults migrate to deeper waters of the shelf (100 to 200 m) south of 60º N to the Alaskan Peninsula.

EFH Definition for GOA Shallow Water Complex—Rock Sole

Eggs (duration unknown)—Level 0_a
Areas of pebbles and sand at depths from 125 to 250 m in winter (December through March) along the shelf-slope break in the GOA from Dixon Entrance to 170º W.

Larvae (duration 2 to 3 months)—Level 0_a
Pelagic waters of the GOA from Dixon Entrance to 170º W over the inner, middle, and outer portions of the continental shelf and the slope.

Early Juveniles (to 3.5 years old)—Level 0_a
Inner, middle, and outer portions of the continental shelf (down to 250 m) of the GOA and the lower portion of the water column from Dixon Entrance to 170º W. Feeding areas would be those containing polychaetes, bivalves, amphipods, and crustaceans.

Late Juveniles (3.5 to 8 years old)—Level 1
Areas of pebbles and sand and the lower portion of the water column within nearshore bays and on the inner, middle, and outer portions of the continental shelf (down to 250 m) of the GOA from Dixon Entrance to 170º W. Feeding areas would be those containing polychaetes, bivalves, amphipods, and crustaceans.

Adults (8+ years old)—Level 2
Areas of pebbles and sand and the lower portion of the water column on the inner, middle, and outer portions of the continental shelf (down to 250 m) of the GOA from Dixon Entrance to 170º W. Areas of known concentrations vary seasonally and include adult spawning areas in winter (see Eggs) and feeding areas in summer (May through October) in the EBS (see BSAI EFH definition). Feeding areas would be those containing polychaetes, bivalves, amphipods, and crustaceans.

EFH Definition for GOA Rex Sole

Eggs—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W from February through July.

Larvae—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W during the spring and summer months.

Juveniles (up to 2 years)—Level 0_a
Areas of gravel, sand, and mud along the inner, middle, and outer continental shelf deeper than 300 m, and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing polychaetes, amphipods, euphausiids, and Tanner crab.

Adults (2+ years)—Level 1
Areas of gravel, sand, and mud along the inner, middle, and outer continental shelf deeper than 300 m, and the lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing polychaetes, amphipods, euphausiids, and Tanner crab. Spawning occurs from February through July along areas of sand, mud, and gravel substrates of the continental shelf.

EFH Definition for GOA Flathead Sole

Eggs (duration unknown)—Level 0_a
Pelagic waters (January through April) along the inner, middle, and outer continental shelf in the GOA from Dixon Entrance to 170º W.

Larvae (duration unknown)—Level 0_a
Pelagic waters along the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing phytoplankton and zooplankton.

Juveniles (2 to 3 years)—Level 1
Areas of sand and mud along the inner, middle, and outer continental shelf and upper slope and the lower portion of the water column in the GOA from Dixon Entrance to 170º W. Feeding areas are those containing polychaetes, bivalves, ophiuroids, pollock, and small tanner crab.

Adults (3+ years)—Level 2
Areas of sand and mud along the inner, middle, and outer continental shelf and upper slope and the lower portion of the water column in the GOA from Dixon Entrance to 170º W. Feeding areas, primarily on the inner, middle, and outer shelf in spring, summer and fall, are those containing polychaetes, bivalves, ophiuroids, pollock, small tanner crab, and other crustaceans. Spawning areas in winter and early spring are located primarily on the outer shelf.

EFH Definition for GOA Arrowtooth Flounder

Eggs (duration unknown)—Level 0_a
Pelagic waters (November through March) along the inner, middle, and outer continental shelf in the GOA from Dixon Entrance to 170º W.

Larvae (duration 2 to 3 months)—Level 0_a
Pelagic waters along the inner and outer continental shelf and nearshore bays during spring and summer in the GOA from Dixon Entrance to 170º W. Feeding areas are those that contain phytoplankton and zooplankton.

Early Juveniles (to 2 years old)—Level 0_a
Areas of gravel, mud, and sand and the water column of the inner continental shelf and adjacent nearshore bays in the GOA from Dixon Entrance to 170º W.

Late Juveniles (1 to 4 years)—Level 1
Areas of gravel, mud, and sand along the inner, middle, and outer continental shelf and upper slope and the lower portion of the water column in the GOA from Dixon Entrance to 170º W. Feeding areas are those that contain euphausiids, crustaceans, amphipods, and pollock.

Adults (4+ years)—Level 2
Areas of gravel, mud, and sand along the inner, middle, and outer continental shelf, upper slope and nearshore bays and the lower portion of the water column in the GOA from Dixon Entrance to 170º W. Summer feeding areas on the middle and outer shelf would be those containing gadids, euphausiids, and other fish. Spawning areas in winter are on the outer shelf and upper slope regions.

EFH Definition for GOA Sablefish

Eggs (duration 14 to 20 days)—Level 0_a
Pelagic waters of the continental shelf and in basin areas from 200 to 3,000 m extending to the seaward boundaries of the EEZ of the GOA from Dixon Entrance to 170º W from late winter to early spring (December to April).

Larvae (duration up to 3 months)—Level 0_a
Epipelagic waters of the middle to outer continental shelf and the slope and basin areas of the GOA from Dixon Entrance to 170º W during late spring and early summer months (April through July).

Early Juveniles (up to 2 years)—Level 0_a
During the first summer, Pelagic waters along the outer, middle, and inner continental shelf of the GOA from Dixon Entrance to 170 º W. After the first summer until the end of the second summer, early juveniles use areas of soft-bottom in nearshore bays and island passages in the demersal and semi-demersal regions.

Late Juveniles (2 to 5 years)—Level 1
Areas of soft bottom generally deeper than 100 m and associated with the continental slope and deep shelf gulleys and fjords (presumably demersal within the lower portion of the water column) of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing mesopelagic and benthic fishes, benthic invertebrates, and jellyfish.

Adults (5+ years)—Level 2
Areas of soft bottom deeper than 200 m (presumably within the lower portion of the water column) associated with the continental slope and deep shelf gulleys and fjords (such as Prince William Sound and those in southeastern Alaska) of the GOA from Dixon Entrance to 170º W. Feeding areas would be those containing mesopelagic and benthic fishes, benthic invertebrates, and jellyfish. A large portion of the adult diet is comprised of gadid fishes, mainly pollock.

EFH Definition for GOA Slope Rockfish—Pacific Ocean Perch

Eggs (internal incubation, ~90 days)—No EFH Definition Determined
Infernal fertilization and incubation. Incubation is assumed to occur during the winter months.

Larvae (duration 60 to 180 days)—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170º W during the spring and summer months.

Early Juveniles (larval stage to 3 years)—Level 0_a
Initially pelagic, then demersal in very rocky areas of the inner continental shelf of the GOA from Dixon Entrance to 170º W.

Late Juveniles (3 to 10 years)—Level 1
Areas of cobble, gravel, mud, sandy mud, and muddy sand along the inner, middle, and outer continental shelf and upper slope areas. Late juveniles occur shallower than adults, in the middle to lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing euphausiids.

Adults (10+ years)—Level 1
Areas of cobble, gravel, mud, sandy mud or muddy sand along the outer continental shelf and upper slope areas from 180 to 420 m (actual depths sampled) of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing euphausiids. Areas of high concentrations tend to vary seasonally and may be related to spawning behavior. In summer, adults inhabit shallower depths (180 to 250 m), and in the fall, they migrate farther offshore (300 to 420 m).

EFH Definition for GOA Slope Rockfish—Shortraker and Rougheye Rockfish

Eggs—No EFH Definition Determined
Internal fertilization and incubation.

Larvae—Level 0_b
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170º W during the spring and summer months.

Early Juveniles (up to 20 cm)—Level $0_{a\text{-}b}$
Between nearshore waters and outer continental shelf of the GOA from Dixon Entrance to 170º W.

Late Juveniles (greater than 20 cm)—Level 0_b and Level 1
Areas shallower than adult along the continental shelf of the GOA (includes substrate and water column) from Dixon Entrance to 170º W. Juvenile shortraker rockfish have been observed on only a few rare occasions. Presence is presumed somewhere between nearshore and outer continental shelf between Dixon Entrance and 170º W.

Adults (15+ years)—Level 1
Areas of mud, sand, rock, sandy mud, cobble, muddy sand, and gravel at depths ranging from 200 to 500 m and the lower third of the water column of the outer continental shelf and the upper slope of the GOA from Dixon Entrance to 170º W. Fishery concentrations are at 300 to 500 m. Feeding areas would be those areas where shrimps, squid, and myctophids occur.

EFH Definition for GOA Slope Rockfish—Northern Rockfish

Eggs—No EFH Definition Determined
Internal fertilization and incubation.

Larvae—Level 0_b
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170º W during the spring and summer months.

Early Juveniles (up to 25 cm)—Level 0_b
Pelagic waters of the inner, middle, and outer continental slope of the GOA from Dixon Entrance to 170º W.

Late Juveniles (greater than 25 cm)—Level 1
Areas of cobble and rock along the shallower regions (relative to adults) of the outer continental shelf and the middle and lower portions of the water column of the GOA from Dixon Entrance to 170º W.

Adults (13+ years)—Level 1
Areas of cobble and rock along the outer continental slope and upper slope regions and the middle and lower portion of the water column of the GOA from Dixon Entrance to 170º W. Areas of relatively shallow banks of the outer continental shelf have been found to have concentrated populations.

EFH Definition for GOA Pelagic Shelf Rockfish—Dusky Rockfish

Eggs—No EFH Definition Determined
Internal fertilization and incubation.

Larvae—Level 0_b
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope, and the basin areas extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170º W during the spring and summer months.

Early Juveniles (less than 25 cm)—Level 0_b
Pelagic waters of the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W.

Late Juveniles (greater than 25 cm)—Level 0_a
Areas of cobble, rock, and gravel along the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W. Location in water column is currently unknown.

Adults (up to 50 years)—Level 1
Areas of cobble, rock, and gravel along the outer continental shelf and upper slope region and the middle to lower portion of the water column of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing euphausiids. Also found in nearshore waters of southeast Alaska along rocky shores at depths less than 50 m.

EFH Definition for GOA Demersal Shelf Rockfish—Yelloweye Rockfish

Eggs—No EFH Definition Determined
Internal fertilization and incubation.

Larvae (less than 6 months)—Level 0_b
Epipelagic areas of the water column of the GOA from Dixon Entrance to 170º W during the spring and summer months.

Early Juveniles (to 10 years)—Level 0_a
Areas of rock and coral along the inner, middle, and outer continental shelf, bays, island passages, and the entire water column of the GOA from Dixon Entrance to 170º W. Concentrations of young juveniles (2.5 to 10 cm) have been observed in areas of high relief (such as vertical walls, cloud sponges, and fjord-like areas).

Late Juveniles (10 to 18 yrs)—Level 1
Areas of rock and coral along the inner, middle, and outer continental shelf, nearshore bays, and island passages of the GOA from Dixon Entrance to 170º W and the lower portion of the water column. High concentrations are found associated with high relief with refuge spaces such as overhangs, crevices, and caves.

Adults (18+ years)—Level 1
Areas of rock, coral, and cobble along the inner, middle, and outer continental shelf, upper slope, nearshore bays, and island passages of the GOA from Dixon Entrance to 170º W from and the lower portion of the water column. High concentrations are found associated with high relief containing refuge spaces such as overhangs, crevices, and caves. Feeding areas are those containing fish, shrimp, and crab.

EFH Definition for GOA Thornyhead Rockfish

Eggs—Level 0_a
Pelagic waters of the GOA from Dixon Entrance to 170º W during the late winter and early spring.

Larvae (less than 15months)—Level 0_a
Pelagic waters extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170º W during the early spring through summer.

Juveniles (more than 15 months)—Level 0_a
Areas of mud, sand, rock, sandy mud, cobble, muddy sand, and gravel and the lower portion of the water column along the middle and outer continental shelf and upper slope of the GOA from Dixon Entrance to 170º W.

Adults—Level 1
Areas of mud, sand, rock, sandy mud, cobble, muddy sand, and gravel and the lower portion of the water column along the middle and outer continental shelf and upper and lower slope of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing shrimp, fish (cottids), and small crabs.

EFH Definition for GOA Atka Mackerel

Eggs (40 to 45 days)—Level 0_a
Areas of gravel, rock, and kelp in shallow waters, island passages, and the inner continental shelf of the GOA from Kodiak Island to 170º W.

Larvae (up to 6 months)—Level 0_a
Epipelagic waters of the middle and outer continental shelf and slope and extending seaward to the edge of the EEZ in the GOA from Kodiak Island to 170º W.

Juveniles (up to 2 years)—Level 0_a
Unknown habitat association; assumed to settle near areas inhabited by adults, but have not been observed in fishery or surveys.

Adults—Level 1
Areas of gravel, rock, and kelp on the inner, middle, and outer continental shelf and the entire water column (to the surface) in the GOA from Kodiak Island to 170º W. Feeding areas are those containing copepods, euphausiids, and meso-pelagic fish (myctophids). Spawning occurs in nearshore (inner shelf and in island passages) rocky areas and in kelp in shallow waters in summer and early fall. Atka mackeral move to deep offshore areas nearby in winter and perform diurnal/tidal movements between demersal and pelagic areas.

EFH Definition for GOA Other Species—Sculpins

Eggs—Level 0_a
All substrate types on the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170º W. Some species deposit eggs in rocky shallow waters near shore.

Larvae—Level 0_a
Pelagic waters of the inner, middle, and outer continental shelf and slope of the GOA from Dixon Entrance to 170º W, predominately over the inner and middle shelf.

Juveniles—Level 0_a
Broad range of demersal habitats from intertidal pools, all shelf substrates (mud, sand, gravel, etc.), and rocky areas of the upper slope of the GOA from Dixon Entrance to 170º W.

Adults—Level 1
Broad range of demersal habitats from intertidal pools, all shelf substrates (mud, sand, gravel, etc.), and rocky areas of the upper slope of the GOA from Dixon Entrance to 170º W.

EFH Definition for GOA Other Species—Skates

Eggs—Level 0_a
All bottom substrates of the upper slope and across the shelf throughout the GOA from Dixon Entrance to 170º W.

Larvae—No EFH Definition Determined
Not applicable (no larval stage).

Juveniles—Level 0_a
Broad range of substrate types (mud, sand, gravel, and rock) and the water column on the shelf and the upper slope of the GOA from Dixon Entrance to 170º W.

Adults—Level 1
Broad range of substrate types (mud, sand, gravel, and rock) and the lower portion of the water column on the shelf and the upper slope of the GOA from Dixon Entrance to 170º W.

EFH Definition for GOA Other Species—Sharks

Eggs—No EFH Definition Determined
Not applicable (most are oviparous).

Larvae—No EFH Definition Determined
Not applicable (most species are oviparous/ no larval stage).

Juveniles and Adults—Level 0_a
All waters and substrate types in the inner, middle, and outer continental shelf and slope of the GOA from Dixon Entrance to 170º W to the seaward edge of the EEZ.

EFH Definition for GOA Other Species—Octopus

Eggs—Level 0_a
All bottom substrates of the shelf throughout the GOA from Dixon Entrance to 170º W.

Larvae—No EFH Definition Determined
Not applicable (no larval stage).

Juveniles and Adults—Level 0_a
Broad range of substrate types (mostly rock, gravel, and sand) and the lower portion of the water column on the shelf and the upper slope of the GOA from Dixon Entrance to 170º W. Feeding areas are those containing crustaceans and molluscs.

EFH Definition for GOA Squid—Red Squid

Eggs—Level 0_a
Areas of mud and sand on the upper and lower slope GOA from Dixon Entrance to 170º W.

Larvae—No EFH Definition Determined
Not applicable (no larval stage).

Juveniles and Adults—Level 0_a
Pelagic waters of the shelf, slope, and basin to the seaward edge of the EEZ in the GOA from Dixon Entrance to 170º W. Feeding areas are those containing euphausiids, shrimp, forage fish, and other cephalopods.

D.2.2.3 EFH Map Descriptions for GOA Groundfish

Figures D-22 through D-42 show EFH distribution under Alternative 2 for the GOA groundfish species as described in Section D.2.2.2.

D.2.3 Description of Essential Fish Habitat for BSAI King and Tanner Crab

D.2.3.1 EFH Information Levels for BSAI Crab

Species/Stock	Eggs	Larvae	Early Juveniles[1]	Late Juveniles[2]	Adults
Red King Crab					
Bristol Bay	2	2	1	2	2
Pribilof Islands	2	1	0c	2	2
Norton Sound	2	0c	0c	2	2
Dutch Harbor	2	0c	0c	2	2
Adak	1	0c	0c	0c	1
Blue King Crab					
Pribilof Islands	2	1	2	2	2
St. Matthew I.	1	0c	0c	1	2
St. Lawrence I.	0b	0c	0c	0c	1
Golden King Crab					
Seaguam Pass	2	0c	0c	2	2
Adak	1	0c	0c	1	2
Pribilof Islands	1	0c	0c	1	2
Northern District	0c	0c	0c	0c	0c
Scarlet King Crab					
EBS	0b	0c	0c	0c	1
Adak	0b	0c	0c	0c	1
Dutch Harbor	0b	0c	0c	0c	1
Tanner Crab (C. bairdi)					
Bristol Bay	2	1	1	2	2
Pribilof Islands	2	1	1	2	2
Eastern Aleutians	1	0c	1	2	2
Western Aleutians	0b	0c	0c	0c	1
Snow Crab (C. Opilio)					
BS	2	1	1	2	2
Grooved Crab (C. tanneri)					
EBS	0b	0c	0c	0c	1
Eastern Aleutians	0b	0c	0c	0c	1
Western Aleutians	0b	0c	0c	0c	1
Triangle Crab (C. angulatus)					
Bristol Bay	1	0c	0c	0c	1
Eastern Aleutians	1	0c	0c	0c	1

[1] Early juvenile crab are defined as settled crab up to a size approximating age 2.

[2] Late juvenile crab are defined as age 2 through the first size of functional maturity.

0a: For any crab species/stock's life stage at Level 0, information was insufficient to infer general distribution.

0b: No information on the life stage is available, but some information exists on a similar species or adjacent.

D.2.3.2 EFH Text Descriptions for BSAI Crab

EFH Definition for Red King Crab

Eggs—Level 1 & 2
Egg hatch of larvae is synchronized with the spring phytoplankton bloom in southeast Alaska, suggesting temporal sensitivity in the transition from benthic to planktonic habitat. Essential habitat of the red king crab egg stage is based on the general distribution (Level 1) and habitat-related density (level 2) of egg-bearing red king crabs of the Bristol Bay, Pribilof Islands, Norton Sound, and Dutch Harbor stocks. General distribution (Level 1) of egg-bearing female red king crab is used to identify essential habitat for the Adak stock (see also Adults).

Larvae—Level 0_c, Levels 1 and Level 2 (no EFH definition determined for the Norton Sound, Dutch Harbor, and Adak stocks)
Red king crab larvae spend 2 to 3 months in pelagic larval stages before settling to the benthic life stage. Reverse diel migration and feeding patterns of larvae coincide with the distribution of food sources. Essential habitat is identified for larvae of the Bristol Bay red king crab stock using the general distribution (Level 1) and density (Level 2) of larvae in the water column. Essential habitat is defined for larvae of the Pribilof Islands stock based on knowledge of the general distribution (Level 1) of larvae in the water column. No essential habitat is defined for larvae of red king crab stocks in Norton Sound, Dutch Harbor, and Adak waters.

Early Juveniles—Levels 0_c and 1 (no EFH definition determined for the Northern District stock)
Early juvenile stage red king crabs are solitary and need high relief habitat or coarse substrate such as boulders, cobble, shell hash, and living substrates such as bryozoans and stalked ascidians. Young-of-the-year crabs occur at depths of 50 m or less. Essential habitat for early juveniles is defined for Bristol Bay red king crabs as the general distribution (Level 1). No essential fish habitat is defined for red king crab early juveniles in Pribilof Islands, Norton Sound, Dutch Harbor, and Adak stocks.

Late Juveniles—Levels 0_c and 2 (no EFH definition determined for the Adak stock)
Late juvenile stage red king crabs from 2 to 4 years exhibit decreasing reliance on habitat and a tendency for the crab to form pods consisting of thousands of crabs. Podding generally continues until 4 years of age (about 6.5 cm), when the crab move to deeper water and join adults in the spring migration to shallow water for molting and mating. Essential habitat based on general distribution (Level 1) and density (Level 2) of late juvenile red king crabs is known for Bristol Bay, Pribilof Islands, Norton Sound, and Dutch Harbor stocks. Essential habitat is not defined for late juvenile red king crabs in the Adak stock.

Adults—Levels 1 and 2
Mature red king crabs exhibit seasonal migration to shallow waters for reproduction. During the remainder of the year, red king crabs are found in deep waters. In Bristol Bay, red king crabs mate when they enter shallower waters (less than 50 m), generally beginning in January and continuing through June. Males grasp females just prior to female molting, after which the eggs (43,000 to 500,000 eggs) are fertilized and extruded on the female's abdomen. The female red king crab carries the eggs for 11 months before they hatch, generally in April. Essential habitat for mature red king crabs is known for Bristol Bay, Pribilof Islands, Norton Sound, and Dutch Harbor stocks based on general distribution (Level 1) and density (Level 2). Essential habitat for mature red king crabs in Adak is known from general distribution data (Level 1).

EFH Definition for Blue King Crab

Eggs—Levels 0_b, 1, and 2

Essential habitat for eggs is known for the stock of blue king crab in the Pribilof Islands based on general distribution (Level 1) and density (Level 2) of egg-bearing female crabs. Essential habitat for eggs of the St. Matthew Island blue king crab stock is based on general distribution (Level 1) of the egg-bearing females. Essential habitat for eggs of the St. Lawrence Island blue king crab stock is inferred from incidental catch of mature female crab (see also Adults).

Larvae—Levels 0_c and 1 (no EFH definition determined for the St. Matthew Island and St. Lawrence stocks)

Blue king crab larvae spend 3.5 to 4 months in pelagic larval stages before settling to the benthic life stage. Larvae are found in waters of depths between 40 to 60 m. Essential habitat of larval blue king crab of the Pribilof Islands stock is defined using the general distribution (Level 1) of larvae in the water column. Information to define essential habitat is not available for the St. Matthew Island and St. Lawrence Island stocks of larval blue king crab.

Early Juveniles—Levels 0_c and 2 (no EFH definition determined for the St. Matthew and St. Lawrence Island stocks)

Early juvenile blue king crabs require refuge substrate characterized by gravel and cobble overlaid with shell hash and sponge, hydroid, and barnacle assemblages. These habitat areas have been found at 40 to 60 m around the Pribilof Islands. Essential habitat of early juvenile blue king crabs is based on general distribution (Level 1) and density (Level 2) of this life stage in the Pribilof Island stock. Information to define essential habitat for early juvenile blue king crabs in the St. Matthew Island and St. Lawrence Island stocks is not available.

Late Juveniles—Levels 0_c, 1 and 2 (no EFH definition determined for the St. Lawrence Island stock)

Late juvenile blue king crab require nearshore rocky habitat with shell hash. Essential habitat is based on general distribution (Level 1) and density (Level 2) of late juvenile blue king crab of the Priblilof Islands stock. General distribution (Level 1) of the late juvenile blue king crabs is used to identify essential habitat for the St. Matthew Island stock. Information is not available to define essential habitat for the St. Lawrence Island stock of late juvenile blue king crab.

Adults—Levels 1 and 2

Mature blue king crabs occur most often between 45 and 75 m depth on mud-sand substrate adjacent to gravel rocky bottom. Female crabs are found in a habitat with a high percentage of shell hash. Mating occurs in mid-spring. Larger, older females reproduce biennially while small females tend to reproduce annually. Fecundity of females range from 50,000 to 200,000 eggs per female. It has been suggested that spawning may depend on availability of nearshore rocky-cobble substrate for protection of females. Larger, older crabs disperse farther offshore and are thought to migrate inshore for molting and mating. General distribution (Level 1) and density (Level 2) of mature blue king crab are used to identify essential habitat for the Pribilof Islands and St. Matthew Island stocks. Essential habitat of mature blue king crab is based on distribution (Level 1) data for the St. Lawrence Island stock.

EFH Definition for Golden King Crab

Eggs—Levels 0_c, 1 and 2 (no EFH definition determined for the Northern District stock)

General distribution (Level 1) and density (Level 2) of egg-bearing female golden king crabs is used to identify essential habitat for the Sequam Pass stock. Essential habitat for the egg life stage of the Adak and Priblilof Islands stocks is based on general distribution (Level 1) of the egg-bearing female crabs (see also Adults).

Larvae—Level 0_c (no EFH definition determined)

Information to define essential habitat of golden king crab larvae is not available for the Seguam Pass, Adak, Pribilof Islands, or Northern District stocks.

Early Juveniles—Level 0_c (no EFH definition determined)

Information to define essential habitat of early juvenile golden king crabs is not available for the Seguam Pass, Adak, Pribilof Islands, or Northern District stocks.

Late Juveniles—Levels 0_c, 1 and 2 (no EFH definition determined for the Northern District stock)

Late juvenile golden king crabs are found throughout the depth range of the species. Abundance of late juvenile crab increases with depth and these crab are most abundant at depths greater than 548 m. Essential habitat for late juvenile golden king crabs is based on general distribution (Level 1) and density (Level 2) of this life stage for the Sequam Pass stock. General distribution (Level 1) of late juvenile golden king crabs is used to identify essential habitat for the Adak and Pribilof Islands stock. Information to define essential habitat is not available for late juvenile golden king crabs of the Northern District stock.

Adults—Levels 0_c and 2 (no EFH definition determined for the Northern District stock)

Mature golden king crabs occur at all depths within their distribution. Males tend to congregate in somewhat shallower waters than females, and this segregation appears to be maintained throughout the year. Legal male crabs are most abundant between 274 m and 639 m. Abundance of sub-legal males increases at depth greater than 364 m. Female abundance is greatest at intermediate depths between 274 m and 364 m. General distribution (Level 1) and density (Level 2) of mature golden king crabs are used to identify essential habitat for the Sequam Pass, Adak, and Pribilof Islands stocks. Information is not available to define essential habitat for mature golden king crabs of the Northern District stock.

EFH Definition for Scarlet King Crab

Eggs—Level 0_b

Information for scarlet king crab eggs is not available for the EBS, Adak, or Dutch Harbor stocks. General distribution of the egg life stage is inferred from incidental catch of mature females (see also Adults).

Larvae—Level 0_c (no EFH definition determined)

Information to define essential habitat for scarlet king crab larvae is not available for the EBS, Adak, or Dutch Harbor stocks.

Early Juveniles—Level 0_c (no EFH definition determined)

Information to define essential habitat for early juvenile scarlet king crabs is not available for the EBS, Adak, or Dutch Harbor stocks.

Late Juveniles—Level 0_c (no EFH definition determined)
Information to define essential habitat for late juvenile scarlet king crabs is not available for the EBS, Adak, or Dutch Harbor stocks.

Adults—Level 1
Essential habitat for mature scarlet king crabs is based on the general distribution (Level 1) of mature golden king crabs. Mature scarlet king crabs are caught incidentally in the golden king crab and *C. tanneri* fisheries.

EFH Definition for Tanner Crab (*C. bairdi*)

Eggs—Levels 0_b, 1, and 2
Essential habitat for eggs is known for the stocks of *C. bairdi* Tanner crabs in Bristol Bay and the Pribilof Islands based on general distribution (Level 1) and density (Level 2) of egg-bearing female crabs. Essential habitat for eggs of the Eastern Aleutian *C. bairdi* Tanner crab stock is based on general distribution (Level 1) of the egg-bearing females. Essential habitat for eggs of the Western Aleutian *C. bairdi* Tanner crab stock is inferred from the general distribution of mature females (see also Adults).

Larvae—Levels 0_c and 1 (no EFH definition determined for the Eastern Aleutian and Western Aleutian stocks)
Larvae of *C. bairdi* Tanner crabs are typically found in EBS Aleutian Island water column from 0 to 100 m in early summer. They are strong swimmers and perform diel migrations in the water column (down at night). They usually stay near the depth of the chlorophyll maximum during the day. The last larval stage settles onto the bottom mud. Essential habitat of *C. bairdi* Tanner crab larvae is based on general distribution (Level 1) for the Bristol Bay and Pribilof Islands stocks. Information is not available to define essential habitat for larval *C. bairdi* Tanner crab in the Eastern Aleutian and Western Aleutian stocks.

Early Juveniles—Levels 0_c and 1 (no EFH definition determined for the Western Aleutian stock)
Early juvenile *C. bairdi* Tanner crabs occur at depths of 10 to 20 m in mud habitat in summer and are known to burrow or associate with many types of cover. Early juvenile *C. bairdi* Tanner crabs are not easily found in winter. Essential habitat of early juvenile *C. bairdi* Tanner crabs is identified by the general distribution (Level 1) of this life stage for the Bristol Bay, Pribilof Islands, and Eastern Aleutian stocks. Information to identify essential habitat of early juvenile *C. bairdi* Tanner crabs in not available for the Western Aleutian stock.

Late Juveniles—Levels 0_c and 1 (no EFH definition determined for the Western Aleutian stock)
The preferred habitat for late juvenile *C. bairdi* Tanner crabs is mud. Late juvenile Tanner crab migrate offshore of their early juvenile nursery habitat. Essential habitat of late juvenile *C. bairdi* Tanner crabs is based on the general distribution (Level 1) and density (Level 2) of this life stage for the Bristol Bay, Pribilof Islands, and Eastern Aleutian stocks. Information to identify essential habitat of late juvenile *C. bairdi* Tanner crabs in not available for the Western Aleutian stock.

Adults—Levels 1 and 2
Mature *C. bairdi* Tanner crabs migrate inshore and mating is known to occur from February through June. Mature female *C. bairdi* Tanner crabs have been observed in high-density mating aggregations, or pods, consisting of hundreds of crabs per mound. These mounds may provide protection from predators and also attract males for mating. Mating need not occur every year, as female *C. bairdi* Tanner crabs can retain viable sperm in spermathecae for 2 years or more. Females carry clutches of 50,000 to

400,000 eggs and nurture the embryos for 1 year after fertilization. Primiparous females may carry the fertilized eggs for as long as 1.5 years. Brooding occurs in depths from 100 to 150 m. Essential habitat is based on the general distribution (Level 1) and density (Level 2) of mature *C. bairdi* Tanner crabs of the Bristol Bay, Pribilof Islands, and Eastern Aleutian stocks. Essential habitat of mature *C. bairdi* Tanner crabs is identified as the general distribution (Level 1) for the Western Aleutian stock.

EFH Definition for Snow Crab (*C. opilio*)

Eggs—Level 2

Essential habitat for eggs is known for the stocks of *C. opilio* snow crabs in the BS based on general distribution (Level 1) and density (Level 2) of egg-bearing female crabs (see also Adults).

Larvae—Level 1

Larvae of *C. opilio* snow crab are found in early summer and exhibit diel migration. The last of three larval stages settles onto the bottom in nursery areas. Essential habitat is based on general distribution (Level 1) of *C. opilio* snow crab larvae of the BS stock.

Early Juveniles—Level 1

Shallow water areas of the BS are considered nursery areas for *C. opilio* snow crabs and are confined to the mid-shelf area due to the thermal limits of early and late juvenile life stages. Essential habitat is identified as the general distribution (Level 1) of early juvenile crabs of the BS stock of *C. opilio* snow crabs.

Late Juveniles—Level 2

A geographic decline in size of *C. opilio* snow crabs indicates a large number of morphometrically immature crabs occur in shallow waters less than 80 m. Essential habitat is based on the general distribution (Level 1) and density (Level 2) of juvenile crabs of the BS stock of *C. opilio* snow crabs.

Adults—Level 2

Female *C. opilio* snow crabs are acknowledged to attain terminal molt status at maturity. Primiparous female snow crabs mate from January through June and may exhibit longer egg development period and lower fecundity than multiperous female crabs. Multiparous female snow crabs are able to store spermatophores in seminal vesicles and fertilize subsequent egg clutches without mating. At least two clutches can be fertilized from stored spermatophores, but the frequency of this occurring in nature is not known. Females carry clutches of approximately 36,000 eggs and nurture the embryos for approximately 1 year after fertilization. However, fecundity may decrease up to 50 percent between the time of egg extrusion and hatching presumably due to predation, parasitism, abrasion, or decay of unfertilized eggs. Brooding probably occurs in depths greater than 50 m. Changes in proportion of morphometrically mature crabs by carapace width have been related to an interaction between cohort size and depth.

EFH Definition for Grooved Tanner Crab (*C. tanneri*)

Eggs—Level 0_b

Information for grooved Tanner crab eggs is not available for the EBS, Eastern Aleutian, or Western Aleutian stocks. General distribution of the egg life stage is inferred from the distribution of mature females (see also Adults).

Larvae—Level 0_c (no EFH definition determined)
Information to define essential habitat for larvae of grooved Tanner crabs is not available for the EBS, Eastern Aleutian, or Western Aleutian stocks.

Early Juveniles—Level 0_c (no EFH definition determined)
Information to define essential habitat for early juvenile grooved Tanner crabs is not available for the EBS, Eastern Aleutian, or Western Aleutian stocks.

Late Juveniles—Level 0_c (no EFH definition determined)
Information to define essential habitat for late juvenile grooved Tanner crabs is not available for the EBS, Eastern Aleutian, or Western Aleutian stocks.

Adults—Level 1
In the BS, mature male grooved Tanner crabs may be found in somewhat more shallow areas than mature females, but male and female crabs do not show clear segregation by depth. General distribution (Level 1) of mature grooved Tanner crabs is used to identify essential habitat of the EBS, Eastern Aleutian, and Western Aleutian stocks.

EFH Definition for Triangle Tanner Crab (*C. angulatus*)

Eggs—Level 1 (no EFH definition determined)
General distribution (Level 1) of mature triangle Tanner crabs is used to identify essential habitat of the Bristol Bay and Eastern Aleutian stocks (see also Adults).

Larvae—Level 0_c (no EFH definition determined)
Information to define essential habitat for larvae of triangle Tanner crabs is not available for the Bristol Bay or Eastern Aleutian stocks.

Early Juveniles—Level 0_c (no EFH definition determined)
Information to define essential habitat for early juvenile triangle Tanner crabs is not available for the Bristol Bay or Eastern Aleutian stocks.

Late Juveniles—Level 0_c (no EFH definition determined)
Information to define essential habitat for late juvenile triangle Tanner crabs is not available for the Bristol Bay or Eastern Aleutian stocks.

Adults—Level 1
The mean depth of mature male triangle Tanner crabs (647 m) is significantly less than for mature females (748 m) indicating some pattern of sexual segregation by depth. General distribution (Level 1) of mature triangle Tanner crabs is used to identify essential habitat of the Bristol Bay and Eastern Aleutian stocks.

D.2.3.3 EFH Map Descriptions for BSAI Crab

Figures D-43 through D-68 show EFH distributions under Alternative 2 for the BSAI crab species described in Section D.2.3.2.

D.2.4 Description of Essential Fish Habitat for Alaska Scallops

D.2.4.1 EFH Information Levels for Alaska Scallops

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Weathervane scallops	0a	0a	0a	1	2
Pink scallops	0a	0c	0a	0a	0a
Spiny scallops	0a	0c	0a	0a	0a
Rock scallops	0a	0c	0a	0a	0a

Note: Information for the larval stages of pink, spiny, and rock scallops is insufficient to infer general distributions.
0a: Some information on a species' life stage is available upon which to infer general distribution.
0c: No information on the actual species' life stage and no information on a similar species or adjacent life stages is available, or the complexity of a species stock structure prohibited inference of general distribution.

D.2.4.2 EFH Text Descriptions for Alaska Scallops

EFH Definition for Alaskan Weathervane Scallops

Eggs (several days)—Level 0_a
Demersal waters of the inner and middle continental shelf of the GOA and to a lesser extent in the BSAI. Eggs are released in the late spring and early summer.

Larvae (2 to 3 weeks)—Level 0_a
Pelagic waters along the inner, middle, and outer continental shelf of the GOA west of Dixon entrance, extending into the BSAI.

Juveniles (to 3 years)—Level 1
Areas of clay, mud, sand, and gravel along the mid-continental shelf of the BSAI and GOA.

Adults (3+ years)—Level 2
Areas of clay, mud, sand, and gravel along the mid continental shelf of the GOA and BSAI. Areas of concentration are those between the depths of 40 to 130 m. Scallop beds are generally elongated in the direction of current flow.

EFH Definition for Alaskan Pink Scallops

Eggs (several days)—Level 0_a
Demersal waters of the inner and middle continental shelf of the GOA and to a lesser extent in the BSAI. Eggs are released in the winter and early spring.

Larvae (2 to 3 weeks?)—Level 0_c (no EFH definition determined)
Pelagic waters with unknown distribution.

Juveniles (to 2 years)—Level 0_a
Soft bottom areas along the inner and mid-continental shelf of the BSAI and GOA.

Adults (2+ years)—Level 0_a
Soft bottom areas less than 200 m along the inner, middle, and outer continental shelf of the GOA and BSAI.

EFH definition for Alaskan Spiny Scallops

Eggs (several days)—Level 0_a
Demersal waters of the inner continental shelf of the GOA and to a lesser extent in the BSAI. Eggs are released in the late summer.

Larvae (2 to 3 weeks?)—Level 0_c (no EFH definition determined)
Pelagic waters with unknown distribution.

Juveniles (to 2 years)—Level 0_a
Hard bottom areas characterized by strong currents along the inner and middle continental shelf of the GOA.

Adults (2+ years)—Level 0_a
Hard bottom areas shallower than 150 m characterized by strong currents along the inner and middle continental shelf of the GOA.

EFH Definition for Alaskan Rock Scallops

Eggs (several days)—Level 0_a
Demersal waters of the inner continental shelf of the GOA. Eggs are released in the spring and also the autumn months.

Larvae (2 to 3 weeks?)—Level 0_c (no EFH definition determined)
Pelagic waters with unknown distribution.

Juveniles (to 3 years)—Level 0_a
Rocky bottoms in shallow waters (0 to 80 m) characterized by strong currents.

Adults (3+ years)—Level 0_a
Rocky bottoms in shallow waters (0 to 80 m) characterized by strong currents.

D.2.4.3 EFH Map Descriptions for Alaska Scallops

Figures D-69 and D-70 show EFH distribution under Alternative 2 for GOA and BSAI Alaskan weathervane scallops (late juveniles and adults), respectively.

D.2.5 Description of Essential Fish Habitat for Alaska Stocks of Pacific Salmon

D.2.5.1 EFH Information Levels for Alaska Stocks of Pacific Salmon

Region I, Southeastern

Species	Eggs and larvae	Juveniles fresh water (fry - smolt)	Juveniles estuarine	Juveniles marine	Adults, immature/ maturing marine	Adults, fresh water
Chinook	1-2	1-2	1-2	1-2	1-2	1-3
Coho	1-3*	2-4*	1-2	1	1	1-3
Pink	1-3	1-3	1-3	1-3	1-3	1-3
Sockeye	1-3	1-4*	1-3	1-2	1-2	1-3
Chum	1-3	1-3	1-3	1-3	1-2	1-3

Region II, Southcentral

Species	Eggs and larvae	Juveniles fresh water (fry - smolt)	Juveniles estuarine	Juveniles marine	Adults, immature/ maturing marine	Adults fresh water
Chinook	1-2	1-3	1	1	1-2	1-3
Coho	1-2	1-2	1-2	1	1-2	1-2
Pink	1-3	1-2	1-2	1-3	1-3	1-3
Sockeye	1-3	1-4	1-2	1	1-2	1-3
Chum	1-3	1-3	1-2	1-3	1-2	1-3

Region III, Southwestern

Species	Eggs and larvae	Juveniles fresh water (fry-smolt)	Juveniles estuarine	Juveniles marine	Adults, immature/ maturing marine	Adults fresh water
Chinook	1-2	1-2	1	1	1-2	1-3
Coho	1-2	1-2	1-2	1	1-2	1-2
Pink	1-2	1-2	1-2	1-2	1-2	1-3

Region IV, Western

Species	Eggs and larvae	Juveniles fresh water (fry - smolt)	Juveniles estuarine	Juveniles marine	Adults, immature/ maturing marine	Adults, fresh water
Chinook	1-2	1	1	1	1-2	1-2
Coho	1-2	1	1	1	1	1-2
Pink	1	1	1	1	1	1
Sockeye	1	1	0a	0a	1-2	1
Chum	1-2	0a	0a	0a	1-2	1-2

Region V, Arctic

Species	Eggs and larvae	Juveniles fresh water (fry - smolt)	Juveniles estuarine	Juveniles marine	Adults, immature/ maturing marine	Adults fresh water
Chinook	1	1	1	1	1	1
Coho	1	1	1	0a	1	1
Pink	1	0a	0a	0a	0a	1
Sockeye	1	1	0a	0a	0a	1
Chum	1	0a	0a	0a	0a	1-2

Region VI, Interior

Species	Eggs and larvae	Juveniles fresh water (fry-smolt)	Juveniles estuarine	Juveniles marine	Adults, immature/ maturing marine	Adults fresh water
Chinook	1	1	1	1	1	1
Coho	1	1	1	1	1	1
Pink	1	0a	0a	1	0a	1
Sockeye	1	1	0a	0a	0a	1
Chum	1-2	1	1	1	1	1-2

D.2.5.2 EFH Text Descriptions for Alaska Stocks of Pacific Salmon

EFH Definition for Chinook Salmon

Eggs and Larvae—Levels 1 and 2
Those portions of freshwaters within the bounds of ordinary high water where chinook salmon currently or historically occur, that are accessible to adult chinook salmon (or could be cost-effectively made accessible) and that have bottom substrate, water quality, and seasonal flow adequate for the incubation and development of chinook salmon eggs and larvae. Impaired areas with potential for cost-effective restoration are also EFH for chinook salmon. Eggs and larvae require more than 200 days over the period from July to May for incubation in intragravel flows.

Juveniles (freshwater)—Levels 1 to 3
Those portions of freshwaters in Alaska within the bounds of ordinary high water where chinook salmon currently or historically occur that are accessible to juvenile chinook salmon (or could be cost-effectively made accessible), and that provide adequate water quality and productivity conditions for seasonal or year-round rearing or migration for juvenile chinook salmon. Impaired areas with potential for cost-effective restoration are also EFH for chinook salmon. Juvenile chinook salmon require year-round rearing habitat and also migration habitat from April to September to provide access to the sea.

Juveniles (estuarine)—Levels 1 and 2
The salinity transition zone (ecotone) and contiguous intertidal and nearshore habitats below mean higher high tide in Alaska where chinook salmon currently or historically occur. Chinook salmon smolts and post-smolt juveniles may be present in these estuarine habitats from April through September.

Juveniles (marine)—Levels 1 and 2
Marine waters from Dixon Entrance to the Bering Straits, extending from the intertidal to the limits of the U.S. EEZ. Juvenile chinook salmon are present in this habitat from April until annulus formation in January or February of their first winter at sea.

Immature and Maturing Adults (marine)—Levels 1 and 2
Marine waters below mean higher high tide from Dixon Entrance to the Bering Straits, extending from the intertidal to the limits of the EEZ. Immature chinook salmon use this marine habitat year-round. Maturing fish generally are considered to be in their ultimate year of life, and thus, use the habitat from January until September, by which time they have entered freshwater or moved out of the marine EFH in Alaska.

Adults (freshwater)—Levels 1 to 3
Those portions of freshwaters in Alaska within the bounds of ordinary high water where chinook salmon currently or historically occur that are accessible to adult chinook salmon (or could be cost-effectively made accessible) and that provide suitable water quality, migration access, holding areas, spawning substrates, and flow regimes. Impaired areas with potential for cost-effective restoration are also EFH for chinook salmon. Adult chinook salmon use such freshwater habitats in Alaska from April through September.

EFH Definition for Coho Salmon

Eggs and Larvae (freshwater)—Levels 1 to 3
Those portions of freshwaters in Alaska within the bounds of ordinary high water where coho salmon currently or historically occur that are accessible to adult coho salmon (or could be cost-effectively made accessible), and that have substrate, water quality, and seasonal flow adequate for the incubation and development of coho salmon eggs and larvae. Impaired areas with potential for cost-effective restoration are also EFH for coho salmon. Eggs and larvae require more than150 days of incubation (generally over the period from October to May). Preferred substrate is gravel containing less than 15 percent fine sediment (less than 2-millimeter [mm] diameter).

Juveniles (freshwater)—Levels 1 to 4
Those portions of freshwaters in Alaska within the bounds of ordinary high water where coho salmon currently or historically occur that are accessible to juvenile coho salmon (or could be cost-effectively made accessible) and that provide adequate water quality and productivity conditions for seasonal or year-round rearing or migration for juvenile coho salmon. Impaired areas with potential for cost-effective restoration are also EFH for coho salmon. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.

Juveniles (estuary)—Levels 1 and 2
Those portions of the salinity transition zone (ecotone) and contiguous intertidal and nearshore habitat below mean higher high tide in Alaska where coho salmon currently or historically occur. Smolts may be present May to August; non-smolts rear in spring and summer.

Juveniles (marine)—Levels 0_a and 1
Marine waters below mean higher high tide from Dixon Entrance to the Bering Straits, extending from the intertidal to the limits of the continental shelf and to a depth of 50 m. Juveniles occupy this area from June to September.

Immature and Maturing Adults (marine)—Levels 1 and 2
Marine waters below mean higher high tide from Dixon Entrance to the Bering Straits, extending from the intertidal to the limits of the EEZ and to a depth of 200 m. Immature coho salmon use this marine habitat year-round. Immature fish generally enter this habitat in late summer and maturing coho salmon return to freshwater to spawn the following late summer or fall.

Adults (freshwater)—Levels 1 to 3
Those portions of freshwaters in Alaska within the bounds of ordinary high water where coho salmon currently or historically occur that are accessible to adult coho salmon (or could be cost-effectively made accessible) and that provide suitable water quality, migration access, holding areas, and spawning substrates and flow regimes. Impaired areas with potential for cost-effective restoration are also EFH for coho salmon. Adult coho may be present in freshwater from July to December.

EFH Definition for Pink Salmon

Eggs and Larvae (freshwater)—Levels 1 to 3

Those portions of freshwaters and the intertidal portion of streams in Alaska within the bounds of ordinary high water where pink salmon currently or historically occur that are accessible to adult pink salmon (or could be cost-effectively made accessible) and that have substrate, water quality, and seasonal flow adequate for the incubation and development of pink salmon eggs and larvae. Impaired areas with potential for cost-effective restoration are also EFH for pink salmon. Eggs and larvae require approximately 225 days of incubation over the period of late summer to early spring. Preferred substrate is medium to course gravel containing less than 15 percent fine sediment (less than 2 mm diameter), 15 to 50 cm in depth.

Juveniles (freshwater)—Levels 0_a and 1 to 3

Those portions of freshwaters in Alaska within the bounds of ordinary high water where pink salmon currently or historically occur that are accessible to pink salmon (or could be cost-effectively made accessible) and that provide adequate water quality conditions for seasonal migration for pink salmon fry. Impaired areas with potential for cost-effective restoration are also EFH for pink salmon. Migrating pink salmon fry are in stream systems during spring, generally migrate in darkness in the upper water column. Fry leave streams within 15 days, and the duration of migration from a stream may last 2 months.

Juveniles (estuary)—Levels 0_a and 1 to 3

Those portions of the salinity transition zone (ecotone) and contiguous intertidal and nearshore habitats below mean higher high tide in Alaska where pink salmon currently or historically occur. Pink salmon juveniles may be present from late April through June.

Juveniles (marine)—Level 0_a and 1 to 3

Coastal waters all along the continental shelf throughout Alaska from mid-summer until December; then moving further off shelf into more pelagic oceanic areas, generally in the upper 50 m of the water column.

Immature and Maturing Adults (marine)—Levels 0_a and 1 to 3

Marine waters below mean higher high tide from Dixon Entrance to the Bering Straits, extending from the intertidal to the limits of the EEZ and to a depth of 200 m. Pink salmon are present from fall through the mid-summer in pelagic waters.

Adults (freshwater)—Levels 1 to 3

Those portions of freshwaters and intertidal areas of streams within the bounds of ordinary high water in Alaska where pink salmon currently or historically occur that are accessible to adult pink salmon (or could be cost-effectively made accessible) and that provide suitable water quality, migration access, holding areas, and spawning substrates and flow regimes. Impaired areas with potential for cost-effective restoration are also EFH for pink salmon. Adult pink salmon may be present in freshwater and the intertidal areas of streams from June through September.

EFH Definition for Chum Salmon

Eggs and Larvae (freshwater)—Levels 1 to 3

Those portions of freshwaters and the intertidal portion of streams in Alaska within the bounds of ordinary high water where chum salmon currently or historically occur that are accessible to adult chum salmon (or could be cost-effectively made accessible) and that have substrate, water quality, and seasonal flow (including upwelling ground water) adequate for the incubation and development of chum salmon eggs and larvae. Impaired areas with potential for cost-effective restoration are also EFH for chum salmon. Eggs and larvae incubate from late summer to early spring. Preferred substrate is medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter); finer substrates can be used in upwelling areas of streams and sloughs.

Juveniles (freshwater)—Level 0_a and 1 to 3

Those portions of freshwaters in Alaska within the bounds of ordinary high water where chum salmon currently or historically occur that are accessible to chum salmon (or could be cost-effectively made accessible) and that provide adequate water quality conditions for seasonal migration for chum salmon fry. Impaired areas with potential for cost-effective restoration are also EFH for chum salmon. Migrating chum salmon fry are in stream systems during spring, generally migrate in darkness in the upper water column.

Juvenile Stages (estuarine)—Levels 0_a and 1 to 3

Those portions of the salinity transition zone (ecotone) and contiguous intertidal and nearshore habitats below mean higher high tide in Alaska where chum salmon currently or historically occur. Chum salmon juveniles may be present from late April through June.

Juvenile Stages (marine)—Levels 0_a and 1 to 3

Those areas of ocean in the State of Alaska and the EEZ over the continental shelf between 0 and 50 m in depth.

Immature and Maturing Adults (marine)—Levels 0_a and 1 to 3

Marine waters below mean higher high tide from Dixon Entrance to the Bering Straits, extending from the intertidal to the limits of the EEZ and to a depth of 200 m. Chum salmon are present year round in pelagic waters.

Adults (freshwater)—Levels 1 to 3

Those portions of freshwaters and intertidal areas of streams within the bounds of ordinary high water in Alaska where chum salmon currently or historically occur that are accessible to adult chum salmon (or could be cost-effectively made accessible) and that provide suitable water quality, migration access, holding areas, and spawning substrates and flow regimes. Impaired areas with potential for cost-effective restoration are also EFH for chum salmon. Adult chum salmon may be present in freshwater and intertidal areas of streams from June through January.

EFH Definition for Sockeye Salmon

Eggs and Larvae (freshwater)—Levels 1 to 3
Those portions of freshwaters in Alaska within the bounds of ordinary high water where sockeye salmon currently or historically occur that are accessible to adult sockeye salmon (or could be cost-effectively made accessible) and that have substrate, water quality, and seasonal flow (including upwelling ground water) adequate for the incubation and development of sockeye salmon eggs and larvae. Impaired areas with potential for cost-effective restoration are also EFH for sockeye salmon. Sockeye often spawn in lake substrates, as well as in streams. Eggs and larvae are in these habitats from July through May. Preferred substrate is medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter); finer substrates can be used in upwelling areas of streams and sloughs.

Juveniles (freshwater)—Levels 1 to 4
Those portions of freshwaters in Alaska within the bounds of ordinary high water where sockeye salmon currently or historically occur that are accessible to juvenile sockeye salmon (or could be cost-effectively made accessible) and that provide adequate water quality and productivity conditions for seasonal rearing and migration for juvenile sockeye salmon. Impaired areas with potential for cost-effective restoration are also EFH for sockeye salmon. Juvenile sockeye salmon require year-round rearing habitat and also migration habitat from April to November to provide access to the estuary. Fry generally migrate downstream to a lake or, in systems lacking a freshwater lake, to estuarine and riverine rearing areas. Migration of fry and smolts is generally in spring and summer.

Juveniles (estuary)—Levels 0_a, 1, and 2
Those portions of the salinity transition zone (ecotone) and contiguous intertidal and nearshore habitats below mean higher high tide in Alaska where sockeye salmon currently or historically occur. Under-yearling, yearling, and older smolts occupy estuaries from March through early August.

Juveniles (marine)—Levels 0_a, 1 and 2
Coastal waters all along the continental shelf throughout Alaska and the EEZ from mid-summer until December; generally in the upper 50 m of the water column.,

Immature and Maturing Adults (marine)—Levels 0_a, 1, and 2
Marine waters below mean higher high tide from Dixon Entrance to the Bering Straits, extending from the intertidal to the limits of the EEZ and to a depth of 200 m. Sockeye salmon are present year round in pelagic waters. Ocean residence is 1 to 3 years.

Adults (freshwater)—Levels 1 to 3
Those portions of freshwaters and upper intertidal areas of streams within the bounds of ordinary high water in Alaska where sockeye salmon currently or historically occur that are accessible to adult sockeye salmon (or could be cost-effectively made accessible) and that provide suitable water quality, migration access, holding areas, and spawning substrates and flow regimes. Impaired areas with potential for cost-effective restoration are also EFH for sockeye salmon. Adult sockeye salmon may be present in freshwater from June through September, and sockeye often spawn in lake substrates, as well as in streams.

D.2.5.3 EFH Map Descriptions for Alaska Stocks of Pacific Salmon

Figures D-71 through D-76 show EFH distributions by region for the Alaska stocks of Pacific salmon described in Section D.2.5.2.

D.3 Alternative 3 (Preliminary Preferred Alternative)—Revised General Distribution

EFH is the general distribution of a species described by life stage. General distribution is a subset of a species population and is 95 percent of the population for a particular life stage, if life history data are available for the species. Where information is insufficient and a suitable proxy cannot be inferred, EFH is not described. General distribution is used to describe EFH for all stock conditions, whether or not higher levels of information exist, because the available higher level data are not sufficiently comprehensive to account for changes in stock distribution (and thus habitat use) over time.

Alternative 3 describes EFH for FMP-managed species by life stage as general distribution using new guidance from the EFH Final Rule, such as the updated EFH Level of Information definitions. Alternative 3 uses new analytical tools and incorporates recent scientific information for each life history stage from updated scientific habitat assessment reports (see Appendix F). EFH descriptions include both text and a map, if information is available for a species' particular life stage. Alternative 3 is risk averse, supported by scientific rationale, and accounts for changing oceanographic conditions, regime shifts, and the seasonality of migrating fish stocks.

Objective

The objective of this alternative is to describe EFH for each life stage using the best available scientific information, i.e. only those waters and substrates where the species is known to associate or recruit in scientific surveys and commercial fishery catches. EFH is described as 95 percent of the population where the species' life stage has been recruited to the survey, investigated through research, officially observed, or reported in a vessel catch log.

Methodology

In addition to scientific information sources analyzed in Alternative 2, the Alternative 3 analysis focused on two significant fishery geographic information data resources: survey (Resource Assessment and Conservation Engineering Division [RACE]) and observer (NORPAC). For adult and late juvenile life stages, each data set was analyzed for 95 percent of the total accumulated population for the species using GIS. For eggs and larvae, the EFH description was based on presence/absence data from surveys (AFSC RACE Matarese 2003). EFH was identified as the areas where eggs and larvae were most commonly encountered in those surveys, which was the best available information regarding habitat use for those life stages. EFH shape files were developed based on these data sets.

For adult and late juvenile life stages of BSAI groundfish, GOA groundfish, BSAI crab, and scallop FMP species, fishery catch per unit of effort (CPUE) data from the NMFS observer database (NORPAC, 1990 to 2001), NMFS trawl survey data from RACE, 1987 to 2002, and, where appropriate, ADF&G survey data were analyzed to estimate the population distribution of each species. Where this information exists, the area described by these data is identified as EFH. The analyzed EFH data and area were further reviewed by scientific stock assessment authors for accuracy. This review ensures that any outlying areas not considered were included, and errors in the data or described EFH area were removed.

For salmon FMP species, the analysis is broken into three parts: marine, nearshore, and freshwater. Marine and nearshore salmon EFH is generally described to include all marine waters from the mean higher tide line to the limits of the EEZ since science recognizes that salmon are 1) distributed throughout all marine waters during late juvenile and adult life stages and 2) found nearshore and along coastal migration corridors as early juvenile life stages out-migrate and adult life stages return to and from freshwater areas, respectively. Freshwater areas used by egg, larvae, and returning adult salmon will be analyzed as those areas indexed in ADF&G's *Catalogue of Waters Important for the Spawning,* *Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), specifically Pacific salmon species. Freshwater salmon systems are generally defined as those areas above mean higher tide to the upper limits of those freshwater systems supporting salmon and may include contiguous wetland areas, such as those areas hydrologically connected to the main water source via access channels to an adjacent river, stream, lake, pond, etc.

Rationale

Alternative 3 incorporates the same basic rationales to describe EFH as those applied in Alternative 2.

D.3.1 Description of Essential Fish Habitat for the Groundfish Resources of the BSAI Regions

D.3.1.1 EFH Information Levels for BSAI Groundfish

BSAI Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Walleye pollock	1	1	x	1	1
Pacific cod	x	1	x	1	1
Yellowfin sole	x	x	x	1	1
Greenland turbot	1	1	x	1	1
Arrowtooth flounder	x	x	x	1	1
Rock sole	x	1	x	1	1
Alaska plaice	1	x	x	1	1
Rex sole	x	x	x	1	1
Dover sole	x	x	x	1	1
Flathead sole	1	1	x	1	1
Sablefish	x	1	x	1	1
Pacific ocean perch	x	1	x	1	1
Shortraker/rougheye rockfish	x	1	x	x	1
Northern rockfish	x	1	x	x	1
Thornyhead rockfish	x	1	x	1	1
Yelloweye rockfish	x	1	x	1	1
Dusky rockfish	x	1	x	x	1
Atka mackerel	x	1	x	x	1
Skates	x	x	x	x	1
Sculpins	x	x	x	1	1
Sharks	x	x	x	x	x
Forage fish complex	x	x	x	x	x
Squid	x	x	x	1	1
Octopus	x	x	x	x	x

x - No information available.

D.3.1.2 EFH Text Descriptions for BSAI Groundfish

<u>EFH Description for BSAI Walleye Pollock</u>

Eggs

EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-77.

Larvae

EFH for larval walleye pollock is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-78.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI, as depicted in Figure D-79. No known preference for substrates exist.

Adults

EFH for adult walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the entire shelf (0 to 200 m) and slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-79. No known preference for substrates exist.

EFH Description for BSAI Pacific Cod

Eggs—No EFH Description Determined

Scientific information notes the rare occurrence of Pacific cod eggs in the BSAI.

Larvae

EFH for larval Pacific cod is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-80.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, and muddy sand, as depicted in Figure D-81.

Adults

EFH for adult Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, muddy sand, and gravel, as depicted in Figure D-81.

EFH Description for BSAI Yellowfin Sole

Eggs—No EFH Description Determined

Scientific information notes the rare occurrence of yellowfin sole eggs in the BSAI.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval yellowfin sole in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-82.

Adults
EFH for adult yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-82.

EFH Description for BSAI Greenland Turbot

Eggs
EFH for Greenland turbot eggs is the general distribution area for this life stage, located principally in benthypelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) throughout the BSAI in the fall, as depicted in Figure D-83.

Larvae
EFH for larval Greenland turbot is the general distribution area for this life stage, located principally in benthypelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) throughout the BSAI and seasonally abundant in the spring, as depicted in Figure D-84.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Greenland turbot is the general distribution area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are softer substrates consisting of mud and sandy mud, as depicted in Figure D-85.

Adults
EFH for late adult Greenland turbot is the general distribution area for this life stage, located in the lower and middle portion of the water column along the outer shelf (100 to 200 m), upper slope (200 to 500 m), and lower slope (500 to 1,000 m) throughout the BSAI wherever there are softer substrates consisting of mud and sandy mud, as depicted in Figure D-85.

EFH Description for BSAI Arrowtooth Flounder

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae—No EFH Description Determined

Scientific information notes the rare occurrence of larval arrowtooth flounder in the BSAI.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-86.

Adults

EFH for adult arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-86.

EFH Description for BSAI Rock Sole

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-87.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-88.

Adults

EFH for adult rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-88.

EFH Description for BSAI Alaska Plaice

Eggs
EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the BSAI in the spring, as depicted in Figure D-89.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval Alaska plaice in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-90.

Adults
EFH for adult Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-90.

EFH Description for BSAI Rex Sole

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of rex sole eggs in the BSAI.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval rex sole in the BSAI.

Late Juveniles
EFH for juvenile rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-91.

Adults
EFH for adult rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-91.

EFH Description for BSAI Dover Sole

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of Dover sole eggs in the BSAI.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval Dover sole in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates consisting of sand and mud, as depicted in Figure D-92**.**

Adults
EFH for adult Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates consisting of sand and mud, as depicted in Figure D-92.

EFH Description BSAI Flathead Sole

Eggs
EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI in the spring, as depicted in Figure D-93.

Larvae
EFH for larval flathead sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-94.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-95.

Adults
EFH for adult flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-95.

EFH Description for BSAI Sablefish

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of sablefish eggs in the BSAI.

Larvae
EFH for larval sablefish is the general distribution area for this life stage, located in epipelagic waters along the middle shelf (50 to 100 m), outer shelf (100 to 200 m), and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-96.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-97.

Adults
EFH for adult sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-97.

EFH Description for BSAI Pacific Ocean Perch

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval Pacific ocean perch is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (1 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-99.

Adults
EFH for adult Pacific ocean perch is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-99.

EFH Descriptions for BSAI Shortraker and Rougheye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult shortraker and rougheye rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) regions throughout the BSAI wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure D-100.

EFH Description for BSAI Northern Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult northern rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer slope (100 to 200 m) and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of cobble and rock, as depicted in Figure D-101.

EFH Description for BSAI Thornyhead Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval thornyhead rockfish is the general distribution area for this life stage, located in epipelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the BSAI wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-102.

Adults
EFH for adult Thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the BSAI wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-102.

EFH Description for BSAI Yelloweye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval yelloweye rockfish is the general distribution area for this life stage, located in the epipelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-103.

Adults
EFH for adult yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), outer shelf (100 to 100 m), and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of rock and in vegetated areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-103.

EFH Description for BSAI Dusky Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval dusky rockfish is the general distribution area for this life stage, located in the pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult dusky rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of cobble, rock, and gravel, as depicted in Figure D-104.

EFH Description for BSAI Atka Mackerel

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval atka mackerel is the general distribution area for this life stage, located in epipelagic waters along the shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-105.

Early Juveniles —No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult Atka mackerel is the general distribution area for this life stage, located in the entire water column, from sea surface to the sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates of gravel and rock and in vegetated areas of kelp, as depicted in Figure D-106.

EFH Description for BSAI Skates

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult skates is the general distribution area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) throughout the BSAI wherever there are of substrates of mud, sand, gravel, and rock, as depicted in Figure D-107.

EFH Description for BSAI Sculpins

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Juveniles
EFH for juvenile sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-108.

Adults
EFH for adult sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m, outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-108.

EFH Description for BSAI Sharks

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for BSAI Forage Fish Complex—Eulachon, Capelin, Sand Lance, Sand Fish, Euphausiids, Myctophids, Pholids, Gonostomatids, etc.

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for BSAI Squid

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for older juvenile squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-109.

Adults
EFH for adult squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-109.

EFH Description for BSAI Octopus

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

D.3.1.3 EFH Map Descriptions for BSAI Groundfish

Figures D-77 through D-109 show EFH distribution under Alternative 3 for the BSAI groundfish species as described in Section D.3.1.2.

D.3.2 Description of Essential Fish Habitat for the Groundfish Resources of the GOA Region

D.3.2.1 EFH Information Levels for GOA Groundfish

GOA Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Walleye pollock	1	1	x	1	1
Pacific cod	1	1	x	1	1
Yellowfin sole	1	1	x	1	1
Arrowtooth flounder	x	1	x	1	1
Rock sole	x	1	x	1	1
Alaska plaice	1	1	x	1	1
Rex sole	1	1	x	1	1
Dover sole	1	1	x	1	1
Flathead sole	1	1	x	1	1
Sablefish	1	1	x	1	1
Pacific ocean perch	x	1	x	1	1
Shortraker/rougheye rockfish	x	1	x	x	1
Northern rockfish	x	1	x	x	1
Thornyhead rockfish	x	1	x	1	1
Yelloweye rockfish	x	1	x	1	1
Dusky rockfish	x	1	x	x	1
Atka mackerel	x	1	x	x	1
Sculpins	x	x	x	1	1
Skates	x	x	x	x	1
Sharks	x	x	x	x	x
Forage fish complex	x	x	x	x	x
Squid	x	x	x	1	1
Octopus	x	x	x	x	x

x - No information available.

D.3.2.2 EFH Text Descriptions for GOA Groundfish

<u>EFH Description for GOA Walleye Pollock</u>

Eggs
EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-110.

Larvae
EFH for larval walleye pollock is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-111.

Early Juveniles—No EFH Description Determined
Limited information exists to describe walleye pollock early juvenile larval general distribution; however, the data cannot be analyzed in the same manner as directed by the approach for Alternative 3.

Late Juveniles
EFH for late juvenile walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf along the throughout the GOA, as depicted in Figure D-112. No known preference for substrates exist.

Adults
EFH for adult walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the entire shelf (0 to 200) and slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-112. No known preference for substrates exist.

EFH Description for GOA Pacific Cod

Eggs
EFH for Pacific cod eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper (200 to 500 m) slope throughout the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure D-113.

Larvae
EFH for larval Pacific cod is the general distribution area for this life stage, located in pelagic waters along the inner (0 to 50 m) and middle (50 to 100 m) shelf throughout the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure D-114.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, and muddy sand, as depicted in Figure D-115.

Adults
EFH for adult Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting of sand, mud, sandy mud, muddy sand, and gravel, as depicted in Figure D-115.

EFH Description for GOA Yellowfin Sole

Eggs

EFH for yellowfin sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper (200 to 500 m) slope throughout the GOA, as depicted in Figure D-116.

Larvae

EFH for larval yellowfin sole is the general distribution area for this life stage, located in pelagic waters along the shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-117.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-118.

Adults

EFH for adult yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-118.

EFH Description for GOA Arrowtooth Flounder

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval arrowtooth flounder is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-119.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-120.

Adults

EFH for adult arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-120.

EFH Description for GOA Rock Sole

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-121.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-122.

Adults

EFH for adult rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble. Depicted in Figure D-122.

EFH Description for GOA Alaska Plaice

Eggs

EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring, as depicted in Figure D-123.

Larvae

EFH for larval Alaska plaice is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-124.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-125.

Adults
EFH for adult Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-125.

EFH Description for GOA Rex Sole

Eggs
EFH for rex sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring, as depicted in Figure D-126.

Larvae
EFH for larval rex sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-127.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-128.

Adults
EFH for adult rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-128.

EFH Description for GOA Dover Sole

Eggs
EFH for Dover sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-129.

Larvae
EFH for larval Dover sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-130.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure D-131.

Adults
EFH for adult Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure D-131.

EFH Description GOA Flathead Sole

Eggs
EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-132.

Larvae
EFH for larval flathead sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-133.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-134.

Adults
EFH for adult flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-134.

EFH Description for GOA Sablefish

Eggs
EFH for sablefish eggs is the general distribution area for this life stage, located in deeper waters along the slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-135.

Larvae
EFH for larval sablefish is the general distribution area for this life stage, located in epipelagic waters along the middle shelf (50 to 100 m), outer shelf (100 to 200 m), and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-136.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-137.

Adults
EFH for adult sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-137.

EFH Description for GOA Pacific Ocean Perch

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the GOA as depicted in Figure D-138.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-139.

Adults
EFH for adult Pacific ocean perch is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-139.

EFH Descriptions for GOA Shortraker and Rougheye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult shortraker and rougheye rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) regions throughout the GOA wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure D-140.

EFH Description for GOA Northern Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult northern rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer slope (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of cobble and rock, as depicted in Figure D-141.

EFH Description for GOA Thornyhead Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval thornyhead rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-142.

Adults
EFH for adult Thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-142.

EFH Definition for GOA Yelloweye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval yelloweye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-143.

Adults
EFH for adult Yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-143.

EFH Description for GOA Dusky Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval dusky rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult Dusky rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of cobble, rock, and gravel, as depicted in Figure D-144.

EFH Description for GOA Atka Mackerel

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval atka mackerel is the general distribution area for this life stage, located in epipelagic waters along the shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-145.

Early Juveniles —No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult Atka mackerel is the general distribution area for this life stage, located in the entire water column, from sea surface to the sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of gravel and rock and in vegetated areas of kelp, as depicted in Figure D-146.

EFH Description for GOA Sculpins

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Juveniles
EFH for juvenile sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-147.

Adults
EFH for adult sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-147.

EFH Description for GOA Skates

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult skates is the general distribution area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) throughout the GOA wherever there are of substrates of mud, sand, gravel, and rock, as depicted in Figure D-148.

EFH Description for GOA Sharks

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for GOA Forage Fish Complex—Eulachon, Capelin, Sand Lance, Sand Fish, Euphausiids, Myctophids, Pholids, Gonostomatids, etc.

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults. No EFH Description Determined
Insufficient information is available.

EFH Description for GOA Squid

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for older juvenile squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-149.

Adults
EFH for adult squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-149.

EFH Description for GOA Octopus

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults. No EFH Description Determined
Insufficient information is available.

D.3.2.3 EFH Map Descriptions for GOA Groundfish

Figures D-110 through D-149 show EFH distribution under Alternative 3 for the GOA groundfish species as described in Section D.3.2.2.

D.3.3 Description of Essential Fish Habitat for BSAI King and Tanner Crab

D.3.3.1 EFH Information Levels for BSAI Crab

BSAI Crab Species	Egg	Larvae	Early Juvenile	Late Juvenile	Adult
Red king crab	inferred	x	x	1	1
Blue king crab	inferred	x	x	1	1
Golden king crab	inferred	x	x	1	1
Tanner crab	inferred	x	x	1	1
Snow crab	inferred	x	x	1	1

x - No information available.

D.3.3.2 EFH Text Descriptions for BSAI Crab

EFH Description for BSAI Red King Crab

Eggs
Essential fish habitat of the red king crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile red king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel and biogenic structures such as boltenia, bryozoans, ascidians, and shell hash, as depicted in Figure D-150.

Adults
EFH for adult red king crab is the general distribution area for this life stage, located in bottom habitats along the nearshore (spawning aggregations) and the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand, mud, cobble, and gravel, as depicted in Figure D-150.

EFH Description for BSAI Blue King Crab

Eggs
Essential fish habitat of the blue king crab eggs is inferred from the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile blue king crab is the general distribution area for this life stage, located in bottom habitats along the nearshore where there are rocky areas with shell hash and the inner (0 to 50), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel, as depicted in Figure D-151.

Adults
EFH for adult blue king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand and mud adjacent to rockier areas and areas of shell hash, as depicted in Figure D-151.

EFH Description for BSAI Golden King Crab

Eggs
Essential fish habitat of golden king crab eggs is inferred from the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high-relief living habitats, such as coral, and vertical substrates, such as boulders, vertical walls, ledges, and deep water pinnacles, as depicted in Figure D-152.

Adults
EFH for adult golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the outer shelf (100 to 200 m), upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high relief living habitats, such as coral, and vertical substrates such as boulders, vertical walls, ledges, and deep water pinnacles, as depicted in Figure D-152.

EFH Description for BSAI Tanner Crab

Eggs
Essential fish habitat of Tanner crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Tanner crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-153.

Adults
EFH for adult Tanner crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-153.

EFH Description for BSAI Snow Crab

Eggs
Essential fish habitat of snow crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-154.

Adults
EFH for adult snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-154.

D.3.3.3 EFH Map Descriptions for BSAI Crab

Figures D-150 through D-154 show EFH distribution under Alternative 3 for the BSAI crab species as described in Section D.3.4.2.

D.3.4 Description of Essential Fish Habitat for Alaska Scallops

D.3.4.1 EFH Information Levels for Alaska Scallops

Scallop Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Weathervane scallop	x	x	x	1	1

x - No information available.

D.3.4.2 EFH Text Descriptions for Alaska Scallops

EFH Description for Weathervane Scallops

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile weathervane scallops is the general distribution area for this life stage, located in the sea floor along the middle (50 to 100 m), and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow, as depicted in Figure D-155.

Adults
EFH for adult weathervane scallops is the general distribution area for this life stage, located in the sea floor along the middle (50 to 100 m) and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow, as depicted in Figure D-155.

EFH Description for Other Species of Scallops

Information is insufficient or lacking to describe EFH for any life stage of pink, spiny, and rock scallops.

D.3.4.3 EFH Map Descriptions for Weathervane Scallops

Figure D-155 shows EFH distribution under Alternative 3 for weathervane scallops.

D.3.5 Description of Essential Fish Habitat for Alaska Stocks of Pacific Salmon

D.3.5.1 EFH Information Levels for Alaska Stocks of Pacific Salmon

Salmon Species	Freshwater Eggs	Freshwater Larvae and Juveniles	Estuarine Juveniles	Marine Juveniles	Marine Immature and Maturing Adults	Freshwater Adults
Pink	1	1	1	1	1	1
Chum	1	1	1	1	1	1
Sockeye	1	1	1	1	1	1
Chinook	1	1	1	1	1	1
Coho	1	1	1	1	1	1

D.3.5.2 EFH Text Descriptions for Alaska Stocks of Pacific Salmon

EFH Description for Pink Salmon

Freshwater Eggs
EFH for pink salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures D-156 through D-161.

Freshwater Larvae and Juveniles
EFH for larval and juvenile pink salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water during the spring, generally migrate in darkness in the upper water column. Fry leave streams in within 15 days and the duration of migration from a stream towards sea may last 2 months, as depicted in Figures D-156 through D-161.

Estuarine Juveniles
Estuarine EFH for juvenile pink salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters and generally present from late April through June, as depicted in Figures D-156 through D-161.

Marine Juveniles
Marine EFH for juvenile pink salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nautical mile (nm) limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-162.

Marine Immature and Maturing Adults
EFH for immature and maturing adult pink salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Mature adult pink salmon frequently spawn in intertidal areas and are know to associate with smaller coastal streams, as depicted in Figure D-162.

Freshwater Adults

EFH for pink salmon is the general distribution area for this life stage, located in freshwaters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter), 15 to 50 cm in depth from June through September, as depicted in Figures D-156 through D-161.

EFH Description for Chum Salmon

Freshwater Eggs

EFH for chum salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures D-163 through D-168.

Freshwater Larvae and Juveniles

EFH for larval and juvenile chum salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water and contiguous rearing areas within the boundaries of ordinary high water during the spring, generally migrate in darkness in the upper water column. Fry leave streams in within 15 days and the duration of migration from a stream towards sea may last 2 months, as depicted in Figures D-163 through D-168.

Estuarine Juveniles

Estuarine EFH for juvenile chum salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters from late April through June, as depicted in Figures D-163 through D-168.

Marine Juveniles

Marine EFH for juvenile chum salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to approximately 50 m in depth from the mean higher tide line to the 200-nm limit of the EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.Ocean, as depicted in Figure D-169.

Marine Immature and Maturing Adults

EFH for immature and maturing adult chum salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and ranging from the mean higher tide line to the 200-nm limit of the EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-169.

Freshwater Adults

EFH for chum salmon is the general distribution area for this life stage, located in freshwaters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter) and finer substrates can be used in upwelling areas of streams and sloughs from June through January, as depicted in Figures D-163 through D-168.

EFH Description for Sockeye Salmon

Freshwater Eggs

EFH for sockeye salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures D-170 through D-175.

Freshwater Larvae and Juveniles

EFH for larval and juvenile sockeye salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Juvenile sockeye salmon require year-round rearing habitat. Fry generally migrate downstream to a lake or, in systems lacking a freshwater lake, to estuarine and riverine rearing areas for up to 2 years. Fry out migration occurs from approximately April to November and smolts generally migrate during the spring and summer, as depicted in Figures D-170 through D-175.

Estuarine Juveniles

Estuarine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Under-yearling, yearling, and older smolts occupy estuaries from March through early August, as depicted in Figures D-170 through D-175.

Marine Juveniles

Marine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to depths of 50 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean from mid-summer until December of their first year at sea, as depicted in Figure D-176.

Marine Immature and Maturing Adults

EFH for immature and maturing adult sockeye salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-176.

Freshwater Adults

EFH for sockeye salmon is the general distribution area for this life stage, located in freshwaters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diam.) and finer substrates can be used in upwelling areas of streams and sloughs from June through September. Sockeye often spawn in lake substrates, as well as in streams, as depicted in Figures D-170 through D-175.

EFH Description for Chinook Salmon

Freshwater Eggs

EFH for Chinook salmon eggs is the general distribution for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) (see Figures D-177 through D-182).

Freshwater Larvae and Juveniles

EFH for larval and juvenile Chinook salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Juvenile Chinook salmon out-migrate from freshwater areas in April toward the sea and may spend up to a year in a major tributaries or rivers, such as the Kenai, Yukon, Taku, and Copper Rivers (see Figures D-177 through D-182).

Estuarine Juveniles

Estuarine EFH for juvenile Chinook salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Chinook salmon smolts and post-smolt juveniles may be present in these estuarine habitats from April through September (see Figures D-177 through D-182).

Marine Juveniles

Marine EFH for juvenile Chinook salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean. Juvenile marine Chinook salmon are at this life stage from April until annulus formation in January or February during their first winter at sea (see Figure D-183).

Marine Immature and Maturing Adults

EFH for immature and maturing adult Chinook salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska and ranging from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean (see Figure D-183).

Freshwater Adults

EFH for adult Chinook salmon is the general distribution area for this life stage, located in fresh waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) wherever there are spawning substrates consisting of gravels from April through September (see Figures D-177 through D-182).

EFH Description for Coho Salmon

Freshwater Eggs

EFH for coho salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures D-184 through D-189.

Freshwater Larvae and Juveniles

EFH for larval and juvenile coho salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Fry generally migrate to a lake, slough, or estuary and rear in these areas for up to 2 years, as depicted in Figures D-184 through D-189.

Estuarine Juveniles

Estuarine EFH for juvenile coho salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.

Marine Juveniles
Marine EFH for juvenile coho salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-190.

Marine Immature and Maturing Adults
EFH for immature and maturing adult coho salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to 200 m in depth and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-190.

Freshwater Adults
EFH for coho salmon is the general distribution area for this life stage, located in freshwaters as identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting mainly of gravel containing less than 15 percent fine sediment (less than 2-mm diameter) from July to December, as depicted in Figures D-184 through D-189.

D.3.5.3 EFH Map Descriptions for Alaska Stocks of Pacific Salmon

Figures D-155 through D-190 show EFH distribution under Alternative 3 by region for the Alaska stocks of Pacific salmon as described in Section D.3.5.2.

D.4 Alternative 4—Presumed Known Concentration

EFH is described as areas of presumed known concentrations of each life stage of each FMP species. EFH is described using the highest level of information known for each life history stage. If no information is available, then EFH is not described. If information is only available to delineate presence/absence for a particular life history stage, then EFH is described as General Distribution. If information is sufficient to further refine the species population through analysis, then EFH is described as Known Concentrations.

However, for most EFH species in Alaska, the highest level of information known is Level 2 and only described using a refinement of the analysis used in Alternative 3. Sufficient information to describe EFH using even higher levels of information, such as Level 3, is limited to a few life history stages of salmon, and mostly where this habitat has been documented by field observation. In these instances, EFH at Level 3 is for only the freshwater adult life history stage of the salmon species and is described as only those areas which are linked to productivity and/or production rates for that life stage, such as spawning areas. (See list, *Highest Level of Information Available for Each of the 5 EFH Example Species by Life History Stage*, in Section D.4.1.1.)

To develop Level 2 information, the analytical approach used for Alternative 3 was refined to encompass 75 percent of the species population. A percentile of 75 percent was chosen as to be narrower than 95 percent and not as restrictive as the upper two-thirds known concentration percentile (66 percent) as defined in the original EFH EA. The EFH EA in 1999 did not choose known concentration as the preferred alternative, however, discussion is located in the EFH EA document for reference.

Alternative 4 describes EFH for FMP managed species by life history stage using new guidance and definitions from the EFH Final Rule, such as the updated EFH Level of Information definitions. Alterative 4 uses new analytical tools and incorporates recent scientific information for each life history stage from updated scientific habitat assessment reports (see Appendix F). EFH descriptions include both text and a map, if information is available for a species particular life stage. EFH description maps for known concentrations depict EFH in more discrete areas for those species and life stages where information exists to do so.

It is important to note that the major difference between Alternatives 3 and 4, even when higher levels of information are available for a particular species' life stage, is that Alterative 3 describes EFH for the life stage as general distribution, while Alternative 4 describes EFH with the highest level of information.

Objective

The objective is to describe EFH for each particular life stage using best scientific information for only those waters and substrates where the species is concentrated for all instances where data are available to make these determinations.

Methodology

Scientific information sources used in the Alternative 4 analysis focused on two significant fishery data sources, survey (RACE) and catch (NORPAC). Each data set was analyzed for 75 percent of the total cumulated population for the species using GIS. An EFH shape file was developed as the intersection of these data sets.

For BSAI Groundfish, GOA Groundfish, BSAI Crab, and Scallop FMP species, fishery CPUE data from the NMFS Observer database (NORPAC 1990–2001) and NMFS trawl survey data from the Resource Assessment and Conservation Engineering Division (RACE 1987-2002) and, where appropriate, ADF&G survey data were analyzed to estimate the population distribution of each species. Where this information exists, the area described by this data is EFH. The analyzed EFH data and area are further reviewed by scientific stock assessment authors for accuracy to include any outlying areas not considered and remove any errors in the data or described EFH area.

For Salmon FMP species, the analysis is broken into three parts; marine, nearshore, and freshwater. Marine and Nearshore Salmon EFH will be generally described as to include all marine waters from the mean higher tide line to the limits of the EEZ, since science recognizes salmon are: 1) distributed throughout all marine waters during late juvenile and adult life stages, and 2) found nearshore and along coastal migration corridors as early juvenile life stages outmigrate and adult life stages return to and from freshwater areas, respectively. Freshwater areas used by egg, larvae, and returning adult salmon will be analyzed as those areas indexed in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) - Pacific salmon species. Freshwater salmon systems are generally defined as those areas above mean higher tide to the upper limits of those freshwater systems supporting salmon and may include contiguous wetland areas, such as those areas hydrologically connected to the main water source via access channels to an adjacent river, stream, lake, pond, etc.

Higher levels of habitat information exist in known spawning areas. Therefore, EFH for adult freshwater salmon is those areas where salmon are known to concentrate or spawn as compared to just those areas where freshwater adult salmon are present.

Rationale

Alternative 4 incorporates the basic rationales for Level 1 information described for Alternative 3. Further, Alternative 4 will describe EFH using higher levels of concentration, if known. Specifically for salmon:

- Concentrations reflect points where fish become concentrated on migration routes from the open ocean to fresh water (e.g., Unimak Pass) and may not indicate exceptional habitats necessary for rearing and maturing;
- Research has identified one area off Prince William Sound to Kodiak Island as a possible area of concentration of chum salmon in summer;
- Freshwater concentrations of salmon reflect locations of specific habitats for spawning, rearing, and migration are patchily distributed on a finer scale (at the reach level) within watersheds;
- Areas of spawning have been identified for a small number of specific river systems that have been intensively surveyed, primarily in Southeast (Region I), South-central (Region II); and Southwestern (Region III) Alaska.

D.4.1 Description of Essential Fish Habitat for the Groundfish Resources of the BSAI Regions

D.4.1.1 Highest Known EFH Information Levels for BSAI Groundfish

BSAI Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Walleye pollock	1	1	x	2	2
Pacific cod	x	1	x	2	2
Yellowfin sole	x	x	x	2	2
Greenland turbot	1	1	x	2	2
Arrowtooth flounder	x	x	x	2	2
Rock sole	x	x	x	2	2
Alaska plaice	1	x	x	2	2
Rex sole	x	x	x	2	2
Dover sole	x	x	x	2	2
Flathead sole	1	1	x	2	2
Sablefish	x	1	x	2	2
Pacific ocean perch	x	1	x	2	2
Shortraker/rougheye rockfish	x	1	x	x	2
Northern rockfish	x	1	x	x	2
Thornyhead rockfish	x	1	x	2	2
Yelloweye rockfish	x	1	x	2	2
Dusky rockfish	x	1	x	x	2
Atka mackerel	x	1	x	x	2
Sculpins	x	x	x	2	2
Skates	x	x	x	x	2
Sharks	x	x	x	x	x
Forage fish complex	x	x	x	x	x
Squid	x	x	x	2	2
Octopus	x	x	x	x	x

x - No information available.

D.4.1.2 EFH Text Descriptions for BSAI Groundfish

EFH Description for BSAI Walleye Pollock

Eggs
EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-77.

Larvae
EFH for larval walleye pollock is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-78.

Early Juveniles—No EFH Description Determined
Limited information exists to describe walleye pollock early juvenile larval general distribution; however, the data cannot be analyzed in the same manner as directed by the approach for Alternative 3.

Late Juveniles
EFH for late juvenile walleye pollock is the known concentration area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI, as depicted in Figure D-191. No known preference for substrates exist.

Adults
EFH for adult walleye pollock is the known concentration area for this life stage, located in the lower and middle portion of the water column along the entire shelf (0 to 200 m) and slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-191. No known preference for substrates exist.

EFH Description for BSAI Pacific Cod

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval Pacific cod is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-80.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific cod is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrate consisting of sand, mud, sandy mud, and muddy sand, as depicted in Figure D-192.

Adults
EFH for adult Pacific cod is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrate consisting of sand, mud, sandy mud, muddy sand, and gravel, as depicted in Figure D-192.

EFH Description for BSAI Yellowfin Sole

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile yellowfin sole is the known concentration area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting mainly of sand.

Adults
EFH for adult yellowfin sole is the known concentration area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-193.

EFH Description for BSAI Greenland Turbot

Eggs
EFH for Greenland turbot eggs is the general distribution area for this life stage, located principally in benthypelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) throughout the BSAI in the fall, as depicted in Figure D-83.

Larvae
EFH for larval Greenland turbot is the general distribution area for this life stage, located principally in benthypelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) throughout the BSAI and seasonally abundant in the spring, as depicted in Figure D-84.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Greenland turbot is the known concentration area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are softer substrates consisting of mud and sandy mud, as depicted in Figure D-194.

Adults

EFH for late adult Greenland turbot is the known concentration area for this life stage, located in the lower and middle portion of the water column along the outer shelf (100 to 200 m), upper slope (200 to 500 m), and lower slope (500 to 1,000 m) throughout the BSAI wherever there are softer substrates consisting of mud and sandy mud, as depicted in Figure D-194.

EFH Description for BSAI Arrowtooth Flounder

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae—No EFH Description Determined

Insufficient information is available.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile arrowtooth flounder is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-195.

Adults

EFH for adult arrowtooth flounder is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-195.

EFH Description for BSAI Rock Sole

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-87.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile rock sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-196.

Adults
EFH for adult rock sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-196.

EFH Description for BSAI Alaska Plaice

Eggs
EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the BSAI in the spring, as depicted in Figure D-89.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Alaska plaice is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-197.

Adults
EFH for adult Alaska plaice is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-197.

EFH Description for BSAI Rex Sole

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile rex sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-198.

Adults
EFH for adult rex sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-198.

EFH Description for BSAI Dover Sole

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Dover sole is the known concentration area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates consisting of sand and mud, as depicted in Figure D-199.

Adults
EFH for adult Dover sole is the known concentration area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates consisting of sand and mud, as depicted in Figure D-199.

EFH Description BSAI Flathead Sole

Eggs
EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI in the spring, as depicted in Figure D-93.

Larvae
EFH for larval flathead sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-94.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile flathead sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-200.

Adults
EFH for adult flathead sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-200.

EFH Description for BSAI Sablefish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval sablefish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-96.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile sablefish is the known concentration area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-201.

Adults
EFH for adult sablefish is the known concentration area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the BSAI, as depicted in Figure D-201.

EFH Description for BSAI Pacific Ocean Perch

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval Pacific ocean perch is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific ocean perch is the known concentration area for this life stage, located in the middle to lower portion of the water column along the inner shelf (1 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-202.

Adults
EFH for adult Pacific ocean perch is the known concentration area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m)

throughout the BSAI wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-202.

EFH Descriptions for BSAI Shortraker and Rougheye Rockfish

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult shortraker and rougheye rockfish is the known concentration area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) regions throughout the BSAI wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure D-203.

EFH Description for BSAI Northern Rockfish

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult northern rockfish is the known concentration area for this life stage, located in s the middle and lower portions of the water column along the outer slope (100 to 200 m) and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of cobble and rock, as depicted in Figure D-204.

EFH Description for BSAI Thornyhead Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval thornyhead rockfish is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (100 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Thornyhead rockfish is the known concentration area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the BSAI wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-205.

Adults
Level 2. EFH for adult Thornyhead rockfish is the known concentration area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the BSAI wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-205.

EFH Definition for BSAI Yelloweye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval yelloweye rockfish is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Yelloweye rockfish is the known concentration area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-206.

Adults
EFH for adult Yelloweye rockfish is the known concentration area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA

wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-206.

EFH Description for BSAI Dusky Rockfish

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval dusky rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the BSAI, as depicted in Figure D-98.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult Dusky rockfish is the known concentration area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of cobble, rock, and gravel, as depicted in Figure D-207.

EFH Description for BSAI Atka Mackerel

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval atka mackerel is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-105.

Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult Atka mackerel is the known concentration area for this life stage, located in the entire water column, from sea surface to the sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates of gravel and rock and in vegetated areas of kelp, as depicted in Figure D-208.

EFH Description for BSAI Sculpins

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Juveniles
EFH for adult sculpin is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-209.

Adults
EFH for adult sculpins is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the BSAI wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-209.

EFH Description for BSAI Skates

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult skates is the known concentration area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) throughout the BSAI wherever there are of substrates of mud, sand, gravel, and rock, as depicted in Figure D-210.

EFH Description for BSAI Sharks

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for BSAI Forage Fish Complex—Eulachon, Capelin, Sand Lance, Sand Fish, Euphausiids, Myctophids, Pholids, Gonostomatids, etc.

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for BSAI Squid

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for older juvenile squid is the known concentration area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the BSAI.

Adults
EFH for adult squid is the known concentration area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the BSAI, as depicted in Figure D-211.

EFH Description for BSAI Octopus

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults. No EFH Description Determined
Insufficient information is available.

D.4.1.3 EFH Map Descriptions for BSAI Groundfish

Figures D-191 through D-211 show EFH distribution under Alternative 4 for the BSAI groundfish species as described in Section D.4.1.2.

D.4.2 Description of Essential Fish Habitat for the Groundfish Resources of the GOA Region

D.4.2.1 Highest Known EFH Information Levels for GOA Groundfish

GOA Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Walleye pollock	1	1	x	2	2
Pacific cod	1	1	x	2	2
Yellowfin sole	1	1	x	2	2
Arrowtooth flounder	x	1	x	2	2
Rock sole	x	1	x	2	2
Alaska plaice	1	1	x	2	2
Rex sole	1	1	x	2	2
Dover sole	1	1	x	2	2
Flathead sole	1	1	x	2	2
Sablefish	1	1	x	2	2
Pacific ocean perch	x	1	x	2	2
Shortraker/rougheye rockfish	x	1	x	x	2
Northern rockfish	x	1	x	x	2
Thornyhead rockfish	x	1	x	2	2
Yelloweye rockfish	x	1	x	2	2
Dusky rockfish	x	1	x	x	2
Atka mackerel	x	1	x	x	2
Sculpins	x	x	x	2	2
Skates	x	x	x	x	2
Sharks	x	x	x	x	x
Forage fish complex	x	x	x	x	x
Squid	x	x	x	2	2
Octopus	x	x	x	x	x

x - No information available.

D.4.2.2 EFH Text Descriptions for GOA Groundfish

EFH Description for GOA Walleye Pollock

Eggs
EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-110.

Larvae
EFH for larval walleye pollock is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-111.

Early Juveniles—No EFH Description Determined
Limited information exists to describe walleye pollock early juvenile larval general distribution; however, the data cannot be analyzed in the same manner as directed by the approach for Alternative 3.

Late Juveniles
EFH for late juvenile walleye pollock is the known concentration area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf along the throughout the GOA, as depicted in Figure D-212. No known preference for substrates exist.

Adults
EFH for adult walleye pollock is the known concentration area for this life stage, located in the lower and middle portion of the water column along the entire shelf (0 to 200 m) and slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-212. No known preference for substrates exist.

EFH Description for GOA Pacific Cod

Eggs
EFH for Pacific cod eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure D-113.

Larvae
EFH for larval Pacific cod is the general distribution area for this life stage, located in pelagic waters along the inner (0 to 50 m) and middle shelf (50 to 100 m) throughout the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure D-114.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific cod is the known concentration area for this life stage, located in the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, and muddy sand, as depicted in Figure D-213.

Adults
EFH for adult Pacific cod is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting of sand, mud, sandy mud, muddy sand, and gravel, as depicted in Figure D-213.

EFH Description for GOA Yellowfin Sole

Eggs
EFH for yellowfin sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-116.

Larvae
EFH for larval yellowfin sole is the general distribution area for this life stage, located in pelagic waters along the shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-117.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile yellowfin sole is the known concentration area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-214.

Adults
EFH for adult yellowfin sole is the known concentration area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-214.

EFH Description for GOA Arrowtooth Flounder

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval arrowtooth flounder is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-119.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile arrowtooth flounder is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m) and outer (100 to

200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-215.

Adults
EFH for adult arrowtooth flounder is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-215.

EFH Description for GOA Rock Sole

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-121.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile rock sole i the known concentration area for this life stage, located in s the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-216.

Adults
EFH for adult rock sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-216.

EFH Description for GOA Alaska Plaice

Eggs
EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring, as depicted in Figure D-123.

Larvae
EFH for larval Alaska plaice is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-124.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Alaska plaice is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-217.

Adults
EFH for adult Alaska plaice is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-217.

EFH Description for GOA Rex Sole

Eggs
EFH for rex sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring, as depicted in Figure D-126.

Larvae
EFH for larval rex sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-127.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile rex sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-218.

Adults
EFH for adult rex sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-218.

EFH Description for GOA Dover Sole

Eggs
EFH for Dover sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 500 m) throughout the GOA, as depicted in Figure D-129.

Larvae
EFH for larval Dover sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 500 m) throughout the GOA, as depicted in Figure D-130.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Dover sole is the known concentration area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure D-219.

Adults
EFH for adult Dover sole is the known concentration area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure D-219.

EFH Description GOA Flathead Sole

Eggs
EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-132.

Larvae
EFH for larval flathead sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-133.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile flathead sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-220.

Adults
EFH for adult flathead sole is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-220.

EFH Description for GOA Sablefish

Eggs
EFH for sablefish eggs is the general distribution area for this life stage, located in deeper waters along the slope (200 to 3,000 m) throughout the GOA in the spring, as depicted in Figure D-135.

Larvae
EFH for larval sablefish is the general distribution area for this life stage, located in epipelagic waters along the middle shelf (50 to 100 m), outer shelf (100 to 200 m), and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-136.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile sablefish is the known concentration area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-221.

Adults
EFH for adult sablefish is the known concentration area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the GOA, as depicted in Figure D-221.

EFH Description for GOA Pacific Ocean Perch

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure D-138.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific ocean perch is the known concentration area for this life stage, located in the middle to lower portion of the water column along the inner shelf (1 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-222.

Adults
EFH for adult Pacific ocean perch is the known concentration area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-222.

EFH Descriptions for GOA Shortraker and Rougheye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult shortraker and rougheye rockfish is the known concentration area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) regions throughout the GOA wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure D-223.

EFH Description for GOA Northern Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult northern rockfish is the known concentration area for this life stage, located in the middle and lower portions of the water column along the outer slope (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of cobble and rock, as depicted in Figure D-224.

EFH Description for GOA Thornyhead Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval thornyhead rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Thornyhead rockfish is the known concentration area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-225.

Adults
EFH for adult Thornyhead rockfish is the known concentration area for this life stage, located in the known concentration area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-225.

EFH Definition for GOA Yelloweye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval yelloweye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Yelloweye rockfish is the known concentration area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-226

Adults
EFH for adult Yelloweye rockfish is the known concentration area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-226.

EFH Description for GOA Dusky Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae

EFH for larval dusky rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure D-138.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult Dusky rockfish is the known concentration area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of cobble, rock, and gravel, as depicted in Figure D-227.

EFH Description for GOA Atka Mackerel

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval atka mackerel is the general distribution area for this life stage, located in epipelagic waters along the shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-145.

Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult Atka mackerel is the known concentration area for this life stage, located in the entire water column, from sea surface to the sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of gravel and rock and in vegetated areas of kelp, as depicted in Figure D-228.

EFH Description for GOA Sculpins

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae—No EFH Description Determined

Insufficient information is available.

Juveniles

EFH for adult sculpins is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-229.

Adults
EFH for adult sculpins is the known concentration area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-229.

EFH Description for GOA Skates

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult skates is the known concentration area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) throughout the GOA wherever there are of substrates of mud, sand, gravel, and rock, as depicted in Figure D-230.

EFH Description for GOA Sharks

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for GOA Forage Fish Complex—Eulachon, Capelin, Sand Lance, Sand Fish, Euphausiids, Myctophids, Pholids, Gonostomatids, etc.

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults. No EFH Description Determined
Insufficient information is available.

EFH Description for GOA Squid

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for older juvenile squid is the known concentration area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-231.

Adults
EFH for adult squid is the known concentration area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the GOA, as depicted in Figure D-231.

EFH Description for GOA Octopus

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

D.4.2.3 EFH Map Descriptions for GOA Groundfish

Figures D-212 through D-231 show EFH distribution under Alternative 4 for the GOA groundfish species as described in Section D.4.2.2.

D.4.3 Description of Essential Fish Habitat for BSAI King and Tanner Crab

D.4.3.1 Highest Known EFH Information Levels for BSAI Crab

BSAI Crab Species	Egg	Larvae	Early Juvenile	Late Juvenile	Adult
Red king crab	inferred	x	x	2	2
Blue king crab	inferred	x	x	2	2
Golden king crab	inferred	x	x	2	2
Tanner crab	inferred	x	x	2	2
Snow crab	inferred	x	x	2	2

x - No information available.

D.4.3.2 EFH Text Descriptions for BSAI Crab

EFH Description for BSAI Red King Crab

Eggs
Essential fish habitat of the red king crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile red king crab is the known concentration area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel and biogenic structures such as boltenia, bryozoans, ascidians, and shell hash, as depicted in Figure D-232.

Adults
EFH for adult red king crab is the known concentration area for this life stage, located in bottom habitats along the nearshore (spawning aggregations) and the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand, mud, cobble, and gravel, as depicted in Figure D-232.

EFH Description for BSAI Blue King Crab

Eggs
Essential fish habitat of the blue king crab eggs is inferred from the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile blue king crab is the known concentration area for this life stage, located in bottom habitats along the nearshore where there are rocky areas with shell hash and the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel, as depicted in Figure D-233.

Adults
EFH for adult blue king crab is the known concentration area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand and mud adjacent to rockier areas and areas of shell hash, as depicted in Figure D-233.

EFH Description for BSAI Golden King Crab

Eggs
Essential fish habitat of golden king crab eggs is inferred from the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile golden king crab is the known concentration area for this life stage, located in bottom habitats along the along the upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high-relief living habitats, such as coral, and vertical substrates, such as boulders, vertical walls, ledges, and deep water pinnacles, as depicted in Figure D-234.

Adults
EFH for adult golden king crab is the known concentration area for this life stage, located in bottom habitats along the along the outer shelf (100 to 200 m), upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high-relief living habitats, such as coral, and vertical substrates such as boulders, vertical walls, ledges, and deep water pinnacles, as depicted in Figure D-234.

EFH Description for BSAI Tanner Crab

Eggs
Essential fish habitat of Tanner crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Tanner crab is the known concentration area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-235.

Adults
EFH for adult Tanner crab is the known concentration area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-235.

EFH Description for BSAI Snow Crab

Eggs
Essential fish habitat of snow crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile snow crab is the known concentration area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-236.

Adults
EFH for adult snow crab is the known concentration area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-236.

D.4.3.3 EFH Map Descriptions for BSAI Crab

Figures D-232 to D-236 show EFH distribution under Alternative 4 for the BSAI crab species as described in Section D.4.3.2.

D.4.4 Description of Essential Fish Habitat for Alaska Scallops

D.4.4.1 Highest Known EFH Information Levels for Alaska Scallops

Scallop Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Weathervane scallop	x	x	x	2	2

x - No information available.

D.4.4.2 EFH Text Descriptions for Alaska Scallops

EFH Description for Weathervane Scallops

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile weathervane scallops is the known concentration area for this life stage, located in the sea floor along the middle (50 to 100 m) and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow, as depicted in Figure D-237.

Adults
EFH for adult weathervane scallops is the known concentration area for this life stage, located in the sea floor along the middle (50 to 100 m) and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow, as depicted in Figure D-237.

EFH Description for Other Species of Scallops

Information is insufficient or lacking to describe EFH for any life stage of pink, spiny, and rock scallops.

D.4.4.3 EFH Map Descriptions for Weathervane Scallops

Figure D-237 shows the EFH distribution under Alternative 4 for weathervane scallops.

D.4.5 Description of Essential Fish Habitat for Alaska Stocks of Pacific Salmon

D.4.5.1 Highest Known EFH Information Levels for Alaska Stocks of Pacific Salmon

Salmon Species	Freshwater Eggs	Freshwater Larvae and Juveniles	Estuarine Juveniles	Marine Juveniles	Marine Immature and Maturing Adults	Freshwater Adults
Pink	3	1	1	1	1	3
Chum	3	1	1	1	1	3
Sockeye	3	1	1	1	1	3
Chinook	3	1	1	1	1	3
Coho	3	1	1	1	1	3

D.4.5.2 EFH Text Descriptions for Alaska Stocks of Pacific Salmon

EFH Description for Pink Salmon

Freshwater Eggs
EFH for pink salmon eggs is the known concentration area of adult spawning areas, consisting of gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a).

Freshwater Larvae and Juveniles
EFH for larval and juvenile pink salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water during the spring, generally migrate in darkness in the upper water column. Fry leave streams within 1 to 15 days and the duration of migration from a stream towards sea may last 2 months.

Estuarine Juveniles
Estuarine EFH for juvenile pink salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters and generally present from late April through June.

Marine Juveniles
Marine EFH for juvenile pink salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Marine Immature and Maturing Adults
EFH for immature and maturing adult pink salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Mature adult pink salmon frequently spawn in intertidal areas and are known to associate with smaller coastal streams.

Freshwater Adults

EFH for pink salmon is the known concentration of adult spawning areas, located in freshwaters as identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter), 15 to 50 cm in depth from June through September.

EFH Description for Chum Salmon

Freshwater Eggs

EFH for chum salmon eggs is the known concentration area of adult spawning areas, consisting of gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a).

Freshwater Larvae and Juveniles

EFH for larval and juvenile chum salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water and contiguous rearing areas within the boundaries of ordinary high water during the spring. Chum salmon generally migrate in darkness in the upper water column. Fry leave streams within 15 days and the duration of migration from a stream towards sea may last 2 months.

Estuarine Juveniles

Estuarine EFH for juvenile chum salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters from late April through June.

Marine Juveniles

Marine EFH for juvenile chum salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to approximately 50 m in depth from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Marine Immature and Maturing Adults

EFH for immature and maturing adult chum salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and ranging from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Freshwater Adults

EFH for chum salmon is the known concentration of adult spawning areas, located in freshwaters as identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter) and finer substrates can be used in upwelling areas of streams and sloughs from June through January.

EFH Description for Sockeye Salmon

Freshwater Eggs

EFH for sockeye salmon eggs is the known concentration area of adult spawning areas, consisting of gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a).

Freshwater Larvae and Juveniles

EFH for larval and juvenile sockeye salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Juvenile sockeye salmon require year-round rearing habitat. Fry generally migrate downstream to a lake or, in systems lacking a freshwater lake, to estuarine and riverine rearing areas for up to 2 years. Fry outmigration occurs from approximately April to November and smolts generally migrate during the spring and summer.

Estuarine Juveniles

Estuarine EFH for juvenile scokeye salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Under-yearling, yearling, and older smolts occupy estuaries from March through early August.

Marine Juveniles

Marine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to depths of 50 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean from mid-summer until December of their first year at sea.

Marine Immature and Maturing Adults

EFH for immature and maturing adult sockeye salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Freshwater Adults

EFH for sockeye salmon is the known concentration of adult spawning areas, located in freshwaters as identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter) and finer substrates can be used in upwelling areas of streams and sloughs from June through September. Sockeye often spawn in lake substrates as well as in streams.

EFH Description for Chinook Salmon

Freshwater Eggs

EFH for chinook salmon eggs is the known concentration area of adult spawning areas, consisting of gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a).

Freshwater Larvae and Juveniles

EFH for larval and juvenile chinook salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Juvenile chinook salmon out migrate from freshwater areas in April toward sea and may spend up to a year in major tributaries or rivers, such as the Kenai, Yukon, Taku, and Copper Rivers.

Estuarine Juveniles

Estuarine EFH for juvenile chinook salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Chinook salmon smolts and post-smolt juveniles may be present in these estuarine habitats from April through September.

Marine Juveniles

Marine EFH for juvenile chinook salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean. Juvenile marine chinook salmon are at this life stage from April until annulus formation in January or February during their first winter at sea.

Marine Immature and Maturing Adults

EFH for immature and maturing adult chinook salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska and ranging from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Freshwater Adults

EFH for adult chinook salmon is the known concentration of adult spawning areas, located in freshwaters as identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) wherever there are spawning substrates consisting of gravels from April through September.

EFH Description for Coho Salmon

Freshwater Eggs

EFH for coho salmon eggs is the known concentration area of adult spawning areas, consisting of gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a).

Freshwater Larvae and Juveniles

EFH for larval and juvenile coho salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Fry generally migrate to a lake, slough, or estuary and rear in these areas for up to 2 years.

Estuarine Juveniles

Estuarine EFH for juvenile coho salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.

Marine Juveniles
Marine EFH for juvenile coho salmon is all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Marine Immature and Maturing Adults
EFH for immature and maturing adult coho salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to 200 m in depth and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean.

Freshwater Adults
EFH for coho salmon is the known concentration of adult spawning areas, located in freshwaters as identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting mainly of gravel containing less than 15 percent fine sediment (less than 2-mm diameter) from July to December.

D.4.5.3 EFH Map Descriptions for Alaska Stocks of Pacific Salmon

Figures D-238 through D-267 show EFH distribution under Alternative 4 by region for the Alaska stocks of Pacific salmon as described in Section D.4.5.2.

D.5 Alternative 5—Eco-region Strategy

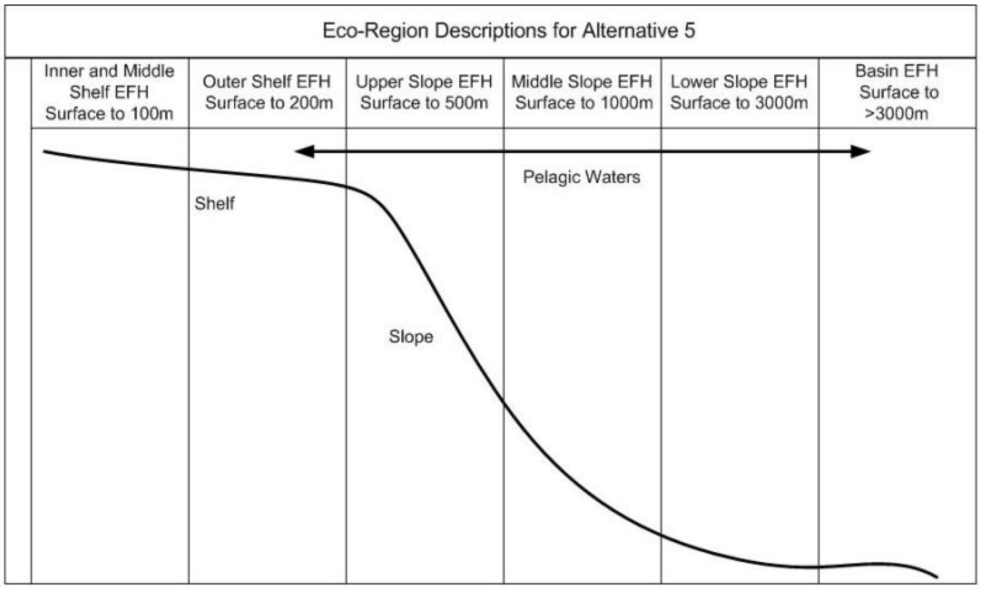
Under this alternative, EFH is described for all life history stages for all species listed within these eight eco-regions (freshwater, nearshore and estuarine, inner and middle shelf, outer shelf, upper slope, middle slope, lower slope, and basin) by characterizing the species that use each eco-region and the habitat types present. The eco-region description of EFH consists of:

- A description of species association within the eco-region, which may lead to finer habitat definitions;
- A description of the range of physical bottom habitat characteristics from available information, if any; and
- An index that links species by habitat type (to satisfy the requirement in the final rule for a species by species EFH description).

Objective
The objective of this alternative is to describe EFH using an ecosystem approach relating the physical, oceanographic, and biological environments to describe EFH as areas containing many species and their associated habitats. EFH Descriptions general distributions, depth, substrate, water circulation patterns, temperature, predator-prey relationships, and other characteristics of the BSAI and GOA for any life stage of the species, if known.

Rationale
This alternative will describe EFH as broad areas for all life stages of the species (discrete areas will not be described as EFH), thereby incorporating uncertainty relative to habitat use by individual FMP species.

Methodology
The North Pacific Ocean, EBS, Chukchi Sea, and Beaufort Sea are broken into three sub-regions as the GOA, EBS, and AI. Each sub-region is analyzed using best scientific information and other sources of information such as the Ecosystem SAFE Reports for each FMP. EFH is then described listing those characteristics of the sub-area.



D.5.1 EFH Text Descriptions for EBS, AI, and GOA Eco-Regions

Freshwater Ecosystem

EFH for the freshwater ecosystem is those waters and substrate necessary for all freshwater life history stages of anadromous fish, specifically salmon. Freshwater areas described for salmonids are as identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a). There are over 15,000 anadromous waters catalogued in this atlas.

Freshwater EFH provides habitat for spawning and rearing of anadromous fish species, including salmon and eulachon.

EFH Habitat Domain		Freshwater EFH Species	Life History Stage
Ecosystem:	Freshwater	Chinook salmon	Eggs, Juveniles, Adults
Ecoregion:	BSAI; GOA	Coho salmon	Eggs, Juveniles, Adults
Habitat Type:	Riverine	Pink salmon	Eggs, Juveniles, Adults
Habitat Modifiers		Sockeye salmon	Eggs, Juveniles, Adults
Depth Range:	N/A	Chum salmon	Eggs, Juveniles, Adults
Substrate:	Gravel; sand; mud; cobble	Eulachon	Eggs, Juveniles, Adults
Structure:	Flow; organic debris		

Nearshore and Estuarine Ecosystem

EFH in nearshore and estuarine ecosystem is those waters and substrate from the surface to and including the sea floor. EFH species are listed below for this domain. Estuarine areas are those areas measured by water quality parameters such as salinity and meeting the following general criteria:

- A partly enclosed tidal inlet of the sea in which seawater and river water mix to some degree
- Any embayment or partially enclosed body of water that opens to the ocean somewhere and (normally) also has some freshwater inflow
- A semi-enclosed coastal body of water that has a free connection with the open sea and within which seawater is measurably diluted with fresh water

Estuarine EFH provides habitat for juvenile life history stages and adult EFH species, such as rearing areas, migratory corridors, maturing areas, and spawning habitats.

EFH Habitat Domain	
Ecosystem:	Nearshore and estuarine
Ecoregion:	BSAI; GOA
Habitat Type:	Intertidal
Habitat Modifiers	
Depth Range:	High tide to 3 m
Substrate:	Rock, sand, gravel, mud, organic debris
Structure:	Living structure: eelgrass, kelp, rockweed Non-living bio-structure: shell hash

Roundfish	**Flatfish**	**Rockfish**	**Crab**	**Other**
Pacific Cod 1	Yellowfin sole 1	Thornyhead 1,3	Blue king crab 1,3	Sculpins
*Atka mackerel	Rock sole 1	Yelloweye 1,3	Red king crab 1,3	*Squid
*Walleye pollock	Arrowtooth flounder 1	Dusky 1,3	Snow crab	Octopus
Sablefish		Copper 1,3		*Forage fish
*Chinook salmon 1,2		Northern 1,3		
*Coho salmon 1,2				
*Pink salmon 1,2				
*Sockeye salmon 1,2				
*Chum salmon 1,2				

1 Juvenile area
2 Adult and juvenile seasonal migratory or spawning areas
3 Adult nearshore area
* Species is pelagic or semi-demersal.

Inner and Middle Shelf Ecosystem

EFH for the inner and middle continental shelf is those waters and substrate, within this depth range, from the surface to and including the benthos. EFH species are listed below for this domain.

EFH for the inner and middle continental shelf is those waters and substrate, within this depth range, from the surface to and including the benthos. EFH species are listed below for this domain.

EFH Habitat Domain	
Ecosystem:	Marine
Ecoregion:	BS/AI; GOA
Habitat Type:	Shallows; banks
Habitat Modifiers	
Depth Range:	0 to 100 m
Substrate:	Gravel, mud, sand, pebble, rock, organic debris
Structure:	Living structure: eelgrass, kelps, soft corals, anemones, sea pens Non-living bio-structure: shell hash

Roundfish	**Flatfish**	**Rockfish**	**Crab**	**Scallop**	**Other**
Pacific Cod	Arrowtooth flounder	Thornyhead	Blue king crab	Weathervane	Sculpins
*Atka mackerel	Flathead sole	Yelloweye	Red king crab		*Squid
*Walleye pollock	Yellowfin sole		Snow crab		*Sharks
	Rock sole				Octopus
*Chinook salmon	Rex sole				*Forage fish
*Coho salmon	Alaska plaice				
*Pink salmon	Dover sole				
*Sockeye salmon					
*Chum salmon					

*Species is pelagic or semi-demersal.

Outer Shelf Ecosystem

EFH for the outer continental shelf is those waters and substrate, within this depth range, from the surface to and including the sea floor. EFH species are listed below for this domain.

EFH Habitat Domain	
Ecosystem:	Marine
Ecoregion:	BSAI; GOA
Habitat Type:	Shallows, gullies, flats
Habitat Modifiers	
Depth Range:	0 to 200 m
Substrate:	Gravel, mud, sand, pebble, rock
Structure:	Living structure: soft corals, hard corals, anemones, sea pens Non-living bio-structure: shell hash

Roundfish	**Flatfish**	**Rockfish**	**Crab**	**Scallop**	**Other**
Pacific Cod	Arrowtooth flounder	Dusky	Blue king crab	Weathervane	Sculpins
*Atka mackerel	Flathead sole	Pacific ocean perch	Red king crab		*Squid
*Walleye pollock	Yellowfin sole	Thornyhead	Snow crab		*Sharks
	Rock sole	Yelloweye	Golden king crab		Octopus
*Chinook salmon	Rex sole	Northern	Grooved Tanner crab		Forage fish
*Coho salmon		Shortraker	Scarlet king crab		
*Pink salmon	Dover sole	Rougheye	Triangle tanner crab		
*Sockeye salmon	Greenland turbot				
*Chum salmon					

*Species is pelagic or semi-demersal.

Upper Slope Ecosystem

EFH is the upper slope is those waters and substrate, within this depth range, from the surface to and including the benthos. EFH species are listed below for this domain.

EFH Habitat Domain

Ecosystem: Marine
Ecoregion: BSAI; GOA
Habitat Type: Gullies, flats, edge, deep gullies, slopes
Habitat Modifiers
  Depth Range: 0 to 500 m
  Substrate: Gravel, mud, sand, pebble, rock
  Structure: Living structure: soft corals, hard corals, anemones, sea pens
    Non-living bio-structure: shell hash

Roundfish	**Flatfish**	**Rockfish**	**Crab**	**Scallop**	**Other**
Sablefish	Arrowtooth flounder	Thornyhead	Red king crab		Sculpins
*Salmonids Chinook Coho Pink Sockeye Chum	Rex sole	Yelloweye	Snow crab		Skates
*Walleye pollock	Greenland turbot	Dusky	Golden king crab		*Sharks
	Dover sole	Northern	Grooved Tanner crab		Octopus
		Pacific ocean perch	Scarlett king crab Triangle tanner crab		*Forage fish
		Shortraker Rougheye			

*Species is pelagic or semi-demersal.

Middle Slope Ecosystem

EFH for the middle slope is those waters and substrate, within this depth range, from the surface to and including the sea floor. EFH species are listed below for this domain.

EFH Habitat Domain	
Ecosystem:	Marine
Ecoregion:	BSAI; GOA
Habitat Type:	Slopes
Habitat Modifiers	
Depth Range:	0 to 1,000 m
Substrate:	Gravel, mud, sand, pebble, rock
Structure:	Living structure: deep water corals, sea pens Non-living bio-structure: shell hash

Roundfish	**Flatfish**	**Rockfish**	**Crab**	**Scallop**	**Other**
Sablefish	Arrowtooth flounder	Thornyhead	Snow crab		Sculpins
*Walleye pollock	Rex sole	Yelloweye	Golden king crab		Skates
*Chinook salmon	Greenland turbot	Dusky	Grooved Tanner crab		*Sharks
*Coho salmon		Northern	Scarlett king crab		Octopus
*Pink salmon		Pacific ocean perch	Triangle tanner crab		*Forage fish
* Sockeye salmon		Shortraker			*Squid
*Chum salmon		Rougheye			

*Species is pelagic or semi-demersal.

Lower Slope Ecosystem

EFH in the lower slope is those waters and substrate, within this depth range, from the surface to and including the sea floor. EFH species are listed below for this domain.

EFH Habitat Domain	
Ecosystem:	Marine
Ecoregion:	BSAI; GOA
Habitat Type:	Slopes
Habitat Modifiers	
Depth Range:	0 to 3,000 m
Substrate:	Gravel, mud, sand, boulder, bedrock
Structure:	Living structure: deep water corals, Non-living bio-structure: shell hash, carcasses

Roundfish	**Flatfish**	**Rockfish**	**Crab**	**Scallop**	**Other**
Sablefish	Greenland turbot	Thornyhead	Snow crab		*Squid
*Salmonids			Golden king crab		
Chinook					
Coho					
Pink					
Sockeye					
Chum					
*Walleye pollock			Grooved Tanner crab		
			Scarlett king crab		
			Triangle tanner crab		

*Species is pelagic or semi-demersal.

Basin Ecosystem

EFH in the basin is those waters and substrate, within this depth range, from the surface to and including the sea floor. EFH species are listed below for this domain.

EFH Habitat Domain

Ecosystem:	Marine
Ecoregion:	BSAI; GOA
Habitat Type:	Basin
Habitat Modifiers	
Depth Range:	0 to more than 3,000 m
Substrate:	Mud, boulder, bedrock
Structure:	Living structure: N/A Non-living bio-structure: N/A

Roundfish	**Flatfish**	**Rockfish**	**Crab**	**Scallop**	**Other**
*Walleye pollock			Snow crab Golden king crab Grooved Tanner crab Scarlett king crab Triangle tanner crab		*Squid

*Species is pelagic or semi-demersal.

D.5.2 EFH Map Descriptions for Alaska Marine Ecosystem, BSAI, Marine Ecosystem, and GOA Marine Ecosystem

Figures D-268 through D-280 show EFH distribution under Alternative 5 for all marine species. There are three maps for each of the six marine eco-regions—one for the Alaska marine ecosystem as a whole, one for the BSAI marine ecosystem, and one for the GOA marine ecosystem.

D.6 Alternative 6—EFH is Described in Waters of the EEZ Only (3 to 200 nm)

EFH will be identified and described using the updated general distribution description criteria (i.e., Alternative 3 language), but would be identified and described only within the EEZ. In other words, the FMPs would be amended to remove any reference to EFH descriptions that include freshwater areas and other areas regulated by the State of Alaska (generally described as those waters between the 0 to 3-nm range from shore plus waters of Upper Cook Inlet, Prince William Sound, and portions of southeast Alaska).

Objective
The objective of this alternative is to describe EFH for each particular life stage using analytical tools and updated scientific information for only those waters and substrates in the EEZ where the species is known to associate or recruit in scientific survey and commercial fishery catches. EFH is described as 95 percent of the EEZ where the species life stage has been recruited to the survey, investigated through research, officially observed, or reported in a vessel catch log.

Methodology

In addition to scientific information sources analyzed in Alternative 2, the Alternative 3 analysis focused on two significant fishery geographic information data resources: survey (Resource Assessment and Conservation Engineering Division [RACE]) and observer (NORPAC). For adult and late juvenile life stages, each data set was analyzed for 95 percent of the total accumulated population for the species using GIS. For eggs and larvae, the EFH description is based on presence/absence data from surveys (AFSC RACE Matarese 2003). EFH is identified as the areas where eggs and larvae are most commonly encountered in those surveys, which is the best available information regarding habitat use for those life stages. EFH shape files were developed based on these data sets.

For adult and late juvenile life stages of BSAI Groundfish, GOA Groundfish, BSAI Crab, and Scallop FMP species, fishery catch per unit of effort (CPUE) data from the NMFS Observer database (NORPAC, 1990 to 2001) and NMFS trawl survey data from RACE, 1987 to 2002 and, where appropriate, ADF&G survey data were analyzed to estimate the population distribution of each species. Where this information exists, the area described by these data is identified as EFH. The analyzed EFH data and area were further reviewed by scientific stock assessment authors for accuracy. This review ensures that any outlying areas not considered were included, and errors in the data or described EFH area were removed.

For Salmon FMP species, the analysis is broken into three parts: marine, nearshore, and freshwater. Under Alternative 6, only the marine portion of their life stage would be described as EFH. The nearshore areas used by juveniles and freshwater areas used by egg, larvae, and returning adult salmon would not be included as they are not within the EEZ. Marine areas are generally described as those marine waters from the mean higher high tide line seaward to the limits of the EEZ.

Rationale
Similar to Alternatives 2 and 3, Alternative 6 incorporates the basic rationales to describe EFH as General Distribution.

D.6.1 Description of Essential Fish Habitat for the Groundfish Resources of the BSAI Regions (only the EEZ [3 to 200 nm] portion of the BSAI is described as EFH)

D.6.1.1 EFH Information Levels for BSAI Groundfish

BSAI Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Walleye pollock	1	1	x	1	1
Pacific cod	x	1	x	1	1
Yellowfin sole	x	x	x	1	1
Greenland turbot	1	1	x	1	1
Arrowtooth flounder	x	x	x	1	1
Rock sole	x	1	x	1	1
Alaska plaice	x	x	x	1	1
Rex sole	x	x	x	1	1
Dover sole	x	x	x	1	1
Flathead sole	1	1	x	1	1
Sablefish	x	1	x	1	1
Pacific ocean perch	x	1	x	1	1
Shortraker/rougheye	x	1	x	x	1
Northern rockfish	x	1	x	x	1
Thornyhead rockfish	x	1	x	1	1
Yelloweye rockfish	x	1	x	1	1
Dusky rockfish	x	1	x	x	1
Atka mackerel	x	1	x	x	1
Skates	x	x	x	x	1
Sculpins	x	x	x	1	1
Sharks	x	x	x	1	1
Forage fish complex	x	x	x	x	x
Squid	x	x	x	1	1
Octopus	x	x	x	x	x

x - No information available.

D.6.1.2 EFH Text Descriptions for BSAI Groundfish

EFH Description for BSAI Walleye Pollock

Eggs
EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-281.

Larvae
EFH for larval walleye pollock is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-282.

Early Juveniles—No EFH Description Determined
Limited information exists to describe walleye pollock early juvenile larval general distribution; however, the data cannot be analyzed in the same manner as directed by the approach for Alternative 3.

Late Juveniles
EFH for late juvenile walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI, as depicted in Figure D-283. No known preference for substrates exist.

Adults
EFH for adult walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the entire shelf (0 to 200 m) and slope (200 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-283. No known preference for substrates exist.

EFH Description for BSAI Pacific Cod

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of Pacific cod eggs in the BSAI.

Larvae
EFH for larval Pacific cod is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-284.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, and muddy sand, as depicted in Figure D-285.

Adults
EFH for adult Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, muddy sand, and gravel, as depicted in Figure D-285.

EFH Description for BSAI Yellowfin Sole

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of yellowfin sole eggs in the BSAI.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval yellowfin sole in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m) and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-286.

Adults
EFH for adult yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-286.

EFH Description for BSAI Greenland Turbot

Eggs
EFH for Greenland turbot eggs is the general distribution area for this life stage, located principally in benthypelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI in the fall, as depicted in Figure D-287.

Larvae
EFH for larval Greenland turbot is the general distribution area for this life stage, located principally in benthypelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI and seasonally abundant in the spring, as depicted in Figure D-288.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Greenland turbot is the general distribution area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are softer substrates consisting of mud and sandy mud, as depicted in Figure D-289.

Adults
EFH for late adult Greenland turbot is the general distribution area for this life stage, located in the lower and middle portion of the water column along the outer shelf (100 to 200 m), upper slope (200 to 500 m), and lower slope (500 to 1,000 m) limited to the EEZ of the BSAI wherever there are softer substrates consisting of mud and sandy mud, as depicted in Figure D-289.

EFH Description for BSAI Arrowtooth Flounder

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval arrowtooth flounder in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-290.

Adults
EFH for adult arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-290.

EFH Description for BSAI Rock Sole

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-291.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-292.

Adults
EFH for adult rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-292.

EFH Description for BSAI Alaska Plaice

Eggs
EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the BSAI in the spring, as depicted in Figure D-293.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval Alaska plaice in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-294.

Adults
EFH for adult Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-294.

EFH Description for BSAI Rex Sole

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of rex sole eggs in the BSAI.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval rex sole in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-295.

Adults
EFH for adult rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-295.

EFH Description for BSAI Dover Sole

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of Dover sole eggs in the BSAI.

Larvae—No EFH Description Determined
Scientific information notes the rare occurrence of larval Dover sole in the BSAI.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates consisting of sand and mud, as depicted in Figure D-296.

Adults
EFH for adult Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates consisting of sand and mud, as depicted in Figure D-296.

EFH Description BSAI Flathead Sole

Eggs
EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI in the spring, as depicted in Figure D-297.

Larvae
EFH for larval flathead sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-298.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-299.

Adults
EFH for adult flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-299.

EFH Description for BSAI Sablefish

Eggs—No EFH Description Determined
Scientific information notes the rare occurrence of sablefish eggs in the BSAI.

Larvae
EFH for larval sablefish is the general distribution area for this life stage, located in epipelagic waters along the middle shelf (50 to 100 m), outer shelf (100 to 200 m), and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-300.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-301.

Adults
EFH for adult sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-301.

EFH Description for BSAI Pacific Ocean Perch

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval Pacific ocean perch is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-302, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (1 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-303.

Adults
EFH for adult Pacific ocean perch is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-303.

EFH Descriptions for BSAI Shortraker and Rougheye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-302, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult shortraker and rougheye rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) regions limited to the EEZ of the BSAI wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure D-304.

EFH Description for BSAI Northern Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-302, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult northern rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer slope (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates of cobble and rock, as depicted in Figure D-305.

EFH Description for BSAI Thornyhead Rockfish

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval thornyhead rockfish is the general distribution area for this life stage, located in epipelagic waters along the outer shelf (100 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-302, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile Thornyhead rockfish is the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) limited to the EEZ of the BSAI wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-306.

Adults

EFH for adult Thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) limited to the EEZ of the BSAI wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-306.

EFH Definition for BSAI Yelloweye Rockfish

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval yelloweye rockfish is the general distribution area for this life stage, located in the epipelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-302, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile Yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-307.

Adults

EFH for adult Yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the

GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-307.

EFH Description for BSAI Dusky Rockfish

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae

EFH for larval dusky rockfish is the general distribution area for this life stage, located in the pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-302, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined

Insufficient information is available.

Late Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult Dusky rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates of cobble, rock, and gravel, as depicted in Figure D-308.

EFH Description for BSAI Atka Mackerel

Larvae

EFH for larval atka mackerel is the general distribution area for this life stage, located in epipelagic waters along the shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-309.

Early Juveniles —No EFH Description Determined

Insufficient information is available.

Late Juveniles—No EFH Description Determined

Insufficient information is available.

Adults

EFH for adult Atka mackerel is the general distribution area for this life stage, located in the entire water column, from sea surface to the sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates of gravel and rock and in vegetated areas of kelp, as depicted in Figure D-310.

EFH Description for BSAI Sculpins

Eggs—No EFH Description Determined

Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Juveniles
EFH for juvenile sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-311.

Adults
EFH for adult sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-311.

EFH Description for BSAI Skates

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult skates is the general distribution area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) limited to the EEZ of the BSAI wherever there are of substrates of mud, sand, gravel, and rock, as depicted in Figure D-312.

EFH Description for BSAI Sharks

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for BSAI Forage Fish Complex—Eulachon, Capelin, Sand Lance, Sand Fish, Euphausiids, Myctophids, Pholids, Gonostomatids, etc.

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for BSAI Squid

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for older juvenile squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-313.

Adults
EFH for adult squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) limited to the EEZ of the BSAI, as depicted in Figure D-313.

EFH Description for BSAI Octopus

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

D.6.1.3 EFH Map Descriptions for BSAI Groundfish

Figures D-281 through D-313 show EFH distribution under Alternative 6 for the BSAI groundfish species as described in Section D.6.1.2.

D.6.2 Description of Essential Fish Habitat for the Groundfish Resources of the GOA Region (only the EEZ [3 to 200 nm] portion of the GOA is described as EFH)

D.6.2.1 EFH Information Levels for GOA Groundfish

GOA Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Walleye pollock	1	1	x	1	1
Pacific cod	1	1	x	1	1
Yellowfin sole	1	1	x	1	1
Arrowtooth flounder	x	1	x	1	1
Rock sole	x	1	x	1	1
Alaska plaice	1	1	x	1	1
Rex sole	1	1	x	1	1
Dover sole	1	1	x	1	1
Flathead sole	1	1	x	1	1
Sablefish	1	1	x	1	1
Pacific ocean perch	x	1	x	1	1
Shortraker/rougheye	x	1	x	x	1
Northern rockfish	x	1	x	x	1
Thornyhead rockfish	x	1	x	1	1
Yelloweye rockfish	x	1	x	1	1
Dusky rockfish	x	1	x	x	1
Atka mackerel	x	1	x	x	1
Sculpins	x	x	x	1	1
Skates	x	x	x	x	1
Sharks	x	x	x	x	1
Forage fish complex	x	x	x	x	x
Squid	x	x	x	1	1
Octopus	x	x	x	x	x

x - No information available.

D.6.2.2 EFH Text Descriptions for GOA Groundfish

EFH Description for GOA Walleye Pollock

Eggs
EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-314.

Larvae
EFH for larval walleye pollock is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-315.

Early Juveniles—No EFH Description Determined
Limited information exists to describe walleye pollock early juvenile larval general distribution; however, the data cannot be analyzed in the same manner as directed by the approach for Alternative 3.

Late Juveniles
EFH for late juvenile walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf along the limited to the EEZ of the GOA, as depicted in Figure D-316. No known preference for substrates exist.

Adults
EFH for adult walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the entire shelf (0 to 200 m) and slope (200 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-316. No known preference for substrates exist.

EFH Description for GOA Pacific Cod

Eggs
EFH for Pacific cod eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper (200 to 500 m) slope limited to the EEZ of the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure D-317.

Larvae
EFH for larval Pacific cod is the general distribution area for this life stage, located in pelagic waters along the inner (0 to 50 m) and middle (50 to 100 m) shelf limited to the EEZ of the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure D-318.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, and muddy sand, as depicted in Figure D-319.

Adults
EFH for adult Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the GOA wherever there are soft substrates consisting of sand, mud, sandy mud, muddy sand, and gravel, as depicted in Figure D-319.

EFH Description for GOA Yellowfin Sole

Eggs
EFH for yellowfin sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper (200 to 500 m) slope limited to the EEZ of the GOA, as depicted in Figure D-320.

Larvae
EFH for larval yellowfin sole is the general distribution area for this life stage, located in pelagic waters along the shelf (0 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA, as depicted in Figure D-321.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m) and outer (100 to 200 m) shelf limited to the EEZ of the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-322.

Adults
EFH for adult yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure D-322.

EFH Description for GOA Arrowtooth Flounder

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval arrowtooth flounder is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-323.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to

200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-324.

Adults
EFH for adult arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure D-324.

EFH Description for GOA Rock Sole

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-325.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-326.

Adults
EFH for adult rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure D-326.

EFH Description for GOA Alaska Plaice

Eggs
EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA in the spring, as depicted in Figure D-327.

Larvae
EFH for larval Alaska plaice is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA, as depicted in Figure D-328.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-329.

Adults
EFH for adult Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-329.

EFH Description for GOA Rex Sole

Eggs
EFH for rex sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA in the spring, as depicted in Figure D-330.

Larvae
EFH for larval rex sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA, as depicted in Figure D-331.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-332.

Adults
EFH for adult rex sole is the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure D-332.

EFH Description for GOA Dover Sole

Eggs
EFH for Dover sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-333.

Larvae
EFH for larval Dover sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-334.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure D-335.

Adults
EFH for adult Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m) and outer (100 to 200 m) shelf and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure D-335.

EFH Description GOA Flathead Sole

Eggs
EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-336.

Larvae
EFH for larval flathead sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-337.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for juvenile flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-338.

Adults
EFH for adult flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf limited to the EEZ of the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure D-338.

EFH Description for GOA Sablefish

Eggs
EFH for sablefish eggs is the general distribution area for this life stage, located in deeper waters along the slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-339.

Larvae
EFH for larval sablefish is the general distribution area for this life stage, located in epipelagic waters along the middle shelf (50 to 100 m), outer shelf (100 to 200 m), and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-340.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-341.

Adults
EFH for adult sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-341.

EFH Description for GOA Pacific Ocean Perch

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-342.

Adults
EFH for adult Pacific ocean perch is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure D-342.

EFH Descriptions for GOA Shortraker and Rougheye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-343, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult shortraker and rougheye rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) regions limited to the EEZ of the GOA wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure D-344.

EFH Description for GOA Northern Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-343, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult northern rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer slope (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates of cobble and rock, as depicted in Figure D-345.

EFH Description for GOA Thornyhead Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval thornyhead rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-343, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) limited to the EEZ of the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-346.

Adults
EFH for adult thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) limited to the EEZ of the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure D-346.

EFH Definition for GOA Yelloweye Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval yelloweye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-343, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-347.

Adults
EFH for adult yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure D-347.

EFH Description for GOA Dusky Rockfish

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval dusky rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) limited to the EEZ of the GOA, as depicted in Figure D-343, General Distribution of Rockfish Larvae.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult Dusky rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates of cobble, rock, and gravel, as depicted in Figure D-348.

EFH Description for GOA Atka Mackerel

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae
EFH for larval atka mackerel is the general distribution area for this life stage, located in epipelagic waters along the shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-349.

Early Juveniles —No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult Atka mackerel is the general distribution area for this life stage, located in the entire water column, from sea surface to the sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the GOA wherever there are substrates of gravel and rock and in vegetated areas of kelp, as depicted in Figure D-350.

EFH Description for GOA Sculpins

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Juveniles
EFH for juvenile sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and

portions of the upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-351.

Adults
EFH for adult sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure D-351.

EFH Description for GOA Skates

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults
EFH for adult skates is the general distribution area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) limited to the EEZ of the GOA wherever there are of substrates of mud, sand, gravel, and rock, as depicted in Figure D-352.

EFH Description for GOA Sharks

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for GOA Forage Fish Complex—Eulachon, Capelin, Sand Lance, Sand Fish, Euphausiids, Myctophids, Pholids, Gonostomatids, etc.

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults—No EFH Description Determined
Insufficient information is available.

EFH Description for GOA Squid

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for older juvenile squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-353.

Adults
EFH for adult squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) limited to the EEZ of the GOA, as depicted in Figure D-353.

EFH Description for GOA Octopus

Eggs—No EFH Description Determined
Insufficient information is available.

Young Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles—No EFH Description Determined
Insufficient information is available.

Adults. No EFH Description Determined
Insufficient information is available.

D.6.2.3 EFH Map Descriptions for GOA Groundfish

Figures D-314 through D-353 show EFH distribution under Alternative 6 for the GOA groundfish species as described in Section D.6.2.2.

D.6.3 Description of Essential Fish Habitat for BSAI King and Tanner Crab (only the EEZ [3 to 200 nm] portion of the BSAI is described as EFH)

D.6.3.1 EFH Information Levels for BSAI Crab

BSAI Crab Species	Egg	Larvae	Early Juvenile	Late Juvenile	Adult
Red king crab	inferred	x	x	1	1
Blue king crab	inferred	x	x	1	1
Golden king crab	inferred	x	x	1	1
Tanner crab	inferred	x	x	1	1
Snow crab	inferred	x	x	1	1

x - No information available.

D.6.3.2 EFH Text Descriptions for BSAI Crab

EFH Description for BSAI Red King Crab

Eggs
Essential fish habitat of the red king crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile red king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting of rock, cobble, and gravel and biogenic structures such as boltenia, bryozoans, ascidians, and shell hash, as depicted in Figure D-354.

Adults
EFH for adult red king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting of sand, mud, cobble, and gravel, as depicted in Figure D-354.

EFH Description for BSAI Blue King Crab

Eggs
Essential fish habitat of the blue king crab eggs is inferred from the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile blue king crab is the general distribution area for this life stage, located in bottom habitats along the nearshore where there are rocky areas with shell hash and the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting of rock, cobble, and gravel, as depicted in Figure D-355.

Adults
EFH for adult blue king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting of sand and mud adjacent to rockier areas and areas of shell hash, as depicted in Figure D-355.

EFH Description for BSAI Golden King Crab

Eggs
Essential fish habitat of golden king crab eggs is inferred from the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high-relief living habitats, such as coral, and vertical substrates, such as boulders, vertical walls, ledges, and deep water pinnacles, as depicted in Figure D-356.

Adults
EFH for adult golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the outer shelf (100 to 200 m), upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high-relief living habitats, such as coral, and vertical substrates such as boulders, vertical walls, ledges, and deep water pinnacles, as depicted in Figure D-356.

EFH Description for BSAI Tanner Crab

Eggs
Essential fish habitat of Tanner crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Tanner crab is the general distribution area for this life stage, located in the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-357.

Adults
EFH for adult Tanner crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-357.

EFH Description for BSAI Snow Crab

Eggs
Essential fish habitat of snow crab eggs is inferred form the general distribution of egg-bearing female crab (see also Adults).

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-358.

Adults
EFH for adult snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) limited to the EEZ of the BSAI wherever there are substrates consisting mainly of mud, as depicted in Figure D-358.

D.6.3.3 EFH Map Descriptions for BSAI Crab

Figures D-354 through D-358 show EFH distribution under Alternative 6 for the crab species as described in Section D.6.4.2.

D.6.4 Description of Essential Fish Habitat for Alaska Scallops (only the EEZ [3 to 200 nm] portion of the BSAI and GOA is described as EFH)

D.6.4.1 EFH Information Levels for Alaska Scallops

Scallop Species	Eggs	Larvae	Early Juvenile	Late Juvenile	Adult
Weathervane scallop	x	x	x	2	2

x - No information available.

D.6.4.2 EFH Text Descriptions for Alaska Scallops

EFH Description for Weathervane Scallops

Eggs—No EFH Description Determined
Insufficient information is available.

Larvae—No EFH Description Determined
Insufficient information is available.

Early Juveniles—No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile weathervane scallops is the general distribution area for this life stage, located in the sea floor along the middle (50 to 100 m) and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI and limited to the EEZ where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow.

Adults
EFH for adult weathervane scallops is the general distribution area for this life stage, located in the sea floor along the middle (50 to 100 m) and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI and limited to the EEZ where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow.

EFH Description for Other species of Scallops

Information is insufficient or lacking to describe EFH for any life stage of pink, spiny, and rock scallops.

D.6.4.3 EFH Map Descriptions for Weathervane Scallops

Figure D-359 shows the EFH distribution under Alternative 6 for weathervane scallops.

D.6.5 Description of Essential Fish Habitat for Alaska Stocks of Pacific Salmon (only the EEZ [3 to 200 nm] portion of this area is described as EFH)

D.6.5.1 EFH Information Levels for Alaska Stocks of Pacific Salmon

Salmon Species	Freshwater Eggs	Freshwater Larvae and Juveniles	Estuarine Juveniles	Marine Juveniles	Marine Immature and Maturing Adults	Freshwater Adults
Pink	x	x	x	1	1	x
Chum	x	x	x	1	1	x
Sockeye	x	x	x	1	1	x
Chinook	x	x	x	1	1	x
Coho	x	x	x	1	1	x

x - Life stage not found in areas of the EEZ (3 to 200 nm).

D.6.5.2 EFH Text Descriptions for Alaska Stocks of Pacific Salmon

EFH Description for Pink Salmon

Freshwater Eggs
No EFH description determined (all outside of EEZ area).

Freshwater Larvae and Juveniles
No EFH description determined (all outside of EEZ area).

Estuarine Juveniles
No EFH description determined (all outside of EEZ area).

Marine Juveniles
Marine EFH for juvenile pink salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska (more than 3 nm) extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-360.

Marine Immature and Maturing Adults
EFH for immature and maturing adult pink salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska (more than 3 nm) to depths of 200 m extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-360.

Freshwater Adults
No EFH description determined (all outside of EEZ area).

EFH Description for Chum Salmon

Freshwater Eggs
No EFH description determined (all outside of EEZ area).

Freshwater Larvae and Juveniles
No EFH description determined (all outside of EEZ area).

Estuarine Juveniles
No EFH description determined (all outside of EEZ area).

Marine Juveniles
Marine EFH for juvenile chum salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska (more than 3 nm) to depths of 50 m extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-361.

Marine Immature and Maturing Adults
EFH for immature and maturing adult chum salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska (more than 3 nm) to depths of 200 m extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-361.

Freshwater Adults
No EFH description determined (all outside of EEZ area).

EFH Description for Sockeye Salmon

Freshwater Eggs
No EFH description determined (all outside of EEZ area).

Freshwater Larvae and Juveniles
No EFH description determined (all outside of EEZ area).

Estuarine Juveniles
No EFH description determined (all outside of EEZ area).

Marine Juveniles
Marine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska (more than 3 nm) to depths of 50 m extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean from mid-summer until December of their first year at sea, as depicted in Figure D-362.

Marine Immature and Maturing Adults
EFH for immature and maturing adult sockeye salmon is the general distribution area for this life stage, located in marine waters off the coast (more than 3 nm) of Alaska extending to the 200 nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-362.

Freshwater Adults
No EFH description determined (all outside of EEZ area).

EFH Description for Chinook Salmon

Freshwater Eggs—No EFH Description Determined
All are outside of the EEZ area.

Freshwater Larvae and Juveniles—No EFH Description Determined
All are outside of the EEZ area.

Estuarine Juveniles—No EFH Description Determined
All are outside of the EEZ area.

Marine Juveniles
Marine EFH for juvenile Chinook salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska (more than 3 nm) extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean. Juvenile marine Chinook salmon are at this life stage from April until annulus formation in January or February during their first winter at sea, as depicted in Figure D-363.

Marine Immature and Maturing Adults
EFH for immature and maturing adult Chinook salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska (more than 3 nm) extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-363.

Freshwater Adults—No EFH Description Determined
All are outside of the EEZ area.

EFH Description for Coho Salmon

Freshwater Eggs
No EFH description determined (all outside of EEZ area).

Freshwater Larvae and Juveniles
No EFH description determined (all outside of EEZ area).

Estuarine Juveniles
No EFH description determined (all outside of EEZ area).

Marine Juveniles
Marine EFH for juvenile coho salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska (more than 3 nm) extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-364.

Marine Immature and Maturing Adults
EFH for immature and maturing adult coho salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska (more than 3 nm) extending to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure D-364.

Freshwater Adults
No EFH description determined (all outside of EEZ area).

D.6.5.3 EFH Map Descriptions for Alaska Stocks of Pacific Salmon

Figures D-360 through D-364 show EFH distribution under Alternative 6 for the Alaska stocks of Pacific salmon as described above.

References

Alaska Department of Fish and Game. 1998. Catalogue of waters important for spawning, rearing, or migration of anadromous fishes. ADF&G, Habitat Division, 6 vols. Anchorage, Alaska. Revised periodically.

Fritz, L., A. Greig, and R. Reuter. 1998. “Catch-per-unit effort, length, and depth distributions of major groundfish and bycatch species in the Bering Sea, Aleutian Islands, and Gulf of Alaska regions based on groundfish fishery observer data.” NOAA Technical Memorandum. NMFS-AFSC-88. 179 pp.

Matarese, A.C., D.M. Blood, S.J. Picquelle, and J.L. Benson. 2003. Atlas of abundance and distribution patterns of ichthyoplankton from the norhteast Pacific Ocean and Bering Sea ecosystems based on research conducted by the Alaska Fisheries Science Center (1972-1996). NOAA Professional Paper. 281 pp.

North Pacific Fishery Management Council. 1999. Environmental Assessment for Amendment 55 to the FMP for the BSAI Groundfish Fishery, Amendment 55 to the FMP for the GOA Groundfish Fishery, Amendment 8 to the FMP for BSAI Crab Fisheries, Amendment 5 to the FMP for Scallop Fisheries Off Alaska, and Amendment 5 to the FMP for Salmon Fisheries in the EEZ off Alaska: Essential Fish Habitat. 364pp.

NMFS Observer (NORPAC) database. 1990 to 2001. http://www.afsc.noaa.gov/refm/observers/database.htm.

Appendix E
NMFS Recommendations for the EFH Provisions of the FMPs

Prepared by

National Marine Fisheries Service

April 2005

National Marine Fisheries Service
Recommendations for the EFH Provisions of
North Pacific Fishery Management Council Fishery Management Plans

September 10, 2003

Section 305(b)(1)(B) of the Magnuson-Stevens Fishery Conservation and Act requires that "The Secretary, in consultation with participants in the fishery, shall provide each Council with recommendations and information regarding each fishery under that Council's authority to assist it in the identification of essential fish habitat, the adverse impacts on that habitat, and the actions that should be considered to ensure the conservation and enhancement of that habitat." The EFH regulations at 50 CFR 600.815(b) elaborate on this requirement as follows:

> Development of EFH recommendations for Councils. After reviewing the best available scientific information, as well as other appropriate information, and in consultation with the Councils, participants in the fishery, interstate commissions, Federal agencies, state agencies, and other interested parties, NMFS will develop written recommendations to assist each Council in the identification of EFH, adverse impacts to EFH, and actions that should be considered to ensure the conservation and enhancement of EFH for each FMP. NMFS will provide such recommendations for the initial incorporation of EFH information into an FMP and for any subsequent modification of the EFH components of an FMP. The NMFS EFH recommendations may be provided either before the Council's development of a draft EFH document or later as a review of a draft EFH document developed by a Council, as appropriate.

The North Pacific Fishery Management Council and the National Marine Fisheries Service (NMFS) are developing an Environmental Impact Statement (EIS) to consider potential modifications to the Essential Fish Habitat (EFH) provisions of the Council's five Fishery Management Plans (FMPs). NMFS has used a variety of means to provide recommendations and information to assist the Council with this EIS, such as providing biological information regarding the habitat requirements of managed species; developing spatial analyses of distribution data to facilitate the identification of EFH; developing a model used in the EIS to evaluate the effects of fishing on EFH; developing and/or assisting with all of the analyses in the EIS; participating on the Council's EFH Committee and providing staff support for the Committee's work; and providing technical and policy guidance to advise the Council on how best to fulfill the EFH requirements of the Magnuson-Stevens Act. This appendix to the EIS constitutes NMFS' written recommendations pursuant to 50 CFR 600.815(b).

Recommendations Regarding the Description and Identification of EFH

The EIS evaluates six alternatives for the description and identification of EFH. The alternatives are presented in Section 2.3.1, and their environmental consequences are evaluated in Section 4.1. As discussed in the comparative summary of the alternatives in Section 4.5.1, three of the alternatives would not comply with the requirements of Section 303(a)(7) of the Magnuson-Stevens Act and the EFH regulations at 50 CFR 600.815(a)(1)(iv). Alternatives 1 and 6 are not consistent with the Magnuson-Stevens Act or the EFH regulations because they would not describe and identify any habitats (Alternative 1) or all habitats (Alternative 6) necessary to managed species for spawning, breeding, feeding, or growth to maturity. Alternative 2 is not consistent with the Magnuson-Stevens Act or the EFH regulations because it does not reflect the best (most recent) scientific information available, as required by national standard 2 (16 U.S.C. 1851(a)(2)) and 50 CFR 600.815(a)(1)(ii)(B).

Alternatives 3 through 5 are consistent with the Magnuson-Stevens Act and the EFH regulations. As discussed in Section 4.5.1 of the EIS, those alternatives take different approaches that influence their overall efficacy. In summary, Alternative 3 applies the same approach used in the status quo (Alternative 2) EFH designations, which are relatively broad in scope and are premised on a risk averse approach, but Alternative 3 applies more recent information, improved analytical tools, and better mapping. Alternative 3 would result in geographically smaller EFH areas for some species. Alternative 4 uses a narrower interpretation of the available scientific information, and would result in smaller EFH areas for many species. Alternative 5 uses a very different, habitat-based, ecoregion approach that would result in broader EFH descriptions than the status quo Alternative 2, making it harder to distinguish EFH from all available habitats.

NMFS recommends that the Council endorse Alternative 4 for describing and identifying EFH. Experience implementing the EFH provisions of the Magnuson-Stevens Act using the existing EFH areas (the status quo Alternative 2) since 1999 suggests that there may be advantages to describing and identifying EFH more narrowly in cases where sufficient scientific information exists. Where Level 2 (relative abundance) information is available for adult and/or juvenile life stages, narrower EFH designations would highlight habitat areas that commonly support higher concentrations of the managed species. Such areas presumably represent higher relative habitat value compared to other habitats for the species. Describing and identifying these smaller areas as EFH for specific managed species would enable the Council, NMFS, other federal and state agencies, and fishing and non-fishing industries to focus on smaller areas for purposes of avoiding and minimizing adverse effects to the habitat. Smaller EFH areas – in cases where identifying EFH more narrowly is supported by the best available scientific information – would help to prioritize management efforts and could therefore be a more effective tool for habitat conservation than larger areas. Larger EFH areas arguably may be more risk averse, and that rationale was used by the Council in 1998 to support the existing EFH designations (Alternative 2). However, for some species (e.g., BSAI Pacific cod) sufficient information exists to identify concentration areas with a fairly high degree of confidence. Also, it is relevant to note that the total aggregated area of EFH descriptions for all managed species would be identical under Alternatives 2, 3, and 4 because data limitations for certain species (e.g., Coho salmon) would lead to equally broad EFH designations under any of those alternatives. In summary, Alternative 4 would identify EFH as the area of presumed known concentration for species for which sufficient information exists, and for the remaining species and life stages it would identify EFH according to the general distribution of the species as in Alternative 3.

Recommendations Regarding the Approaches for Identifying HAPCs

The EIS evaluates five alternative approaches for identifying HAPCs. The alternatives are presented in Section 2.3.2, and their environmental consequences are evaluated in Section 4.2. As discussed in the comparative summary of the alternatives in Section 4.5.2, all of the alternatives are consistent with the EFH regulations, which encourage (but do not require) identification of HAPCs and allow HAPCs to be identified as either areas or types of habitat within EFH.

Alternative 1 would rescind the existing HAPCs and provide for no new HAPCs, and thus would fail to take advantage of a tool available to the Council to highlight particularly valuable and/or vulnerable habitats within EFH. Alternative 2 would retain the status quo HAPCs, but the broad and general nature of the existing HAPC designations limits their efficacy as a tool for prioritizing discrete habitat areas. Alternative 3 would limit HAPCs to specific sites, rather than permitting HAPCs to be identified for general types of habitat wherever they may be found, and therefore could be more effective than Alternative 2 by virtue of being more focused. Alternative 4 may offer more potential benefits for target species than the other alternatives because the stepwise process of selecting habitat types and then specific sites could yield a more rational and structured effort to ensure that HAPCs would focus on the habitats within EFH that are most valuable and/or vulnerable. Alternative 5 would limit the identification of HAPCs to specific sites supporting habitat functions for individual target species. It therefore has the potential to benefit target species more directly than the other alternatives, although the scarcity of scientific information about habitat requirements of individual species could limit the effectiveness of this approach.

NMFS recommends that the Council endorse Alternative 4 as the preferred approach for identifying HAPCs. As noted above, Alternative 4 has the advantage of encouraging specific site-based HAPCs that are more focused than the status quo HAPC designations, and it also provides a means for the Council to select habitat types of concern first as a way to prioritize the kinds of habitat for which site-specific HAPC designations should be considered. This approach would promote a structured analysis of candidate HAPCs, thereby encouraging the screening process to evaluate specific areas that meet characteristics defined by the Council as being especially important.

Alternative 4 would rescind the existing HAPC designations (living substrates in deep water, living substrates in shallow water, and freshwater areas used by anadromous salmon) and adopt a new type/site based approach for HAPCs. NMFS' support for this alternative should not be construed to imply that the existing HAPCs represent unimportant habitat types. On the contrary, the habitat types included in the existing HAPCs are extremely important for Council managed species. However, for management purposes, identifying habitat types of concern and then designating specific HAPC sites within those habitat types would yield a more effective tool for habitat conservation.

Recommendations Regarding Measures to Minimize the Effects of Fishing on EFH

The EIS analyzes seven alternatives to minimize to the extent practicable the adverse effects of fishing on EFH. Appendix B evaluates the effects of fishing on EFH in Alaska, and concludes that no Council-managed fishing activities have more than minimal and temporary effects on EFH for any FMP species. Additionally, the analysis concludes that all fishing activities combined have minimal, but not necessarily temporary, effects on EFH. However, Appendix B and Section 4.3 both note that considerable uncertainty remains regarding these conclusions. The fishing impacts model and its application in the EIS have many limitations. Both the developing state of this new model and the limited quality of available data to estimate input parameters prevent the analysis from drawing a complete picture of the effects of fishing on EFH. The model incorporates a number of assumptions about habitat effect rates, habitat recovery rates, habitat distribution, and habitat use by managed species. The quantitative outputs of the analysis may convey an impression of rigor and precision, but the results actually are subject to considerable uncertainty. Thus, while the available information does not identify adverse effects of fishing that are more than minimal and temporary in nature, that finding does not necessarily mean that no such effects exist.

NMFS recommends that the Council pursue three courses of action regarding the effects of fishing on EFH:

1. The Council should continue to analyze carefully the effects of its management actions on sea floor habitats. NMFS remains committed to assisting the Council with such analyses.

2. The Council should continue to support research funded by NMFS, the North Pacific Research Board, and other entities to improve scientific understanding of the effects of fishing on

habitat, the linkages between habitats and managed species, and the recovery rates of sea floor habitats following disturbance by fishing gear.

3. The Council should take specific precautionary management actions to avoid additional disturbance to fragile sea floor habitats that may be especially slow to recover – most notably deep water coral communities.

Although NMFS is not recommending any particular measures at this time, two avenues are especially promising. First, as noted in Section 4.5.3, precautionary actions to prohibit bottom-contact trawling (bottom trawling as well as pelagic trawling that contacts the bottom) in the lower slope/basin areas deeper than 1000 m would protect such habitats from reasonably foreseeable future impacts with almost no short-term costs. The Council could either endorse one of the EIS alternatives that includes such areas, or identify specific lower slope/basin area closures to be analyzed separately from other measures in a distinct new alternative, and then endorse that alternative at the December 2003 Council meeting.

Secondly, the Council could use its forthcoming HAPC process as a means to identify and protect corals and other especially fragile habitats that recover slowly following disturbance. The HAPC process described in Appendix J includes a step for the Council to establish priorities for the kinds of HAPCs it will consider. Choosing corals and other similarly sensitive and slow-growing biogenic habitats as the highest priority would set a course toward additional protection of such habitats in the near future, while affording all stakeholders ample opportunity for involvement in the identification of such areas and the development of appropriate management measures.

Recommendations Regarding Other Actions to Conserve and Enhance EFH

One of the requirements of Section 303(a)(7) of the Magnuson-Stevens Act is for FMPs to identify "other actions to encourage the conservation and enhancement of" EFH. This requirement refers to actions other that those necessary to minimize to the extent practicable the adverse effects of fishing on EFH. The EFH regulations require that FMPs identify activities other than fishing that may adversely affect EFH and recommend options to avoid, minimize, or offset adverse effects.

Appendix G of the EIS discusses threats to EFH from activities other than fishing, and provides recommendations for conducting such activities in a manner to promote the conservation and enhancement of EFH. Appendix G discusses a wide variety of activities, such as mining, forestry, agriculture, oil and gas development, dredging, and filling wetlands. The recommendations presented in Appendix G are advisory, and are not binding upon entities involved in non-fishing activities. NMFS recommends that the Council endorse the Appendix G recommendations.

APPENDIX F.1

ESSENTIAL FISH HABITAT ASSESSMENT REPORT

for the Groundfish Resources of the

Gulf of Alaska Region

April 2005

NOAA Fisheries
NMFS Alaska Region
709 West 9th Street
Juneau, AK 99802

NOAA Fisheries
National Marine Fisheries Service

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Introduction

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to require the description and identification of Essential Fish Habitat (EFH) in Fishery Management Plans (FMPs), adverse impacts on EFH, and actions to conserve and enhance EFH. National Marine Fisheries Service (NMFS) developed guidelines to assist Fishery Management Councils in fulfilling the requirements set forth by the Act.

Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, “waters” includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle.

With respect to type, the information available for almost all species is primarily broad geographic distributions based on specific samples from surveys and fisheries, which have not been linked with habitat characteristics. Furthermore, NMFS’ ability to precisely define the habitat (and its location) of each life stage of each managed groundfish species in terms of its oceanographic (temperature, salinity, nutrient, current), trophic (presence of food, absence of predators), and physical (depth, substrate, latitude, and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions for each species and life stage is restricted primarily to their position in the water column (e.g., demersal, pelagic), broad biogeographic and bathymetric areas (e.g., 100 to 200 meter [m] zone, south of the Pribilof Islands and throughout the Aleutian Islands [AI]) and occasional references to known bottom type associations.

Identification of EFH for some species included historical range information. Traditional knowledge and sampling data have indicated that fish distributions may contract and expand due to a variety of factors including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution.

Background

In preparation of the 1999 EFH Environmental Assessment, EFH Technical Teams, consisting of scientific stock assessment authors, compiled scientific information and prepared the 1999 Habitat Assessment Reports. These reports provided the scientific information baseline to describe EFH. Recent scientific evidence has not proved to change existing life history profiles of the federally managed species. However, where new information does exist, new data help fill information gaps in the region’s limited habitat data environment.

Stock assessment authors used information contained in these summaries and personal knowledge, along with data contained in reference atlases (NOAA 1987, 1990; Council 1997a,b), fishery and survey data (Allen and Smith 1988, Wolotira et al. 1993, NOAA 1998), and fish identification books (Hart 1973, Eschmeyer and Herald 1983, Mecklenburg and Thorsteinson 2002), to describe EFH for each life stage using best scientific judgment and interpretation; see Table 1.

Species Profiles and Habitat Descriptions

FMPs must describe EFH in text, map EFH distributions, and include tables, which provide information on habitat and biological requirements for each life history stage of the species; see Tables 2 to 4.

Information contained in this report details life history information for federally managed fish species. This collection of scientific information is interpreted, then referenced to describe and delineate EFH for each species by life history stage using the geographic information system (GIS). EFH text and map descriptions are not compiled in this report due to differences in the characteristics of a species life history and the overall distribution of the species. Specific EFH text descriptions and maps are in Appendix D.

References

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Council (North Pacific Fishery Management Council). 1997a. Essential fish habitat assessment report for the groundfish resources of the BS and AI regions. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Council. 1997b. Essential fish habitat assessment report for the groundfish resources of the GOA region. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Eschmeyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes. Houghton Mifflin Co., Boston. 336 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180. Ottawa. 740 p.

Mecklenburg, Commerce., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fish Society. Bethsda, Maryland. 1037 p.

NOAA (National Oceanic and Atmospheric Administration). 1987. Bering, Chukchi, and Beaufort Seas. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1990. West coast of North America. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1998. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the BS, AI, and GOA regions based on groundfish fishery observer data. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-88.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Table 1. Summary of Major References and Atlases

Species	Allen and Smith 1988	NOAA 1987	NOAA 1990	Wolotira et al. 1993	NOAA 1998	Mecklenburg and Thorsteinson 2002
	References					
Walleye pollock	X	X	X	X	X	X
Pacific cod	X	X	X	X	X	X
Yellowfin sole	X	X		X	X	X
Greenland turbot	X	X		X	X	X
Arrowtooth flounder	X	X	X	X	X	X
Rock sole	X	X		X	X	X
Alaska plaice	X	X		X	X	X
Flathead sole	X	X	X	X	X	X
Sablefish	X		X	X	X	X
Pacific ocean perch	X		X	X	X	X
Shortraker-rougheye rockfish	X				X	X
Northern rockfish	X				X	X
Dusky rockfish	X				X	X
Thornyhead rockfish	X				X	X
Atka mackerel	X		X	X	X	X
Sculpins	X				X	X
Skates	X				X	X

Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.

Location
ICS = inner continental shelf (1-50 m)
MCS = middle continental shelf (50-100 m)
OCS = outer continental shelf (100-200 m)
USP = upper slope (200-1000 m)
LSP = lower slope (1000-3000 m)
BSN= basin (>3000 m)

BCH = beach (intertidal)
BAY = nearshore bays, give depth if appropriate (e.g., fjords)
IP = island passes (areas of high current), give depth if appropriate

Water column
D = demersal (found on bottom)
SD/SP =semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom
P = pelagic (found off bottom, not necessarily associated with a particular bottom type)
N = neustonic (found near surface)

Bottom Type
M = mud
SM = sandy mud
MS = muddy sand
S = sand
CB = cobble
G = gravel
R = rock
C = coral
K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features
UP = upwelling
G = gyres
F = fronts
E = edges
CL = thermocline or pycnocline

General
U = Unknown
N/A = not applicable

Table 2. Summary of Habitat Associations for Groundfish in the GOA

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location							Physical Oceanography					Substrate													Structure										Community Associations												Oceanographic Properties			
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic																																														
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Walleye Pollock	M						x	x	x	x				x		x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x																								2-10			M
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Pacific Cod	M					x	x	x	x	x					x	x	x	x	x	x					x										x	x	x	x	x	x	x	x	x	x	x	x				x	x			x				x	x	x	x	x					x	x				M
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Sablefish	M								x	x	x	x	x				x				x				x				x						x	x	x								x	x							x																			M
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						Inner	Middle	Outer	Upper	Upper	Inter-mediate	Inter-mediate	Lower	Basin												Pelagic																																															
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surfce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Greenland Turbot	M							x	x	x	x														x										x	x	x		x																																		M
	LJ					x	x																		x										x	x			x																																		LJ
	EJ																								x										x	x			x																																		EJ
	L					x	x	x	x	x																x					x																																										L
	E					x	x	x	x	x																x																																															E
Yelloweye Rockfish	M					x	x	x	x	x						x	x								x											x									x	x						x			x																		M
	LJ					x	x	x								x	x								x																					x																											LJ
	EJ					x	x	x								x	x								x																					x						x			x																		EJ
	L																																																																								L
	E																																																																								E
Shortraker/Rougheye Rockfish	M								x	x																x									x	x		x								x							x								x											M
	LJ					x	x	x	x								x	x	x	x	x																																																			LJ
	EJ												x	x									x																																																	EJ
	L																										x																																													L
Northern Rockfish	M						x	x										x							x																				x	x																										M
	LJ						x	x										x	x						x																																																LJ
	EJ																									x																																															EJ
	L																																																																								L
Thornyhead Rockfish	M								x	x	x	x	x												x												x								x	x							x																			M
	LJ						x	x	x																x												x									x																											LJ
	EJ																									x																																															EJ
	L																									x																																															L
	E																									x																																															E
Light Dusky Rockfish	M							x	x									x		x	x				x												x								x	x																										M
	LJ						x	x										x		x					x																																				x											LJ
	EJ																																																																								EJ
	L																																																																								L
Sculpins	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x																											x																			M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
Skates	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x																																														M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
Sharks	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x																																												M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
Squid	M				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																									x																			M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
Octopus	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x				x	x	x																																														M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E

Table 2. Summary of Habitat Associations for Groundfish in the GOA

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location							Physical Oceanography					Substrate													Structure										Community Associations												Oceanographic Properties			
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic																																														
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Eulachon	M						X	X	X								X									X			X			X	X																																							M
	LJ						X	X																		X			X			X	X																																							LJ
	EJ					X	X																			X			X			X																																							EJ
	L	X	X			X	X										X						X																																																	L
	E	X																																																																			**4-8**			E
Capelin	M						X	X									X									X			X			X	X																																				**-2-3**			M
	LJ						X	X																		X			X			X	X																																							LJ
	EJ					X	X																			X			X			X																																							EJ
	L		X			X	X										X						X																																																	L
	E			X											X																					X	X					X																											**5-9**			E
Sand Lance	M			X	X	X									X		X					X	X	X	X	X										X	X					X																															M
	LJ			X	X	X									X		X					X	X	X	X	X										X	X					X																															LJ
	EJ		X		X	X									X		X					X	X			X																																																EJ
	L		X			X									X		X					X	X			X																																																L
	E			X													X																																																									E

Table 3. Summary of Reproductive Traits for Groundfish in the GOA

GOA Groundfish		Reproductive Traits																										
		Age at Maturity (unless otherwise noted)				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	50%	100%	50%	100%	External	Internal	Oviparous	Ovoviviparous	Viviparous	Batch Spawner	Broadcast Spawner	Egg Case Deposition	Nest Builder	Egg/Young Guarder	Egg/Young Bearer	January	February	March	April	May	June	July	August	September	October	November	December
Walleye Pollock	M	4-5		4-5		x						x						x	x	x	x							
Pacific Cod	M	5		5		x						x					x	x	x	x	x							
Atka Mackerel	M	3.6		3.6		x								x	x						x	x	x	x	x	x		
Sablefish	M	65cm		67cm		x						x					x	x	x	x	x							
Pacific Ocean Perch	M	10.5					x			x	x														x	x	x	x
Flathead Sole	M	10				x											x	x	x	x								x
Yellowfin Sole	M	10.5				x					x										x	x	x					
Arrowtooth Flounder	M	5		4		x											x	x	x	x							x	x
Rock Sole	M	9				x					x						x	x	x									
Rex Sole	M	24cm		16cm		x												x	x	x	x	x	x					
Greenland Turbot	M	5-10				x											x	x	x							x	x	x
Dover Sole	M	33cm				x											x	x	x	x	x	x	x	x				
Yelloweye Rockfish	M	22							x											x	x	x	x					
Shortraker/Rougheye Rockfish	M	20+					x			x	x												x	x	x	x	x	x
Northern Rockfish	M	13					x			x	x																	
Thornyhead Rockfish	M	12									x							x				x						
Dusky Rockfish	M	11					x			x	x																	
Sculpins	M					x									x													
Skates	M						x	x					x															
Sharks	M						x	x	x	x			x			x												
Squid	M						x				x																	
Octopus	M						x				x			x	x													
Eulachon	M	3	5	3	5	X		X			X									X	X	X						
Capelin	M	2	4	2	4	X		X			X										X	X	X	X				
Sand Lance	M	1	2	1	2	X		X			X						X	X									X	X

Table 4. Summary of Predator and Prey Associations for Groundfish in the GOA

GOA Groundfish — Predator to

Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Walleye Pollock	M				x			x			x			x						x	x	x	x	x		x			x	x	x
	LJ				x			x			x			x						x	x	x	x	x		x			x	x	x
	EJ				x			x			x									x	x	x									
	L				x			x			x																				
	E																														
Pacific Cod	M							x		x			x							x										x	
	LJ							x		x			x							x										x	
	EJ							x		x			x							x											
	L			x	x						x																				
	E																														
Atka Mackerel	M							x			x													x							
	J							x			x																				
	L										x																				
	E																														
Sablefish	M							x	x	x	x		x	x				x		x		x	x		x	x		x	x	x	
	LJ							x	x	x	x		x	x				x		x		x	x		x	x		x	x	x	
	EJ							x		x	x		x	x	x			x		x			x					x			
	L				x						x																				
	E																														
Pacifc Ocean Perch	M							x																							
	LJ							x			x																				
	EJ																														
	L			x	x																										
Flathead Sole	M							x		x	x		x			x	x	x	x		x	x								x	
	LJ							x		x	x		x			x	x	x	x											x	
	EJ				x								x			x			x											x	
	L	x		x																											
	E																														
Yellowfin Sole	M							x		x			x			x		x		x					x					x	
	LJ							x		x			x			x		x		x					x						
	EJ				x																										
	L	x		x																											
	E																														
Arrowtooth Flounder	M												x	x				x	x	x			x	x						x	
	LJ												x					x	x	x			x	x						x	
	EJ				x																										
	L	x		x																											
	E																														
Rock Sole	M									x			x			x	x														
	LJ									x			x			x	x														
	EJ				x																										
	L	x		x																											
	E																														

GOA Groundfish — Prey of

Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Walleye Pollock	M								x						x	x	x	x	x	x										
	LJ							x	x						x	x		x	x	x				x		x	x	x		
	EJ							x	x						x	x		x	x	x				x		x	x	x		
	L							x	x						x	x								x		x	x	x		
	E																													
Pacific Cod	M															x	x	x		x		x	x	x						
	LJ															x	x	x		x		x	x	x						
	EJ															x	x	x				x	x	x			x			
	L																													
	E																													
Atka Mackerel	M								x						x	x			x	x	x			x						
	J																			x						x	x			
	L																													
	E																													
Sablefish	M																													
	LJ						x									x														
	EJ																													
	L																													
	E																													
Pacifc Ocean Perch	M															x														
	LJ																													
	EJ						x																							
	L																													
Flathead Sole	M								x				x		x	x														
	LJ																													
	EJ																													
	L																													
	E																													
Yellowfin Sole	M																													
	LJ								x							x														
	EJ								x							x														
	L																													
	E																													
Arrowtooth Flounder	M																													
	LJ							x	x																					
	EJ																													
	L																													
	E																													
Rock Sole	M																													
	LJ							x	x					x		x														
	EJ																													
	L																													
	E																													

Table 4. Summary of Predator and Prey Associations for Groundfish in the GOA

GOA Groundfish		Predator to																															Prey of																											
Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Dover Sole	M												X				X	X														M							X						X															
	LJ												X				X	X														LJ							X						X															
	EJ																															EJ																												
	L	X		X																												L																												
	E																															E																												
Rex Sole	M							X		X			X					X														M							X						X															
	LJ							X		X			X					X														LJ							X						X															
	EJ																															EJ																												
	L	X		X																												L																												
	E																															E																												
Greenland Turbot	M												X					X	X	X			X	X						X		M																												
	LJ																															LJ																												
	EJ				X																											EJ						X	X					X																
	L	X		X																												L																												
	E																															E																												
Yelloweye Rockfish	M																	X		X	X		X				X					M					X			X	X					X														
	LJ																															LJ																												
	EJ										X																					EJ																												
	L																															L																												
	E																															E																												
Shortraker/Rougheye Rockfish	M													X						X				X								M																												
	LJ																															LJ																												
	EJ																															EJ																												
	L																															L																												
Northern Rockfish	M							X			X																					M																												
	LJ																															LJ																												
	EJ																															EJ																												
	L																															L																												
Thornyhead Rockfish	M																			X					X							M																												
	LJ																															LJ																												
	EJ																															EJ																												
	L																															L																												
	E																															E																												
Light Dusky Rockfish	M							X																								M																												
	LJ																															LJ																												
	EJ																															EJ																												
	L																															L																												
Sculpins	M				X			X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X			X	X		M							X	X		X	X	X		X	X	X	X	X	X	X									
	LJ																															LJ																												
	EJ																															EJ																												
	L																															L																												
	E																															E																												
Skates	M								X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	M																		X											

Table 4. Summary of Predator and Prey Associations for Groundfish in the GOA

Predator to

GOA Groundfish Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut
	LJ																														
	EJ																														
	L																														
	E																														
Sharks	M						x		x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	LJ																														
	EJ																														
	L																														
	E																														
Squid	M							x			x										x	x	x	x							
	LJ																														
	EJ																														
	L																														
	E																														
Octopus	M															x	x	x													
	LJ																														
	EJ																														
	L																														
	E																														
Eulachon	M				X			X			X																				
	LJ				X			X			X																				
	EJ				X			X			X																				
	L			X	X	X		X			X																				
	E																														
Capelin	M				X			X			X		X							X											
	LJ				X			X			X																				
	EJ				X			X			X																				
	L			X	X	X		X			X																				
	E																														
Sand Lance	M				X			X		X	X																				
	LJ				X			X		X	X																				
	EJ				X			X		X	X																				
	L			X	X	X		X		X	X																				
	E																														

Prey of

GOA Groundfish Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
	LJ																													
	EJ																													
	L																													
	E																													
Sharks	M															x														
	LJ																													
	EJ																													
	L																													
	E																													
Squid	M	x						x	x	x	x					x	x	x	x	x	x		x	x		x	x	x	x	
	LJ																													
	EJ																													
	L																													
	E																													
Octopus	M							x	x	x	x					x	x	x	x	x										
	LJ																													
	EJ																													
	L																													
	E																													
Eulachon	M						X	X	X							X		X	X	X	X					X	X			X
	LJ						X	X	X							X		X	X	X	X					X	X			
	EJ					X	X	X	X							X														
	L					X	X	X	X							X														
	E																													
Capelin	M						X	X	X						X	X		X	X	X	X					X	X			
	LJ						X	X	X						X	X		X	X	X	X					X	X			
	EJ					X	X	X	X						X	X														
	L					X	X	X	X						X	X														
	E																													
Sand Lance	M						X	X	X						X	X		X	X	X	X					X	X			
	LJ						X	X	X						X	X		X	X	X	X					X	X			
	EJ					X	X	X	X						X	X														
	L					X	X	X	X						X	X														
	E																													

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App_F.1_Tables.xls
Table 4 - Diet Prey

Habitat Description for Walleye Pollock

(*Theragra calcogramma)*

Management Plan and Area GOA

The Gulf of Alaska (GOA) pollock stocks are managed under the GOA Groundfish Fisheries Management Plan, and the eastern Bering Sea (EBS) and AI pollock stocks are managed under the EBS and AI Groundfish Fisheries Management Plan. Pollock occur throughout the area covered by the FMP and straddle into the Canadian and Russian U.S. Exclusive Economic Zone (EEZ), international waters of the central BS, and into the Chukchi Sea.

Life History and General Distribution

Pollock is the most abundant species within the EBS comprising 75 to 80 percent of the catch and 60 percent of the biomass. In the GOA, pollock is the second most abundant groundfish stock comprising 25 to 50 percent of the catch and 20 percent of the biomass.

Four stocks of pollock are recognized for management purposes: GOA, EBS, AI, and Aleutian Basin. There appears to be a high degree of interrelationship among the EBS, AI, and Aleutian Basin stocks with suggestions of movement from one area to the others. There appears to be stock separation between the GOA stocks and stocks to the north.

The most abundant stock of pollock is the EBS stock, which is primarily distributed over the EBS outer continental shelf between approximately 70 to 200 m. Information on pollock distribution in the EBS comes from commercial fishing locations, annual bottom trawl surveys, and triennial acoustic surveys.

The AI stock extends through the AI from 170E W to the end of the AI (Attu Island), with the greatest abundance in the eastern Aleutians (170E W to Seguam Pass). Most of the information on pollock distribution in the AI comes from triennial bottom trawl surveys. These surveys indicate that pollock are primarily located on the BS side of the AI, and have a spotty distribution throughout the AI chain. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass is likely to be unavailable to bottom trawls. Also, many areas of the AI shelf are untrawlable due to rough bottom.

The third stock, Aleutian Basin, appears to be distributed throughout the Aleutian Basin which encompasses the EEZ, Russian EEZ, and international waters in the central BS. This stock appears to move throughout the Basin for feeding, but concentrate in deepwater near the continental shelf for spawning. The principal spawning location is near Bogoslof Island in the eastern AI, but data from pollock fisheries in the first quarter of the year indicate that there are other concentrations of deepwater spawning concentrations in the western AI. The Aleutian Basin spawning stock appears to be derived from migrants from the EBS shelf stock, and possibly some western BS pollock. Recruitment to the stock occurs generally around age 5; very few pollock younger than age 5 have been found in the Aleutian Basin. Most of the pollock in the Aleutian Basin appear to originate from strong year classes.

The GOA stock extends from southeast Alaska to the AI (170E W), with the greatest abundance in the western and central regulatory areas (147E W to 170E W). Most of the information on pollock distribution in the GOA comes from triennial bottom trawl surveys. These surveys indicate that pollock are distributed throughout the shelf regions of the GOA at depths less than 300 m. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls. The principal spawning location is in Shelikof Strait, but data from pollock fisheries and exploratory surveys indicate that there are other concentrations of spawning in the Shumagin Islands, the east side of Kodiak Island and near Prince William Sound.

Peak pollock spawning occurs on the southeastern BS and eastern AI along the outer continental shelf around mid-March. North of the Pribilof Islands, spawning occurs later (April to May) in smaller spawning aggregations. The deep spawning pollock of the Aleutian Basin appear to spawn slightly earlier, late February to early March. In the GOA, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area appears 2 to 3 weeks earlier than in Shelikof Strait.

Spawning occurs in the pelagic zone and eggs develop throughout the water column (70 to 80 m in the BS shelf, 150 to 200 m in Shelikof Strait). Development is dependent on water temperature. In the BS, eggs take about 17 to 20 days to develop at 4 degrees (º) in the Bogoslof area and 25.5 days at 2º on the shelf. In the GOA, development takes approximately 2 weeks at ambient temperature (5ºC). Larvae are also distributed in the upper water column. In the BS, the larval period lasts approximately 60 days. The larvae eat progressively larger naupliar stages of copepods as they grow and then small euphausiids as they approach transformation to juveniles (~25 millimeters [mm] standard length). In the GOA, larvae are distributed in the upper 40 m of the water column and the diet is similar to BS larvae. FOCI survey data indicate larval pollock may utilize the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which reside in the colder bottom water.

At age 1, pollock are found throughout the EBS both in the water column and on bottom. Age 1 pollock from strong year-classes appear to be found in great numbers on the inner shelf, and further north on the shelf than weak year classes which appear to be more concentrated on the outer continental shelf. From ages 2-3, pollock are primarily pelagic and then appear to be most abundant on the outer and mid-shelf northwest of the Pribilof Islands. As pollock reach maturity (age 4) in the BS, they appear to move from the northwest to the southeast shelf to recruit to the adult spawning population. Strong year-classes of pollock persist in the population in significant numbers until about age 12, and very few pollock survive beyond age 16. The oldest recorded pollock was age 31.

Growth varies by area with the largest pollock occurring on the southeastern shelf. On the northwest shelf the growth rate is slower. A newly maturing pollock is around 40 centimeters (cm).

Fishery

The EBS pollock fishery has, since 1990, been divided into two fishing periods; an “A season” occurring in January-March, and a “B season” occurring in August-October. The A season concentrates fishing effort on prespawning pollock in the southeastern BS. During the B season fishing is still primarily in the southeastern BS, but some fishing also occurs on the northwestern shelf. Also during the B season, catcher processor vessels are required to fish north of lat. 56E N because the area to the south is reserved for catcher vessels delivering to shoreside processing plants on Unalaska and Akutan.

Since 1992, the GOA pollock total allowable catch (TAC) has been apportioned spatially and temporally to reduce impacts on Steller sea lions. Although the details of the apportionment scheme have evolved over time, the general objective is to allocate the TAC to management areas based on the distribution of surveyed biomass and to establish three or four seasons between mid-January and autumn during which some fraction of the TAC can be taken. The Steller Sea Lion Protection Measures implemented in 2001 establish four seasons in the Central and Western GOA beginning January 20, March 10, August 25, and October 1, with 25 percent of the total TAC allocated to each season. Allocations to management areas 610, 620, and 630 are based on the seasonal biomass distribution as estimated by groundfish surveys. In addition, a new harvest control rule was implemented that requires a cessation of fishing when spawning biomass declines below 20 percent of unfished stock biomass.

In the GOA, approximately 90 percent of the pollock catch is taken using pelagic trawls. During winter, fishing effort usually targeted primarily on pre-spawning aggregations in Shelikof Strait and near the Shumagin Islands. The pollock fishery has a very low bycatch rate with discards averaging about 2 percent since 1998 (with the 1991-1997 average around 9 percent). Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery, the catch is almost exclusively pollock.

The EBS pollock fishery primarily harvests mature pollock. The age where fish are selected by the fishery roughly corresponds to the age at maturity (management guidelines are oriented towards conserving spawning biomass). Fishery selectivity increases to a maximum around age 6-8 and declines slightly. The reduced selectivity for older ages is due to pollock becoming increasingly demersal with age. Younger pollock form large schools and are semi-demersal, thereby being easier to locate by fishing vessels. Immature fish (ages 2 and 3) are usually caught in low numbers. Generally the catch of immature pollock increases when strong year-classes occur and the abundance of juveniles increase sharply. This occurred with the 1989 year-class, the second largest year-class on record. Juvenile bycatch increased sharply in 1991 and 1992 when this year-class was age 2 and 3. A secondary problem is that strong to moderate year-classes may reside in the Russian EEZ adjacent to the EEZ as juveniles. Russian catch-age data and anecdotal information suggest that juveniles may comprise a major portion of the catch. There is a potential for the Russian fishery to reduce subsequent abundance in the U.S. fishery.

The GOA pollock fishery also targets mature pollock. Fishery selectivity increases to a maximum around age 5-7 and then declines. In both the EBS and GOA, the selectivity pattern varies between years due to shifts in fishing strategy and changes in the availability of different age groups over time.

In response to continuing concerns over the possible impacts groundfish fisheries may have on rebuilding populations of Steller sea lions, NMFS and the North Pacific Fishery Management Council (Council) have made changes to the Atka mackerel (mackerel) and pollock fisheries in the Bering Sea/Aleutian Islands (BSAI) and GOA. These have been designed to reduce the possibility of competitive interactions with Steller sea lions. For the pollock fisheries, comparisons of seasonal fishery catch and pollock biomass distributions (from surveys) by area in the EBS led to the conclusion that the pollock fishery had disproportionately high seasonal harvest rates within critical habitat which could lead to reduced sea lion prey densities. Consequently, the management measures were designed to redistribute the fishery both temporally and spatially according to pollock biomass distributions. The underlying assumption in this approach was that the independently derived area-wide and annual exploitation rate for pollock would not reduce local prey densities for sea lions. Here NMFS examines the temporal and spatial dispersion of the fishery to evaluate the potential effectiveness of the measures.

Three types of measures were implemented in the pollock fisheries:

- Additional pollock fishery exclusion zones around sea lion rookery or haulout sites
- Phased-in reductions in the seasonal proportions of TAC that can be taken from critical habitat
- Additional seasonal TAC releases to disperse the fishery in time

Prior to the management measures, the pollock fishery occurred in each of the three major fishery management regions of the North Pacific ocean managed by the Council: the AI (1,001,780 square kilometer [km^2] inside the EEZ), the EBS (968,600 km^2), and the GOA (1,156,100 km^2). The marine portion of Steller sea lion critical habitat in Alaska west of 150ºW encompasses 386,770 km^2 of ocean surface, or 12 percent of the fishery management regions.

Prior to 1999, a total of 84,100 km^2, or 22 percent of critical habitat, was closed to the pollock fishery. Most of this closure consisted of the 10 and 20 nm radius all-trawl fishery exclusion zones around sea lion rookeries (48,920 km^2 or 13 percent of critical habitat). The remainder was largely management area 518 (35,180 km^2, or 9 percent of critical habitat) which was closed pursuant to an international agreement to protect spawning stocks of central BS pollock.

In 1999, an additional 83,080 km^2 (21 percent) of critical habitat in the AI was closed to pollock fishing along with 43,170 km^2 (11 percent) around sea lion haulouts in the GOA and EBS. Consequently, a total of 210,350 km^2 (54 percent) of critical habitat was closed to the pollock fishery. The portion of critical habitat that remained open to the pollock fishery consisted primarily of the area between 10 and 20 nm from rookeries and haulouts in the GOA and parts of the EBS foraging area.

The BSAI pollock fishery was also subject to changes in total catch and catch distribution. Disentangling the specific changes in the temporal and spatial dispersion of the EBS pollock fishery resulting from the sea lion management measures from those resulting from implementation of the 1999 American Fisheries Act (AFA) is difficult. The AFA reduced the capacity of the catcher/processor fleet and permitted the formation of cooperatives in each industry sector by 2000. Both of these changes would be expected to reduce the rate at which the catcher/processor sector (allocated 36 percent of the EBS pollock TAC) caught pollock beginning in 1999, and the fleet as a whole in 2000. Because of some of its provisions, the AFA gave the industry the ability to respond efficiently to changes mandated for sea lion conservation that otherwise could have been more disruptive to the industry.

In 2000, further reductions in seasonal pollock catches from BSAI sea lion critical habitat were realized by closing the entire AI region to pollock fishing and by phased-in reductions in the proportions of seasonal TAC that could be caught from the Sea Lion Conservation Area, an area which overlaps considerably with sea lion critical habitat. In 1998, over 22,000 t of pollock were caught in the Aleutian Island regions, with over 17,000 t caught in AI critical habitat. Since 1998 directed fishery removals of pollock have been prohibited.

Relevant Trophic Information

Juvenile pollock through newly maturing pollock primarily utilize copepods and euphausiids for food. At maturation and older ages pollock become increasingly piscivorous, with pollock (cannibalism) a major food item in the BS. Most of the pollock consumed by pollock are age 0 and 1 pollock, and recent research suggests that cannibalism can regulate year-class size. Weak year-classes appear to be those located within the range of adults, while strong year-classes are those that are transported to areas outside the range of adult abundance.

Being the dominant species in the EBS pollock is an important food source for other fish, marine mammals, and birds. On the Pribilof Islands hatching success and fledgling survival of marine birds has been tied to the availability of age 0 pollock to nesting birds.

Approximate Upper Size Limit of Juvenile Fish (in cm): The upper size limit for juvenile pollock in the EBS and GOA is about 38 to 42 cm. This is the size of 50 percent maturity. There is some evidence that this has changed over time.

Habitat and Biological Associations

Egg-Spawning: Pelagic on outer continental shelf generally over 100 to 200 m depth in Bering Sea. Pelagic on continental shelf over 100 to 200 m depth in GOA.

Larvae: Pelagic outer to mid-shelf region in BS. Pelagic throughout the continental shelf within the top 40 m in the GOA.

Juveniles: Age 0 appears to be pelagic, as is age 2 and 3. Age 1 pelagic and demersal with a widespread distribution and no known benthic habitat preference.

Adults: Adults occur both pelagically and demersally on the outer and mid-continental shelf of the GOA, EBS and AI. In the EBS few adult pollock occur in waters shallower than 70 m. Adult pollock also occur pelagically in the Aleutian Basin. Adult pollock range throughout the BS in both the U.S. and Russian waters, however, the maps provided for this document detail distributions for pollock in the EEZ and the basin.

Additional Information Sources

Eggs and Larvae: Jeff Napp, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA.

Shallow Water Concentrations: Bill Bechtol, Alaska Department of Fish and Game, 3298 Douglas Place, Homer, Alaska 99603-8027.

Literature

Bailey, K.M. 2000. Shifting control of recruitment of walleye pollock *Theragra chalcogramma* after a major climatic and ecosystem change. Mar. Ecol. Prog. Ser 198:215-224.

Bailey, K.M., P.J. Stabeno, and D.A. Powers. 1997. The role of larval retention and transport features in mortality and potential gene flow of walleye pollock. J. Fish. Biol. 51(Suppl. A):135-154.

Bailey, K.M., S.J. Picquelle, and S.M. Spring. 1996. Mortality of larval walleye pollock (*Theragra chalcogramma*) in the western GOA, 1988-91. Fish. Oceanogr. 5 (Suppl. 1):124-136.

Bailey, K.M., T.J. Quinn II, P. Bentzen, and W.S. Grant. 1999. Population structure and dynamics of walleye pollock, *Theragra chalcogramma*. Advances in Mar. Biol. 37: 179-255.

Bakkala, R.G., V.G. Wespestad, and L.L. Low. 1987. Historical trends in abundance and current condition of walleye pollock in the EBS. Fish. Res.,5:199_215.

Bates, R.D. 1987. Ichthyoplankton of the GOA near Kodiak Island, April-May 1984. NWAFC Proc. Rep. 87-11, 53 pp.

Brodeur, R.D., and M.T. Wilson. 1996. A review of the distribution, ecology and population dynamics of age-0 walleye pollock in the GOA. Fish. Oceanogr. 5 (Suppl. 1):148-166.

Brown, A.L., and K.M. Bailey. 1992. Otolith analysis of juvenile walleye pollock *Theragra chalcogramma* from the western GOA. Mar. Bio. 112:23-30.

Dorn, M., S. Barbeaux, M. Guttormsen, B. Megrey, A. Hollowed, E. Brown, and K. Spalinger. 2002. Assessment of Walleye Pollock in the GOA. In Stock assessment and fishery evaluation report for the groundfish resources of the GOA, 2002. Council, Box 103136, Anchorage, AK 99510. 88 p.

Grant, W.S., and F.M. Utter. 1980. Biochemical variation in walleye pollock *Theragra chalcogramma*: population structure in the southeastern BS and GOA. Can. J. Fish. Aquat. Sci. 37:1093-1100.

Guttormsen, M.A., C.D. Wilson, and S. Stienessen. 2001. Echo integration-trawl survey results for walleye pollock in the GOA during 2001. In Stock Assessment and Fishery Evaluation Report for GOA. Prepared by the GOA Groundfish Plan Team, Council, P.O. Box 103136, Anchorage, AK 99510. Council, Anchorage, AK.

Hinckley, S. 1987. The reproductive biology of walleye pollock, *Theragra chalcogramma*, in the BS, with reference to spawning stock structure. Fish. Bull. 85:481-498.

Hollowed, A.B., J.N. Ianelli, and P. Livingston. 2000. Including predation mortality in stock assessments: a case study for GOA pollock. ICES J. Mar. Sci. 57:279-293.

Hughes, S.E., and G. Hirschhorn. 1979. Biology of walleye pollock, *Theragra chalcogramma*, in Western GOA. Fish. Bull., U.S. 77:263-274.

Ianelli, J.N. 2002. BS walleye pollock stock structure using morphometric methods. Tech. Report Hokkaido National Fisheries Research Inst. No. 5, 53_58.

Ianelli, J.N., S. Barbeaux, T. Honkalehto, G. Walters, and N. Williamson. 2002. BS-AI Walleye Pollock Assessment for 2003. In Stock assessment and fishery evaluation report for the groundfish resources of the EBS and Aleutian Island Region, 2002. Council, Box 103136, Anchorage, AK 99510. 88 p.

Kendall, A.W., Jr., and S.J. Picquelle. 1990. Egg and larval distributions of walleye pollock *Theragra chalcogramma* in Shelikof Strait, GOA. U.S. Fish. Bull. 88(1):133-154.

Kim, S., and A.W. Kendall, Jr. 1989. Distribution and transport of larval walleye pollock (*Theragra chalcogramma*) in Shelikof Strait, GOA, in relation to water movement. Rapp. P.-v. Reun. Cons. int. Explor. Mer 191:127-136.

Livingston, P.A. 1991. Groundfish food habits and predation on commercially important prey species in the EBS from 1884-1986. U.S. Dept. Commerce, NOAA Tech Memo. NMFS F/NWC-207.

Meuter, F.J., and B.L. Norcross. 2002. Spatial and temporal patterns in the demersal fish community on the shelf and upper slope regions of the GOA. Fish. Bull. 100:559-581.

Mulligan, T.J., R.W. Chapman, and B.L. Brown. 1992. Mitochondrial DNA analysis of walleye pollock, *Theragra chalcogramma*, from the EBS and Shelikof Strait, GOA. Can. J. Fish. Aquat. Sci. 49:319-326.

Olsen, J.B., S.E. Merkouris, and J.E. Seeb. 2002. An examination of spatial and temporal genetic variation in walleye pollock (*Theragra chalcogramma*) using allozyme, mitochondrial DNA, and microsatellite data. Fish. Bull. 100:752-764.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Proc. Rep. 90-01, 162 pp.

Shima, M. 1996. A study of the interaction between walleye pollock and Steller sea lions in the GOA. Ph.D. dissertation, University of Washington, Seattle, WA 98195.

Stabeno, P.J., J.D. Schumacher, K.M. Bailey, R.D. Brodeur, and E.D. Cokelet. 1996. Observed patches of walleye pollock eggs and larvae in Shelikof Strait, Alaska: their characteristics, formation and persistence. Fish. Oceanogr. 5 (Suppl. 1): 81-91.

Wespestad V.G., and T.J. Quinn, II. 1997. Importance of cannibalism in the population dynamics of walleye pollock. In: Ecology of Juvenile Walleye Pollock, *Theragra chalcogramma*. NOAA Technical Report, NMFS 126.

Wespestad, V.G. 1993. The status of BS pollock and the effect of the "Donut Hole" fishery. Fisheries 18(3)18-25.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-AFSC-6, 184 pp.

SPECIES: GOA Walleye Pollock

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	14 d. at 5 C	None	Feb-Apr	OCS, UCS	P	N/A	G?	
Larvae	60 days	copepod naupli and small euphausiids	Mar-Jul	MCS, OCS	P	N/A	G? F	pollock larvae with jellyfish
Juveniles	0.4 to 4.5 years	Pelagic crustaceans, copepods and euphausiids	Aug. +	OCS, MCS, ICS	P, SD	N/A	CL, F	
Adults	4.5 to 16 years	Pelagic crustaceans and fish	Spawning Feb-Apr	OCS, BSN	P, SD	UNK	F UP	Increasingly demersal with age

Habitat Description for Pacific Cod

(Gadus macrocephalus)

Management Plan and Area GOA

Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about lat. 34° N, with a northern limit of about lat. 63° N. Adults are demersal and form aggregations during the peak spawning season, which extends approximately from January through May. Pacific cod eggs are demersal and adhesive. Eggs hatch in about 15 to 20 days. Little is known about the distribution of Pacific cod larvae, which undergo metamorphosis at about 25 to 35 mm. Juvenile Pacific cod start appearing in trawl surveys at a fairly small size, as small as 10 cm in the EBS. Pacific cod can grow to be more than 1 m in length, with weights in excess of 10 kilogram (kg). Natural mortality is believed to be somewhere between 0.3 and 0.4. Approximately 50 percent of Pacific cod are mature by ages 5 to 6. The maximum recorded age of a Pacific cod from the BSAI or GOA is 19 years.

Fishery

The fishery is conducted with bottom trawl, longline, pot, and jig gear. The age at 50 percent recruitment varies between gear types and regions. In the BSAI, the age at 50 percent recruitment is 6 years for trawl gear, 4 years for longline, and 5 years for pot gear. In the GOA, the age at 50 percent recruitment is 5 years for trawl gear and 6 years for longline and pot gear. More than 100 vessels participate in each of the three largest fisheries (trawl, longline, pot). The trawl fishery is typically concentrated during the first few months of the year, whereas fixed-gear fisheries may sometimes run, intermittently, at least, throughout the year. Bycatch of crab and halibut sometimes causes the Pacific cod fisheries to close prior to reaching the TAC. In the BSAI, trawl fishing is concentrated immediately north of Unimak Island, whereas the longline fishery is distributed along the shelf edge to the north and west of the Pribilof Islands. In the GOA, the trawl fishery has centers of activity around the Shumagin Islands and south of Kodiak Island, while the longline fishery is located primarily in the vicinity of the Shumagins.

Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the BSAI and GOA are polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, fishery discards, and yellowfin sole. Small Pacific cod feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod include halibut, salmon shark, northern fur seals, sea lions, harbor porpoises, various whale species, and tufted puffin.

Approximate Upper Size Limit of Juvenile Fish (in cm): The estimated size at 50 percent maturity is 67 cm.

Habitat and Biological Associations

Egg/Spawning: Spawning takes place in the sublittoral-bathyal zone (40 to 290 m) near bottom. Eggs sink to the bottom after fertilization and are somewhat adhesive. Optimal temperature for incubation is 3 to 6°C, optimal salinity is 13 to 23 parts per thousand (ppt), and optimal oxygen concentration is from 2 to 3 ppm to saturation. Little is known about the optimal substrate type for egg incubation.

Larvae: Larvae are epipelagic, occurring primarily in the upper 45 m of the water column shortly after hatching, moving downward in the water column as they grow.

Juveniles: Juveniles occur mostly over the inner continental shelf at depths of 60 to 150 m.

Adults: Adults occur in depths from the shoreline to 500 m. Average depth of occurrence tends to vary directly with age for at least the first few years of life, with mature fish concentrated on the outer continental shelf. Preferred substrate is soft sediment, from mud and clay to sand.

Additional Information Sources

NMFS, Alaska Fisheries Science Center, FOCI Program, Ann Matarese.

Literature

Albers, W.D., and P.J. Anderson. 1985. Diet of Pacific cod, *Gadus macrocephalus*, and predation on the northern pink shrimp, *Pandalus borealis*, in Pavlof Bay, Alaska. Fish. Bull., U.S. 83:601-610.

Alderdice, D.F., and C.R. Forrester. 1971. Effects of salinity, temperature, and dissolved oxygen on early development of the Pacific cod (*Gadus macrocephalus*). J. Fish. Res. Board Can. 28:883-902.

Bakkala, R.G. 1984. Pacific cod of the EBS. Int. N. Pac. Fish. Comm. Bull. 42:157-179.

Dunn, J.R., and A.C. Matarese. 1987. A review of the early life history of northeast Pacific gadoid fishes. Fish. Res. 5:163-184.

Forrester, C.R., and D.F. Alderdice. 1966. Effects of salinity and temperature on embryonic development of Pacific cod (*Gadus macrocephalus*). J. Fish. Res. Board Can. 23:319-340.

Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in Alaska and Pacific Coast regions, 1975-81. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS F/NWC-44. 50 p.

Ketchen, K.S. 1961. Observations on the ecology of the Pacific cod (*Gadus macrocephalus*) in Canadian waters. J. Fish. Res. Board Can. 18:513-558.

Livingston, P.A. 1989. Interannual trends in Pacific cod, *Gadus macrocephalus*, predation on three commercially important crab species in the EBS. Fish. Bull., U.S. 87:807-827.

Livingston, P.A. 1991. Pacific cod. *In* P.A. Livingston (editor), Groundfish food habits and predation on commercially important prey species in the EBS from 1984 to 1986, p. 31-88. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-207.

Matarese, A.C., A.W. Kendall Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dept. Commerce, NOAA Tech. Rep. NMFS 80. 652 p.

Moiseev, P.A. 1953. Cod and flounders of far eastern waters. Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 40. 287 p. (Transl. from Russian: Fish. Res. Board Can. Transl. Ser. 119.)

NOAA. 1987. Bering, Chukchi, and Beaufort Seas--Coastal and ocean zones strategic assessment: Data Atlas. U.S. Dept. Commerce, NOAA, National Ocean Service.

NOAA. 1990. West coast of North America--Coastal and ocean zones strategic assessment: Data Atlas. U.S. Dept. Commerce, NOAA, National Ocean Service and NMFS.

Phillips, A.C., and J.C. Mason. 1986. A towed, self-adjusting sld sampler for demersal fish eggs and larvae. Fish. Res. 4:235-242.

Rugen, W.C., and A.C. Matarese. 1988. Spatial and temporal distribution and relative abundance of Pacific cod (*Gadus macrocephalus*) larvae in the western GOA. NWAFC Proc. Rep. 88-18. Available from Alaska Fish. Sci. Center, 7600 Sand Point Way NE., Seattle, WA 98115-0070.

Thompson, G.G., and M.W. Dorn. 2002. Assessment of the Pacific cod stock in the EBS and AI area. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI Regions, Plan Team for the Groundfish Fisheries of the BS and AI (editor), p. 121-205. Available from Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Thompson, G.G., H.H. Zenger, and M.W. Dorn. 2002. Assessment of the Pacific cod stock in the GOA. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, Plan Team for the GOA (editor), p. 89-167. Available from Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Westrheim, S.J. 1996. On the Pacific cod (*Gadus macrocephalus*) in British Columbia waters, and a comparison with Pacific cod elsewhere, and Atlantic cod (*G. morhua*). Can. Tech. Rep. Fish. Aquat. Sci. 2092. 390 p.

SPECIES: Pacific Cod

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	15 to 20 days	NA	winter-spring	ICS, MCS, OCS	D	M, SM, MS, S	U	optimum 3-6°C optimum salinity 13-23 ppt
Larvae	U	copepods (?)	winter-spring	U	P (?), N (?)	U	U	
Early Juveniles	to 2 years	small invertebrates (mysids, euphausiids, shrimp)	all year	ICS, MCS	D	M, SM, MS, S	U	
Late Juveniles	to 5 years	pollock, flatfish, fishery discards, crab	all year	ICS, MCS, OCS	D	M, SM, MS, S	U	
Adults	5+ yr	pollock, flatfish, fishery discards, crab	spawning (Jan-May) non-spawning (Jun-Dec)	ICS, MCS, OCS ICS, MCS, OCS	D	M, SM, MS, S,G	U	

Habitat Description for Dover Sole

(*Microstomus pacificus*)

Management Plan and Area GOA

Life History and General Distribution

Dover sole are distributed in deep waters of the continental shelf and upper slope from northern Baja California to the BS and the western AI (Hart 1973, Miller and Lea 1972). They exhibit a widespread distribution throughout the GOA. Adults are demersal and are mostly found in water deeper than 300 m in the winter but occur in highest biomass in the 100- to 200-m depth range during summer in the GOA (Turnock et al. 2004). The spawning period off Oregon is reported to range from January through May (Hunter et al. 1992). Off California, Dover sole spawn in deep water, and the larvae eventually settle in the shallower water of the continental shelf. They gradually move down the slope into deeper water as they grow and reach sexual maturity (Jacobson and Hunter 1993,Vetter et al. 1994, Hunter et al. 1990). For mature adults, most of the biomass may inhabit the oxygen minimum zone in deep waters Spawning in the GOA has been observed from January through August, with a peak period in May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over mid-shelf and slope areas (Kendall and Dunn 1985). The age or size at metamorphosis is unknown, but the pelagic larval period is known to be protracted and may last as long as 2 years (Markle et al. 1992). Pelagic postlarvae as large as 48 mm have been reported, and the young may still be pelagic at 10 cm (Hart 1973). Dover sole are batch spawners, and Hunter et al. (1992) concluded that the average 1 kg female spawns its 83,000 advanced yolked oocytes in about nine batches. Maturity studies from Oregon indicate that females were 50 percent mature at 33 cm total length. Juveniles less than 25 cm are rarely found with the adult population from bottom trawl surveys (Martin and Clausen 1995). The natural mortality rate used in recent stock assessments is 0.2 (Turnock et al. 2002).

Fishery

Dover sole are caught in bottom trawls, both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 5. They are caught as bycatch in the rex sole, thornyhead, and sablefish fisheries, and they are caught with these species and Pacific halibut in Dover sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate Upper Size Limit of Juvenile Fish (in cm): The approximate upper size limit of juvenile Dover sole is 32 cm.

Habitat and Biological Associations

Larvae/Juveniles: Dover sole are planktonic larvae for up to 2 years until metamorphosis occurs; juvenile distribution is unknown.

Adults: Dover sole are winter and spring spawners, and summer feeding occurs on soft substrates (combination of sand and mud) of the continental shelf and upper slope. Shallower summer distribution occurs mainly on the middle to outer portion of the shelf and upper slope. They feed mainly on polychaetes, annelids, crustaceans, and mollusks (Livingston and Goiney 1983).

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Hunter, J.R., J.L. Butler, C.A. Kimbrell, and E.A. Lynn. 1990. Bathymetric patterns in size, age, sexual maturity, water content, caloric density of Dover sole, *Microstomus pacificus*. CALCOFI Rep., Vol. 31, 1990.

Hunter, J.R., B.J. Macewicz, N.C. Lo, and C.A. Kimbrell. 1992. Fecundity, spawning, and maturity of female Dove sole *Microstomus pacificus*, with an evaluation of assumptions and precision. Fish. Bull. 90:101-128(1992).

Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in the Alaska and Pacific coast regions. 50 p. NOAA Tech. Mem. NMFS F/NWC-44. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv.

Jacobson, L.D., and J.R. Hunter. 1993. Bathymetric Demography and Management of Dover Sole. NAJFM 13:405-420. 1993.

Kendall, A.W. Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U.S. Dep. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. NOAA Tech. Mem. NMFS F/NWC-54, U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv.

Markle, D.F., Harris, P, and C. Toole. 1992. Metamorphosis and an overview of early-life-history stages in Dover sole *Microstomus pacificus*. Fish. Bull. 90:285-301.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA Bottom Trawl Survey. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv., NOAA Tech. Mem. NMFS-AFSC-59, 217 p.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dept. Fish. Game, Fish. Bull. 157, 235 p.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2002. Flatfish. In Appendix B Stock assessment and fishery evaluation Report for the groundfish resources of the GOA. p 169-197. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Vetter, R.D., E.A. Lynn, M. Garza, and A.S. Costa. 1994. Depth zonation and metabolic adaptation in Dover sole, Microstomus pacificus, and other deep-living flatfishes: factors that affect the sole. Mar. Biol. (1994) 120:145-159.

SPECIES: Dover Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	spring summer	ICS? MCS OCS USP	P			
Larvae	up to 2 years	U phyto/zoo plankton?	all year	ICS? MCS OCS USP	P			
Early Juveniles	to 3 years	polychaetes amphipods annelids	all year	MCS? ICS?	D	S, M		
Late Juveniles	3 to 5 years	polychaetes amphipods annelids	all year	MCS? ICS?	D	S, M		
Adults	5+ years	polychaetes amphipods annelids mollusks	spawning Jan-August non-spawning July-January	MCS OCS USP	D	S, M		

Habitat Description for Greenland Turbot

(Reinhardtius hippoglossoides)

Management Plan and Area GOA

Life History and General Distribution

Greenland turbot has an amphiboreal distribution, occurring in the North Atlantic and North Pacific, but not in the intervening Arctic Ocean. In the North Pacific, species abundance is centered in the EBS and, secondly, in the Aleutians. On the Asian side, they occur in the Gulf of Anadyr along the BS coast of Russia, in the Okhotsk Sea, around the Kurile Islands, and south to the east coast of Japan to northern Honshu Island (Hubbs and Wilimovsky 1964, Mikawa 1963, Shuntov 1965). Adults exhibit a benthic lifestyle, living in deep waters of the continental slope but are known to have a tendency to feed off the sea bottom. During their first few years as immature fish, they inhabit relatively shallow continental shelf waters (<200 m) until about age 4 or 5 before joining the adult population (200 to 1,000 m or more, Templeman 1973). Adults appear to undergo seasonal shifts in depth distribution moving deeper in winter and shallower in summer (Chumakov 1970, Shuntov 1965). Spawning is reported to occur in winter in the EBS and may be protracted starting in September or October and continuing until March with an apparent peak period in November to February (Shuntov 1970, Bulatov 1983). Females spawn relatively small numbers of eggs with fecundity ranging from 23,900 to 149,300 for fish 83 cm and smaller in the BS (D'yakov 1982).

Eggs and early larval stages are benthypelagic (Musienko 1970). In the Atlantic Ocean, larvae (10 to 18 cm) have been found in benthypelagic waters, which gradually rise to the pelagic zone in correspondence to absorption of the yolk sac; this is reported to occur at 15 to 18 mm with the onset of feeding (Pertseva-Ostroumova 1961 and Smidt 1969). The period of larval development extends from April to as late as August or September (Jensen 1935), which results in an extensive larval drift and broad dispersal from the spawning waters of the continental slope. Metamorphosis occurs in August or September at about 7 to 8 cm in length at which time the demersal life begins. Juveniles are reported to be quite tolerant of cold temperatures to less than 0ºC (Hognestad 1969) and have been found on the northern part of the BS shelf in summer trawl surveys (Alton et al. 1988).

The age of 50 percent maturity is estimated to range from 5 to 10 years (D'yakov 1982, 60 cm used in stock assessment), and a natural mortality rate of 0.18 has been used in the most recent BS stock assessment (Ianelli et al. 2002).

Fishery

Greenland turbot are not a fishery target in the GOA. They are caught in bottom trawls and on longlines both as a directed fishery and in the pursuit of other bottom-dwelling species (primarily sablefish). These fisheries operate on the southern side of the AI. Bycatch primarily occurs in the sablefish directed fisheries and also to a smaller extent in the Pacific cod fishery. Recruitment begins at about 50 and 60 cm in the trawl and longline fisheries, respectively.

Relevant Trophic Information

Groundfish predators include Pacific cod, pollock, and yellowfin sole, mostly on fish ranging from 2 to 5 cm standard length (probably age 0).

Approximate Upper Size Limit of Juvenile Fish (in cm): 59 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for up to 9 months until metamorphosis occurs, usually with a widespread distribution inhabiting shallow waters. Juveniles live on continental shelf until about age 4 or 5 feeding primarily on euphausiids, polychaetes and small walleye pollock.

Adults: Inhabit continental slope waters with annual spring/fall migrations from deeper to shallower waters. Diet consists of walleye pollock and other miscellaneous fish species.

Literature

Alton, M.S., R.G. Bakkala, G.E. Walters, and P.T. Munro. 1988. Greenland turbot, *Reinhardtius hippoglossoides*, of the EBS and AI. U.S. Dept. Commer., NOAA Tech. Rpt. NMFS 71, 31 pages.

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Bulatov, O.A. 1983. Distribution of eggs and larvae of Greenland halibut, *Reinhardtius hippoglossoides*, (Pleuronectidae) in the EBS. J. Ichthyol. [Engl. Transl. Vopr. Ikhtiol.] 23(1):157-159.

Chumakov, A.K. 1970. The Greenland halibut, *Reinhardtius hippoglossoides*, in the Iceland area-The halibut fisheries and tagging. Tr. Polyarn. Nauchno-Issled. Proektn. Inst. Morsk. Rybn. Khoz. 1970:909-912.

D'yakov, Yu. P. 1982. The fecundity of the Greenland halibut, *Reinhardtius hippoglossoides* (Pleuronectidae), from the BS. J. Ichthyol. [Engl. Trans. Vopr. Ikhtiol.] 22(5):59-64.

Hognestad, P.T. 1969. Notes on Greenland halibut, *Reinhardtius hippoglossoides*, in the eastern Norwegian Sea. Fiskeridir. Skr. Ser. Havunders. 15(3):139-144.

Hubbs, C.L., and N.J. Wilimovsky. 1964. Distribution and synonymy in the Pacific Ocean and variation of the Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum). J. Fish. Res. Board Can. 21:1129-1154.

Ianelli, J.N.,C. Minte-Vera, T.K. Wilderbuer, and T.M. Sample. 2002. Greenland turbot. *In* Appendix A Stock Assessment and Fishery Evaluation Report for the groundfish resources of the BSAI Regions, Pages 255-282Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Jensen, A.S. 1935. (*Reinhardtius hippoglossoides*) its development and migrations. K. dan. Vidensk. Selsk. Skr. 9 Rk., 6:1-32.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way, NE., Seattle, WA 98115.

Mikawa, M. 1963. Ecology of the lesser halibut, *Reinhardtius hippoglossoides matsuurae* Jordan and Snyder. Bull. Tohoku Reg. Fish. Res. Lab. 29:1-41.

Musienko, L.N. 1970. Reproduction and Development of BS. Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72)161-224. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1972, p. 161-224. In P. A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part V. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT71-50127.

Pertseva-Ostroumova, T.A. 1961. The reproduction and development of far eastern flounders. Izdatel'stvo Akad. Nauk. SSSR, 483 p. [Transl. By Fish. Res. Board Can., 1967, Transl. Ser. 856, 1003 p.]

Shuntov, V.P. 1965. Distribution of the Greenland halibut and arrowtooth halibuts in the North Pacific. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 53):155-163. [Transl. In Soviet Fisheries Investigation in the Northeastern Pacific, Part IV, p. 147-156, by Israel Prog. Sci. Transl., 1972, avail. Natl. Tech. Inf. Serv., Springfield, VA as TT71-50127.]

Templeman, W. 1973. Distribution and abundance of the Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum), in the Northwest Atlantic. Int. Comm. Northwest Atl. Fish. Res. Bull. 10:82-98.

SPECIES: Greenland Turbot

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	winter	OCS MCS	SD, SP			
Larvae	8 to 9 months	U phyto/zoo plankton?	Spring summer	OCS ICS MCS	P			
Juveniles	1 to 5 years	euphausiids polychaets small pollock	all year	ICS MCS OCS USL	D, SD	M/S+M[1]		
Adults	5+ years	pollock small fish	spawning Nov-February	OCS USP LSP	D, SD	M/S+M[1]		
			non-spawning March-October	OCS USP LSP				

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Rock Sole

(Lepidopsetta bilineatus)

The shallow water flatfish management complex in the GOA consists of eight species: rock sole (*Lepidopsetta bileneata and Lepidopsetta polyxystra*), yellowfin sole (*Limanda aspera*), starry flounder (*Platichthys stellatus*), butter sole (*Isopsetta isolepis*), English sole (*Parophrys vetulus*), Alaska plaice (*Pleuronectes quadrituberculatus*) and sand sole (*Psettichthys melanostictus*). The rock sole resource in the GOA consists of two separate species; a northern and a southern form which have distinct characteristics and overlapping distributions. The two species of rock sole and yellowfin sole are the most abundant and commercially important species of this management complex in the GOA, and the description of their habitat and life history best represents the shallow water complex species.

Management Plan and Area GOA

Life History and General Distribution

Rock sole are distributed from California waters north into the GOA and BS to as far north as the Gulf of Anadyr. The distribution continues along the AI westward to the Kamchatka Peninsula and then southward through the Okhotsk Sea to the Kurile Islands, Sea of Japan, and off Korea. Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central GOA, and in the southeastern BS (Alton and Sample 1975). Adults exhibit a benthic lifestyle and, in the EBS, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Rock sole spawn during the winter-early spring period of December-March. Soviet investigations in the early 1960s established two spawning concentrations: an eastern concentration north of Unimak Island at the mouth of Bristol Bay and a western concentration eastward of the Pribilof Islands between 55°30' and 55°0' N and approximately 165°2' W (Shubnikov and Lisovenko 1964). Rock sole spawning in the eastern and western BS was found to occur at depths of 125 to 250 m, close to the shelf/slope break. Spawning females deposit a mass of eggs that are demersal and adhesive (Alton and Sample 1975). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11ºC to about 25 days at 2.9ºC (Forrester 1964). Newly hatched larvae are pelagic and have occurred sporadically in EBS plankton surveys (Waldron and Vinter 1978). Kamchatka larvae are reportedly 20 mm in length when they assume their side-swimming, bottom-dwelling form (Alton and Sample 1975). Forrester and Thompson (1969) report that by age 1 they are found with adults on the continental shelf during summer.

In the springtime, after spawning, rock sole begin actively feeding and commence a migration to the shallow waters of the continental shelf. This migration has been observed on both the eastern (Alton and Sample 1975) and western (Shvetsov 1978) areas of the BS. During this time they spread out and form much less dense concentrations than during the spawning period. Summertime trawl surveys indicate most of the population can be found at depths from 50 to 100 m (Armistead and Nichol 1993). The movement from winter/spring to summer grounds is in response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,00 eggs for fish 42 cm long. Larvae are pelagic, but their occurrence in plankton surveys in the EBS is rare (Musienko 1963). The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach age 1 (Forrester 1969). The estimated age of 50 percent maturity is 9 years for southern rock sole females (approximately 35 cm) and 7 years for northern rock sole females (Stark and Somerton 2002). The natural mortality rate is believed to range from 0.18 to 0.20 (Tournock et al. 2002).

Fishery

Rock sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 4 and they are fully selected at age 11. Historically, the fishery has occurred throughout the mid and inner BS shelf during ice-free conditions and on spawning concentrations north of the Alaska Peninsula during winter for their high-value roe. They are caught as bycatch in Pacific cod, bottom pollock, and other flatfish fisheries and are caught with these species and Pacific halibut in rock sole directed fisheries.

Relevant Trophic Information

Groundfish predators to rock sole include Pacific cod, walleye pollock, skates, Pacific halibut, and yellowfin sole, mostly on fish ranging from 5 to 15 cm standard length.

Approximate Upper Size Limit of Juvenile Fish (in cm): 34 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, juveniles inhabit shallow areas at least until age 1.

Adults: Summertime feeding on primarily sandy substrates of the EBS shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding on bivalves, polychaetes, amphipods and miscellaneous crustaceans. Wintertime migration to deeper waters of the shelf margin for spawning and to avoid extreme cold water temperatures, feeding diminishes.

Literature

Alton, M.S., and T.M. Sample. 1976. Rock sole (Family Pleuronectidae) p. 461-474. *In*: Demersal fish and shellfish resources in the BS in the baseline year 1975. Principal investigators Walter T. Pereyra, Jerry E. Reeves, and Richard Bakkala. U.S. Dep. Comm., Natl. Oceanic Atmos. Admin., Natl. Mar. Serv., Northwest and Alaska Fish Center, Seattle, WA. Processed Rep., 619 p.

Armistead, C.E., and D.G. Nichol. 1993. 1990 Bottom Trawl Survey of the EBS Continental Shelf. U.S. Dep. Commer., NOAA Tech. Mem. NMFS-AFSC-7, 190 p.

Auster, P.J., R.J. Malatesta., R.W. Langton., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Forrester, C.R. 1964. Demersal Quality of fertilized eggs of rock sole. J. Fish. Res. Bd. Canada, 21(6), 1964. P. 1531.

Forrester, C.R., and J.A. Thompson. 1969. Population studies on the rock sole, *Lepidopsetta bilineata*, of northern Hecate Strait British Columbia. Fish. Res. Bd. Canada, Tech. Rep. No. 108, 1969. 104 p.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Musienko, L.N. 1963. Ichthyoplankton of the BS (data of the BS expedition of 1958-59). Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 50)239-269. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 251-286. In P. A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part I. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT67-51203.

Shubnikov, D.A., and L.A. Lisovenko. 1964. Data on the biology of rock sole in the southeastern BS. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 49 (Izv. Tikookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 51) : 209-214. (Transl. In Soviet Fisheries Investigations in the Northeast Pacific, Part II, p. 220-226, by Israel Program Sci. Transl., 1968, available Natl. Tech. Inf. Serv., Springfield, VA, as TT 67-51204).

Shvetsov, F.G. 1978. Distribution and migrations of the rock sole, *Lepidopsetta bilineata*, in the regions of the Okhotsk Sea coast of Paramushir and Shumshu Islands. J. Ichthol., 18 (1), 56-62, 1978.

Stark, J.W., and D. A. Somerton. 2002. Maturation, spawning and growth of rock soles off Kodiak Island in the GOA. J. Fish. Biology (2002) 61, 417-431.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2002. Flatfish. In Appendix B Stock Assessment and Fishery Evaluation for Groundfish Resources of the GOA Region. Pages 169-197. Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. U. S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv. Seattle, WA, Processed rep., 88 p.

SPECIES: Rock Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	winter	OCS	D			
Larvae	2 to 3 months?	U phyto/zoo plankton?	winter/spring	OCS MCS ICS	P			
Early Juveniles	to 3.5 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S[1],G		
Late Juveniles	up to 9 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S[1],G		
Adults	9+ years	polychaetes bivalves amphipods misc. crust.	feeding May-September spawning Dec.-April	MCS ICS MCS OCS	D	S[1], G	ice edge	

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Yellowfin Sole

(Limanda aspera)

Management Plan and Area Shallow water flatfish complex in the GOA

Life History and General Distribution

Yellowfin sole are distributed in North American waters from off British Columbia, Canada (approximately lat. 49° N) to the Chukchi Sea (about lat. 70° N) and south along the Asian coast to about lat. 35° N off the South Korean coast in the Sea of Japan. Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the EBS shelf. From over-winter grounds near the shelf margins, adults begin a migration onto the inner shelf in April or early May each year for spawning and feeding. A protracted and variable spawning period may range from as early as late May through August occurring primarily in shallow water. Fecundity varies with size and was reported to range from 1.3 to 3.3 million eggs for fish 25 to 45 cm long. Eggs have been found to the limits of inshore ichthyoplankton sampling over a widespread area to at least as far north as Nunivak Island. Larvae have been measured at 2.2 to 5.5 mm in July and 2.5 to 12.3 mm in late August - early September. The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach approximately 15 cm. The estimated age of 50 percent maturity is 10.5 years (approximately 29 cm) for females based on samples collected in 1992 and 1993. Natural mortality rate is believed to range from 0.12 to 0.16.

Fishery

Yellowfin sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 6 and they are fully selected at age 13. Historically, the fishery has occurred throughout the mid and inner BS shelf during ice-free conditions although much effort has been directed at the spawning concentrations in nearshore northern Bristol Bay. They are caught as bycatch in Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in yellowfin sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, skates, and Pacific halibut, mostly on fish ranging from 7 to 25 cm standard length.

Approximate Upper Size Limit of Juvenile Fish (in cm): 27 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime spawning and feeding on sandy substrates of the EBS shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding mainly on bivalves, polychaetes, amphipods and echiurids. Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures, feeding diminishes.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Bakkala, R.G., V.G. Wespestad, and L.L. Low. 1982. The yellowfin sole (*Limanda aspera*) resource of the EBS--Its current and future potential for commercial fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-33, 43 p.

Fadeev, N.W. 1965. Comparative outline of the biology of fishes in the southeastern part of the BS and condition of their resources. [In Russ.] Tr. Vses. Nauchno-issled. Inst.Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled Inst. Morsk. Rybn. Khoz. Okeanogr. 53):121-138. (Trans. By Isr. Prog. Sci. Transl., 1968), p 112-129. In P.A. Moiseev (Editor), Soviet Fisheries Investigations in the northeastern Pacific, Pt. IV. Avail. Natl. Tech. Inf. Serv., Springfield, VA as TT 67-51206.

Kashkina, A.A. 1965. Reproduction of yellowfin sole (*Limanda aspera*) and changes in its spawning stocks in the EBS. Tr. Vses. Nauchno-issled, Inst. Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled. Inst. Rbn. Khoz. Okeanogr. 53):191-199. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 182-190. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part IV. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT67-51206.

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Musienko, L.N. 1963. Ichthyoplankton of the BS (data of the BS expedition of 1958-59). Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 50)239-269. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 251-286. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part I. Avail. Natl. Tech. Inf. Serv., Springfield, VA, as TT67-51203.

Musienko, L.N. 1970. Reproduction and Development of BS. Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72)161-224. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1972, p. 161-224. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part V. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT71-50127.

Nichol, D.G. 1994. Maturation and Spawning of female yellowfin sole in the EBS. Preceding of the International North Pacific Flatfish Symposium, Oct. 26-28, 1994, Anchorage, AK. Alaska Sea Grant Program.

Wakabayashi, K. 1986. Interspecific feeding relationships on the continental shelf of the EBS, with special reference to yellowfin sole. Int. N. Pac. Fish. Comm. Bull. 47:3-30.

Waldron, K.D. 1981. Ichthyoplankton. In D.W. Hood and J.A. Calder (Editors), The EBS shelf: Oceanography and resources, Vol. 1, p. 471-493. U.S. Dep. Commer., NOAA, Off. Mar. Poll. Asess., U.S. Gov. Print. Off., Wash., D.C.

Wilderbuer, T.K., G.E. Walters, and R.G. Bakkala. 1992. Yellowfin sole, Pleuronectes asper, of the EBS: Biological Characteristics, History of Exploitation, and Management. Mar. Fish. Rev. 54(4) p 1-18.

SPECIES: Yellowfin Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	summer	BAY, BCH	P			
Larvae	2 to 3 months?	U phyto/zoo plankton?	summer autumn?	BAY BCH ICS	P			
Early Juveniles	to 5.5 years	polychaetes bivalves amphipods echiurids	all year	BAY ICS OCS MCS	D	S[1]		
Late Juveniles	5.5 to 10 years	polychaetes bivalves amphipods echiurids	all year	BAY ICS, OCS, MCS IP	D	S[1]		
Adults	10+ years	polychaetes bivalves amphipods echiurids	spawning/ feeding May-August non-spawning Nov.-April	BAY BEACH ICS, MCS, OCS IP	D	S[1]	ice edge	

1Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Rex Sole

(*Glyptocephalus zachirus)*

Management Plan and Area GOA

Life History and General Distribution

Rex sole are distributed from Baja California to the BS and western AI (Hart 1973, Miller and Lea 1972), and are widely distributed throughout the GOA. Adults exhibit a benthic lifestyle and are generally found in water deeper than 300 m. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year. The spawning period off Oregon is reported to range from January through June with a peak in March and April (Hosie and Horton 1977). Spawning in the GOA was observed from February through July, with a peak period in April and May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets mainly in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over midshelf and slope areas (Kendall and Dunn 1985). Fecundity estimates from samples collected off the Oregon coast ranged from 3,900 to 238,100 ova for fish 24 to 59 cm (Hosie and Horton 1977). The age or size at metamorphosis is unknown Maturity studies from Oregon indicate that males were 50 percent mature at 16 cm and females at 24 cm. Juveniles less than 15 cm are rarely found with the adult population. The natural mortality rate used in recent stock assessments is 0.2 (Turnock et al. 2002).

Fishery

Rex sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3 or 4. They are caught as bycatch in the Pacific ocean perch, Pacific cod, bottom pollock, and other flatfish fisheries and are caught with these species and Pacific halibut in rex sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate Upper Size Limit of Juvenile Fish (in cm): Males 15 cm and females 23 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for an unknown time period until metamorphosis occurs, juvenile distribution is unknown.

Adults: Spring spawning and summer feeding on a combination of sand, mud and gravel substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on polychaetes, amphipods, euphausids and snow crabs.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Hosie, M.J., and H.F. Horton. 1977. Biology of the rex sole, *Glyptocephalus zachirus*, in waters off Oregon. Fish. Bull. Vol. 75, No. 1, 1977, p. 51-60.

Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in the Alaska and Pacific coast regions. 50 p. NOAA Tech. Mem. NMFS F/NWC-44. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U.S. Dep. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. NOAA Tech. Mem. NMFS F/NWC-54, U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dep. Fish. Game, Fish. Bull. 157, 235 p.

Turnock, B.J., T.K. Wilderbuer, and E. S. Brown. 2002. Flatfish. *In* Stock assessment and fishery evaluation Report for the groundfish resources of the GOA. p 169-197. North Pac. Fish. Mgmt. Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

SPECIES: Rex Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	Feb - May	ICS? MCS OCS	P			
Larvae	U	U phyto/zoo plankton?	spring summer	ICS? MCS OCS	P			
Juveniles	2 years	polychaetes amphipods euphausiids Tanner crab	all year	MCS ICS OCS	D	G, S, M		
Adults	2+ years	polychaetes amphipods euphausiids Tanner crab	spawning Feb-May non-spawning May-January	MCS, OCS USP	D	G, S, M		

Habitat Description for Flathead Sole

(*Hippoglossoides elassodon*)

Management Plan and Area GOA

Life History and General Distribution

Flathead sole are distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the GOA and the BS, the Kuril Islands, and possibly the Okhotsk Sea (Hart 1973).

Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the EBS shelf and in the GOA. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year for feeding. The spawning period may range from as early as January but is known to occur in March and April, primarily in deeper waters near the margins of the continental shelf. Eggs are large (2.75 to 3.75 mm) and females have egg counts ranging from about 72,000 (20 cm fish) to almost 600,000 (38 cm fish). Eggs hatch in 9 to 20 days depending on incubation temperatures within the range of 2.4 to 9.8°C and have been found in ichthyoplankton sampling on the southern portion of the BS shelf in April and May (Waldron 1981). Larvae absorb the yolk sac in 6 to 17 days, but the extent of their distribution is unknown. Nearshore sampling indicates that newly settled larvae are in the 40 to 50 mm size range (Norcross et al. 1996). Flathead sole females in the GOA become 50 percent mature at 8 years or about 32 cm (Turnock et al. 2002). Juveniles less than age 2 have not been found with the adult population, remaining in shallow areas. The natural mortality rate used in recent stock assessments is 0.2.

Fishery

Flathead sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3. Historically, the fishery has occurred throughout the mid and outer BS shelf during ice-free conditions (mostly summer and fall). They are caught as bycatch in Pacific cod, bottom Pollock and other flatfish fisheries and are caught with these species and Pacific halibut in flathead sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder, and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length.

Approximate Upper Size Limit of Juvenile Fish (in cm): 31 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for 3 to 5 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Winter spawning and summer feeding on sand and mud substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on ophiuroids, tanner crab, osmerids, bivalves and polychaetes.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on sea floor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Forrester, C.R., and D.F. Alderdice. 1967. Preliminary observations on embryonic development of the flathead sole (*Hippoglossoides elassodon*). Fish. Res. Board Can. Tech. Rep. 100: 20 p

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Miller, B.S. 1969. Life history observations on normal and tumor bearing flathead sole in East Sound, Orcas Island (Washington). Ph.D. Thesis. Univ. Wash. 131 p.

Norcross, B.L., B.A. Holladay, S.C. Dressel, and M. Frandsen. 1996. Recruitment of juvenile flatfishes in Alaska: habitat preference near Kodiak Island. U. Alaska Coastal Marine Institute, OCS Study MMS 96-0003, Vol. 1.

Pacunski, R.E. 1990. Food habits of flathead sole (*Hippoglossoides elassodon*) in the EBS. M.S. Thesis. Univ. Wash. 106 p.

Turnock, B.J., T.K. Wilderbuer, and E. S. Brown. 2002. Flathead sole. *In* Stock assessment and fishery evaluation Report for the groundfish resources of the GOA. p 361-408. North Pac. Fish. Mgmt. Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Waldron, K.D. 1981. Ichthyoplankton. In D.W. Hood and J.A. Calder (Editors), The EBS shelf: Oceanography and resources, Vol. 1, p. 471-493. U.S. Dep. Commer., NOAA, Off. Mar. Poll. Asess., U.S. Gov. Print. Off., Wash., D.C.

SPECIES: Flathead Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	winter	ICS MCS OCS	P			
Larvae	U	U phyto/zoo plankton?	spring summer	ICS MCS OCS	P			
Juveniles	U	polychaetes bivalves ophiuroids	all year	MCS ICS OCS	D	S+M[1]		
Adults	U	polychaetes bivalves ophiuroids pollock and Tanner crab	spawning Jan-April non-spawning May-December	MCS OCS ICS	D	S+M[1]	ice edge	

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Arrowtooth Flounder

(*Atheresthes stomias*)

Management Plan and Area GOA

Life History and General Distribution

Arrowtooth flounder are distributed in North American waters from central California to the EBS on the continental shelf and upper slope.

Adults exhibit a benthic lifestyle and occupy separate winter and summer distributions on the EBS shelf. From over-winter grounds near the shelf margins and upper slope areas, adults begin a migration onto the middle and inner shelf in April or early May each year with the onset of warmer water temperatures. A protracted and variable spawning period may range from as early as September through March (Rickey 1994, Hosie 1976). Little is known of the fecundity of arrowtooth flounder. Larvae have been found from ichthyoplankton sampling over a widespread area of the EBS shelf in April and May and also on the continental shelf east of Kodiak Island during winter and spring (Waldron and Vinter 1978, Kendall and Dunn 1985). Nearshore sampling in the Kodiak Island area indicates that newly settled larvae are in the 40 to 60 mm size range (Norcross et al. 1996). Juveniles are separate from the adult population, remaining in shallow areas until they reach the 10 to 15 cm range (Martin and Clausen 1995). The estimated length at 50 percent maturity is 28 cm for males (4 years) and 37 cm for females (5 years) from samples collected off the Washington coast (Rickey 1994) and 47 cm for GOA females (Zimmerman 1997). The natural mortality rate used in stock assessments differs by sex with females estimated at 0.2 and male natural mortality ranging from 0.28 to 0.35 (Turnock et. al 2002, Wilderbuer and Sample 2002).

Fishery

Arrowtooth flounder are caught in bottom trawls usually in pursuit of other higher value bottom-dwelling species. Historically, they have been undesirable to harvest due to a flesh softening condition caused by protease enzyme activity. Recruitment begins at about age 3 and females are fully selected at age 10. They are caught as bycatch in Pacific cod, bottom pollock, sablefish, and other flatfish fisheries.

Relevant Trophic Information

They are very important as a large, aggressive and abundant predator of other groundfish species. Groundfish predators include Pacific cod and pollock, mostly on small fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): Males 27 cm and females 46 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, juveniles usually inhabit shallow areas until about 10 cm in length.

Adults: Widespread distribution mainly on the middle and outer portions of the continental shelf, feeding mainly on walleye pollock and other miscellaneous fish species when arrowtooth flounder attain lengths greater than 30 cm. Wintertime migration to deeper waters of the shelf margin and upper continental slope to avoid extreme cold water temperatures and for spawning.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180, 740 p.

Hosie, M.J. 1976. The arrowtooth flounder. Oregon Dep. Fish. Wildl. Info. Rep. 76-3, 4 p.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U. S. Dep. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA Bottom Trawl Survey. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv., NOAA Tech. Mem. NMFS-AFSC-59, 217 p.

Norcross, B.L., B.A. Holladay, S.C. Dressel, and M. Frandsen. 1996. Recruitment of juvenile flatfishes in Alaska: habitat preference near Kodiak Island. U. Alaska Coastal Marine Institute, OCS Study MMS 96-0003, Vol. 1.

Rickey, M.H. 1994. Maturity, spawning, and seasonal movement of arrowtooth flounder, *Atheresthes stomias*, off Washington. Fish. Bull. 93:127-138 (1995).

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2002. Arrowtooth flounder. *In* Appendix B Stock Assessment and Fishery Evaluation Report for the groundfish resources of the GOA, Pages 199-228. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. U. S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv. Seattle, WA, Processed rep., 88 p.

Wilderbuer, T.K., and T.M. Sample. 2002. Arrowtooth flounder. *In* Appendix A Stock Assessment and Fishery Evaluation Report for the groundfish resources of the BSAI, Pages 283-320. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Zimmerman, M. 1997. Maturity and fecundity of arrowtooth flounder, Atheresthes stomias, from the GOA. Fish. Bull. 95:598-611 (1997).

SPECIES: Arrowtooth Flounder

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	winter, spring?	ICS OCS	P			
Larvae	2 to 3 months?	U phyto/zoo plankton?	spring summer?	BAY ICS OCS	P			
Juveniles	males - 4 years females - 5 years	euphausiids crustaceans amphipods pollock	all year	ICS OCS USP	D	GMS[1]		
Adults	males - 4+ years females- 5+ years	pollock misc. fish Gadidae sp. Euphausiids	spawning Nov-March non-spawning April-Oct.	ICS OCS USP BAY	D	GMS[1]	ice edge (EBS)	

[1] Pers. Comm., Dr. Robert McConnaughey

Habitat Description for Sablefish

(*Anoplopoma fimbria*)

Management Plan and Area GOA

Life History and General Distribution

Sablefish are distributed from Mexico through the GOA to the Aleutian Chain, BS, along the Asian coast from Sagami Bay, and along the Pacific sides of Honshu and Hokkaido Islands and the Kamchatkan Peninsula. Adult sablefish occur along the continental slope, shelf gullies, and in deep fjords such as Prince William Sound and southeast Alaska, at depths generally greater than 200 m. Adults are assumed to be demersal. Spawning or very ripe sablefish are observed in late winter or early spring along the continental slope. Eggs are apparently released near the bottom where they incubate. After hatching and yolk adsorption, the larvae rise to the surface, where they have been collected with neuston nets. Larvae are oceanic through the spring and by late summer, small pelagic juveniles (10 to 15 cm) have been observed along the outer coasts of Southeast Alaska, where they apparently move into shallow waters to spend their first winter. During most years, there are only a few places where juveniles have been found during their first winter and second summer. It is not clear if the juvenile distribution is highly specific or appears so because sampling is highly inefficient and sparse. During the occasional times of large year-classes, the juveniles are easily found in many inshore areas during their second summer. They are typically 30 to 40 cm long during their second summer, after which they apparently leave the nearshore bays. One or two years later, they begin appearing on the continental shelf and move to their adult distribution as they mature.

Pelagic ocean conditions appear to determine when strong young-of-the-year survival occurs. Water mass movements and temperature appear to be related to recruitment success (Sigler et al. 2001). Above-average young of the year survival was somewhat more likely with northerly winter currents and much less likely for years when the drift was southerly. Recruitment success also appeared related to water temperature. Recruitment was above average in 61 percent of the years when temperature was above average, but was above average in only 25 percent of the years when temperature was below average. Recruitment success did not appear to be directly related to the presence of El Ninos or eddies, but these phenomena could potentially influence recruitment indirectly in years following their occurrence (Sigler et al. 2001).

While pelagic oceanic conditions determine the egg, larval, and juvenile survival through their first summer, juvenile sablefish spend 3 to 4 years in demersal habitat along the shorelines and continental shelf before they recruit to their adult habitat, primarily along the upper continental slope, outer continental shelf, and deep gulleys. As juveniles in the inshore waters and on the continental shelf, they are subject to myriad factors that determine their ability to grow, compete for food, avoid predation, and otherwise survive to adults. Perhaps demersal conditions that may have been brought about by bottom trawling (habitat, bycatch, and increased competitors) have limited the ability of the large year classes that, though abundant at the young-of-the-year stage, survive to adults.

Fishery

The major fishery for sablefish in Alaska uses longlines; however sablefish are valuable in the trawl fishery as well. Sablefish enter the longline fishery at 4 to 5 years of age, perhaps slightly younger in the trawl fishery. The longline fishery takes place between March 1 and November 15. The take of the trawl share of sablefish occurs primarily in association with openings for other species, such as the July rockfish openings, where they are taken as allowed bycatch. Deeper dwelling rockfish, such as shortraker, rougheye, and thornyhead rockfish are the primary bycatch in the longline sablefish fishery. Halibut and rattails (*Albatrossia pectoralis and Corphaenoides acrolepis*) also are taken. By regulation, there is no directed trawl fishery for sablefish; however, directed fishing standards have allowed some trawl hauls to target sablefish, where the bycatch is similar to the longline fishery, in addition perhaps to some deep dwelling flatfish.

In addition to the fishery for sablefish, there are significant fisheries for other species that may have an effect on the habitat of sablefish, primarily juveniles. As indicated above, before moving to adult habitat on the slope and deep gulleys, sablefish 2 to 4 years of age reside on the continental shelf, where significant trawl fisheries have taken place. It is difficult to evaluate the potential effect such fisheries could have had on sablefish survival, as a clear picture of the distribution and intensity of the groundfish fishery prior to 1997 has not been available. It is worth noting however, that the most intensely trawled area from 1998 to 2002 which is just north of the Alaska Peninsula, was closed to trawling by Japan in 1959 and apparently was untrawled until it was opened to U.S. trawling in 1983 (Witherell 1997, Fredin 1987). Juvenile sablefish of the 1977 year class were observed in the western portion of this area by the AFSC trawl survey in 1978 to 1980 at levels of abundance that far exceed levels that have been seen since (Umeda et al 1983). Observations of 1-year-old and young-of-the-year sablefish in inshore waters from 1980 to 1990 indicate that above-average egg to larval survival has occurred for a number of year classes since.

Relevant Trophic Information

Larval sablefish feed on a variety of small zooplankton ranging from copepod naupli to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e., euphausiids).

In their demersal stage, juvenile sablefish less than 60 cm feed primarily on euphausiids, shrimp, and cephalopods (Yang and Nelson 2000) while sablefish greater than 60 cm feed more on fish. Both juvenile and adult sablefish are considered opportunistic feeders. Fish most important to the sablefish diet include pollock, eulachon, capelin, Pacific herring, Pacific cod, Pacific sand lance, and some flatfish, with pollock being the most predominant (10 to 26 percent of prey weight, depending on year). Squid, euphasiids, and jellyfish were also found, squid being the most important of the invertebrates (Yang and Nelson 2000). Feeding studies conducted in Oregon and California found that fish made up 76 percent of the diet (Laidig et al. 1997). Off the southwest coast of Vancouver Island, euphausiids dominated sablefish diet (Tanasichuk 1997). Among other goundfish in the GOA, the diet of sablefish overlaps mostly with that of large flatfish, arrowtooth flounder and Pacific halibut (Yang and Nelson 2000).

Nearshore residence during their second year provides sablefish with the opportunity to feed on salmon fry and smolts during the summer months, while young-of-the-year sablefish are commonly found in the stomachs of salmon taken in the Southeast Alaska troll fishery during the late summer.

Approximate Upper Size Limit of Juvenile Fish (in cm): Size at 50 percent maturity is as follows:

BS:	males 65 cm, females 67 cm
AI:	males 61 cm, females 65 cm
GOA:	males 57 cm, females 65 cm

At the end of the second summer (~1.5 years old), they are 35 to 40 cm long.

Stock Condition

The estimated productivity and sustainable yield of the combined GOA,BS, and AI sablefish stock have declined steadily since the late 1970s. This is demonstrated by a decreasing trend in recruitment and subsequent estimates of biomass reference points and the inability of the stock to rebuild to the target biomass levels despite the decreasing level of the targets and fishing rates below the target fishing rate. While years of strong young-of-the-year survival has occurred in the 1980s and the1990s, the failure of strong recruitment to the mature stage suggests a decreased survival of juveniles during their residence as 2 to 4 year olds on the continental shelf.

Habitat and Biological Associations

Egg/Spawning
Larvae
Juveniles
Adults - other than depth, none is noted

Additional Information Sources

Eggs and Larvae: NMFS, Alaska Fisheries Science Center, FOCI Program, Art Kendall, NMFS Auke Bay Lab, Bruce Wing.

Fredin, R. A. 1987. History of regulation of Alaska groundfish fisheries. NWAFC Processed Report 87-07.

Juveniles: ADFG groundfish surveys: Jim Blackburn, ADFG, Kodiak, AK, Paul Anderson, NMFS/RACE, Kodiak, AK.

Kendall, A.W. and A.C. Materese. Biology of eggs, larvae, and epipelagic juveniles of sablefish, *Anoplopoma fimbria*, in relation to their potential use in management. Mar. Fish. Rev. 49(1)1-13.

Smith, G.B., G.E. Walters, P.A. Raymore, Jr., and W.A, Hischberger. 1984. Studies of the distribution and abundance of juvenile groundfish in the northwestern GOA, 1980-82: Part I, Three-year comparisons. NOAA Tech. Memo. NMFS F/NWC-59. 100p.

Walters, G.E., G.B. Smith, P.A. Raymore, and W.A. Hirschberger. 1985. Studies of the distribution and abundance of juvenile groundfish in the northwestern GOA, 1980-82: Part II, Biological characteristics in the extended region. NOAA Tech. Memo. NMFS F/NWC-77. 95 p.

Witherell, D 1997. A brief history of bycatch management measures for EBS groundfish fisheries. Marine Fisheries Review

Umeda, Y., T. Sample, and R. G. Bakkala. 1983. Recruitment processes of sablefish in the EBS. In Proceedings of the International Sablefish Symposium March 1983, Anchorage, Alaska. Alaska Sea Grant Report 83-8.

Wing, B.L. and D.J. Kamikawa. 1995. Distribution of neustonic sablefish larvae and associated ichthyoplankton in the eastern GOA, May 1990. NOAA Tech. Memo. NMFS-AFSC-53.

Yang, M-S. and M.W. Nelson. 2000. Food habits of the commercially important groundfishes in the GOA in 1990, 1993, and 1996. NOAA Technical Memorandum NMFS-AFSC-112.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and Zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dep. Commer., NOAAS Tech. Rept. NMFS 66, 151 p.

Boehlert, G.W., and M.M. Yoklavich. 1985. Larval and juvenile growth of sablefish, *Anoplopoma fimbria*, as determined from otolith increments. Fish. Bull. 83:475-481.

Grover, J.J., and B.L. Olla. 1986. Morphological evidence for starvation and prey size selection of sea-caught larval sablefish, *Anoplopoma fimbria*. Fish. Bull. 84:484-489.

Grover, J.J., and B.L. Olla. 1987. Effects of and El Niño event on the food habits of larval sablefish, *Anoplopoma fimbria*, off Oregon and Washington. Fish. Bull. 85: 71-79.

Grover, J.J., and B.L. Olla. 1990. Food habits of larval sablefish, *Anoplopoma fimbria* from the BS. Fish Bull. 88:811-814.

Hunter, J.R., B.J. Macewiccz, and C.A. Kimbrell. 1989. Fecundity and other aspects of the reproduction of Sablefish, *Anoplopoma fimbria*, in Central California Waters. Calif. Coop. Fish. Invst. Rep. 30: 61-72.

Kendall, A.W., Jr., and A.C. Matarese. 1984. Biology of eggs, larvae, and epipelagic juveniles of sablefish, *Anoplopoma fimbria*, in relation to their potential use in management. Mar. Fish. Rev. 49(1):1-13.

Mason, J.C., R.J. Beamish, and G.A. McFralen. 1983. Sexual maturity, fecundity, spawning, and early life history of sablefish (*Anoplopoma fimbria*) off the Pacific coast of Canada. Can. J. Fish. Aquat. Sci. 40:2121-2134.

McFarlane, G.A., and R.J. Beamish. 1992. Climatic influence linking copepod production with strong year-classes in sablefish, *Anoplopoma fimbria*. Can J. Fish. Aquat. Sci. 49:743-753.

Moser, H.G., R.L. Charter, P.E. Smith, N.C.H. Lo., D.A. Ambrose, C.A. Meyer, E.M. Sanknop, and W. Watson. 1994. Early life history of sablefish, *Anoplopoma fimbria*, off Washington, Oregon, and California with application to biomass estimation. Calif. Coop. Oceanic Fish. Invest. Rep. 35:144-159.

Rutecki, T.L., and E.R. Varosi. 1993. Distribution, age, and growth of juvenile sablefish in Southeast Alaska. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Rutecki, T.L., and E.R. Varosi. 1993. Migrations of Juvenile Sablefish in Southeast Alaska. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Sasaki, T. 1985. Studies on the sablefish resources in the North Pacific Ocean. Bulletin 22, (1-108), Far Seas Fishery Laboratory. Shimizu, 424, Japan.

Sigler, M.F., E.R. Varosi, and T.R. Rutecki. 1993. Recruitment curve for sablefish in Alaska based on recoveries of fish tagged as juveniles. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Sigler, M. F., T. L. Rutecki, D. L. Courtney, J. F. Karinen, and M.-S.Yang. 2001. Young-of-the-year sablefish abundance, growth, and diet. Alaska Fisheries Research Bulletin 8(1): 57-70.

NOAA. 1990. Sablefish, *Anoplopoma fimbria*. Pl 3.2.22. IN: West Coast of North America Coastal and Ocean Zones Strategic Assessment Data Atlas. Invertebrate and Fish Volume. U.S. Dep. Commer. NOAA. OMA/NOS, Ocean Assessment Division, Strategic Assessment Branch.

Wing, B.L. 1985. Salmon Stomach contents from the Alaska Troll Logbook Program, 1977-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-91, 41 p.

Wing, B.L. 1997. Distribution of sablefish, *Anoplopoma fimbria*, larvae in the eastern GOA: Neuston-net tows versus oblique tows. *In*: M. Wilkins and M. Saunders (editors), Proc. Int. Sablefish Symp., April 3-4, 1993, p. 13-25. U.S. Dep. Commer., NOAA Tech. Rep. 130.

Wing, B.L., and D.J. Kamikawa. 1995. Distribution of neustonic sablefish larvae and associated ichthyoplankton in the eastern GOA, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-53, 48 p.

Wing, B.L., C. Derrah, and V. O'Connell. 1997. Ichthyoplankton in the eastern GOA, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-376, 42 p.

Wolotera, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. NOAA Tech. Memo. NMFS-AFSC-22. 150 p.

SPECIES: GOA Sablefish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	14 to 20 days	NA	late winter-early spring: Dec-Apr	USP, LSP, BSN	P,200-3000 m	NA	U	
Larvae	up to 3 months	copepod nauplii, small copepodites, etc	spring-summer: Apr-July	MCS, OCS, USP, LSP, BSN	N, neustonic near surface	NA	U	
Early Juveniles	up to 3 years	small prey fish, sandlance, salmon, herring, etc		OCS, MCS, ICS, during first summer, then obs in BAY, IP, till end of 2nd summer; not obs'd till found on shelf	P when offshore during first summer, then D, SD/SP when inshore	NA when pelagic. The bays where observed were soft bottomed, but not enough obs. to assume typical.	U	
Late Juveniles	3 to 5 years	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	all year	continental slope, and deep shelf gullies and fjords.	presumably D	varies	U	
Adults	5 to 35+ years	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	apparently year around, spawning movements (if any) are undescribed	continental slope, and deep shelf gullies and fjords.	presumably D	varies	U	

Habitat Description for Pacific Ocean Perch

(*Sebastes alutus*)

Management Plan and Area GOA

Life History and General Distribution

Pacific ocean perch (*Sebastes alutus,* POP) has a wide distribution in the North Pacific from southern California around the Pacific rim to northern Honshu Island, Japan, including the BS. The species appears to be most abundant in northern British Columbia, the GOA, and the AI (Allen and Smith 1988). Adults are found primarily offshore on the outer continental shelf and the upper continental slope in depths from 150 to 420 m. Seasonal differences in depth distribution have been noted by many investigators. In the summer, adults inhabit shallower depths, especially those between 150 and 300 m. In the fall, the fish apparently migrate farther offshore to depths from approximately 300 to 420 m. They reside in these deeper depths until about May, when they return to their shallower summer distribution (Love et al. 2002). This seasonal pattern is probably related to summer feeding and winter spawning. Although small numbers of Pacific ocean perch are dispersed throughout their preferred depth range on the continental shelf and slope, most of the population occurs in patchy, localized aggregations (Hanselman et al. 2001). Pacific ocean perch are generally considered to be semi-demersal, but there can at times be a significant pelagic component to their distribution. Pacific ocean perch often move off-bottom at night to feed, apparently following diel euphausiid migrations. Commercial fishing data in the GOA since 1995 show that pelagic trawls fished off-bottom have accounted for as much as 20 percent of the annual harvest of this species.

There is much uncertainty about the life history of Pacific ocean perch, although generally more is known than for other rockfish species (Kendall and Lenarz 1986). The species appears to be viviparous (the eggs develop internally and receive at least some nourishment from the mother), with internal fertilization and the release of live young. Insemination occurs in the fall, and sperm are retained within the female until fertilization takes place approximately 2 months later. The eggs hatch internally, and parturition (release of larvae) occurs in April and May. Information on early life history is very sparse, especially for the first year of life. Pacific ocean perch larvae are thought to be pelagic and drift with the current. Oceanic conditions may sometimes cause advection to suboptimal areas (Ainley et al. 1993), resulting in high recruitment variability. However, larval studies of rockfish have been hindered by difficulties in species identification since many larval rockfish species share the same morphological characteristics (Kendall 2001). Genetic techniques using allozymes (Seeb and Kendall 1991) and mitochondrial DNA (Li 2004) are capable of identifying larvae and juveniles to species, but are expensive and time-consuming. Post-larval and early young-of-the-year Pacific ocean perch have been positively identified in offshore, surface waters of the GOA (Gharrett et al. 2002), which suggests this may be the preferred habitat of this life stage. Transformation to a demersal existence may take place within the first year (Carlson and Haight 1976). Small juveniles probably reside inshore in very rocky, high relief areas and begin to migrate to deeper offshore waters of the continental shelf by age 3 (Carlson and Straty 1981). As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood.

Pacific ocean perch is a very slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50 percent maturity (10.5 years for females in the GOA), and a very old maximum age of 98 years in Alaska (84 years maximum age in the GOA) (Hanselman et al. 2003). Age at 50 percent recruitment to the commercial fishery has been estimated to be between 7 and 8 years in the GOA.

Despite their viviparous nature, the fish is relatively fecund with number of eggs/female in Alaska ranging from 10,000 to 300,000, depending upon size of the fish (Leaman 1991).

Fishery

The Pacific ocean perch is the most abundant GOA rockfish and the most important commercially. The species was fished intensely in the 1960s by foreign factory trawlers (350,000 mt at its peak in 1965), and the population declined drastically due to this pressure. The domestic fishery began developing in 1985. Quotas climbed rapidly, and the species was declared overfished in 1989. A rebuilding plan was put into place, and quotas were small in the early 1990s. After some good recruitments and high survey biomass estimates, the stock was declared to be recovered in 1995. Pacific ocean perch are caught almost exclusively with trawls. Before 1996, nearly all the catch was taken by factory trawlers using bottom trawls, but a sizeable portion (up to 20 percent some years) has also been taken by pelagic trawls since then. Also in 1996, a shore-based fishery developed that consisted of smaller vessels operating out of the port of Kodiak. These shore-based trawlers now take about 50 percent of the catch in the central GOA. The fishery in the Gulf in recent years has occurred in the summer months, especially July, due to management regulations. Reflecting the summer distribution of this species, the fishery is concentrated in a relatively narrow depth band at approximately180 to 250 m along the outer continental shelf and shelf break, inside major gullies and trenches running perpendicular to the shelf break, and along the upper continental slope. Major fishing grounds include Ommaney Trough (which is no longer fished because of an Council amendment that prohibits trawling in the eastern GOA), Yakutat Canyon, Amatuli Trough, off Portlock and Albatross Banks, Shelikof Trough, off Shumagin Bank, and south of Unimak and Unalaska Islands.

Major bycatch species in the GOA Pacific ocean perch trawl fishery from 1994 to 1996 (the most recent years for which an analysis was done) included (in descending order by percent bycatch rate) other species of rockfish, arrowtooth flounder, and sablefish. Among the other species of rockfish, northern rockfish and shortraker/rougheye were most common, followed by pelagic shelf rockfish (Ackley and Heifetz 2001).

Because collection of small juvenile Pacific ocean perch is virtually unknown in any existing type of commercial fishing gear, it is assumed that fishing does not occur in their habitat. Trawling on the offshore fishing grounds of adults may affect the composition of benthic organisms, but the impact of this on Pacific ocean perch or other fish is unknown.

Relevant Trophic Information

Pacific ocean perch are mostly planktivorous (Carlson and Haight 1976, Yang 1993, 1996, Yang and Nelson 2000, Yang 2003). In a sample of 600 juvenile perch stomachs, Carlson and Haight (1976) found that juveniles fed on an equal mix of calanoid copepods and euphausiids. Larger juveniles and adults fed primarily on euphausiids and, to a lesser degree, on copepods, amphipods, and mysids (Yang and Nelson 2000). In the AI, myctophids have increasingly comprised a substantial portion of the Pacific ocean perch diet, which also compete for euphausiid prey (Yang 2003). It has been suggested that Pacific ocean perch and walleye pollock compete for the same euphausiid prey. Consequently, the large removals of Pacific ocean perch by foreign fishermen in the GOA in the 1960s may have allowed walleye pollock stocks to greatly expand in abundance.

Pacific ocean perch predators are likely sablefish, Pacific halibut, and sperm whales (Major and Shippen 1970). Juveniles are consumed by seabirds (Ainley et al. 1993), other rockfish (Hobson et al. 2001), salmon, lingcod, and other large demersal fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): For GOA, the upper size limit of juvenile fish is 38 cm for females; it is unknown for males, but is presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Habitat and Biological Associations Narrative

Egg/Spawning: Little information is known. Insemination is thought to occur after adults move to deeper offshore waters in the fall. Parturition is reported to occur from 20 to 30 off-bottom at depths from 360 to 400 m.

Larvae: Little information is known. Earlier information suggested that after parturition, larvae rise quickly to near surface, where they become part of the plankton. More recent data from British Columbia indicates that larvae may remain at depths 175 m for some period of time (perhaps 2 months), after which they slowly migrate upward in the water column.

Post-larvae and early young-of-the year: A recent, preliminary study has identified Pacific ocean perch in these life stages from samples collected in epipelagic waters far offshore in the GOA (Gharrett et al. 2002). Some of the samples were as much as 100 nm from land, beyond the continental slope and over very deep water.

Juveniles: Again, information is very sparse, especially for younger juveniles. It is unknown how long young-of-the-year remain in a pelagic stage before eventually becoming demersal. At ages 1 to 3, the fish probably live in very rocky inshore areas. Afterward, they move to progressively deeper waters of the continental shelf. Older juveniles are often found together with adults at shallower locations of the continental slope in the summer months.

Adults: Commercial fishery and research data have consistently indicated that adult Pacific ocean perch are found in aggregations over reasonably smooth, trawlable bottom of the outer continental shelf and upper continental slope (Westrheim 1970; Matthews et al. 1989; Krieger 1993). Generally, they are found in shallower depths (150 to 300 m) in the summer, and deeper (300 to 420 m) in the fall, winter, and early spring. Observations from a manned submersible in Southeast Alaska found adult Pacific ocean perch associated with pebble substrate on flat or low-relief bottom (Krieger 1993). Pacific ocean perch have been observed in association with sea whips in both the GOA (Krieger 1993) and the BS (Brodeur 2001). The fish can at times also be found off-bottom in the pelagic environment, especially at night when they may move up in the water column to feed. There presently is no evidence to support previous conjectures that adult Pacific ocean perch might sometimes inhabit rough, untrawlable bottom.

Additional Information Sources

Larvae: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, Bruce Wing; NMFS, Alaska Fisheries Science Center, FOCI program, Ann Matarese; Art Kendall, AJALA Enterprises, La Conner, WA.

Juveniles: Carlson, H.R. And R.E. Haight. 1976. Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fiords of southeast Alaska: Their environment, growth, food habits, and schooling behavior. Trans. Am, Fish. Soc. 105:191-201.

Adults: Lunsford, C. R. 1999. Distribution patterns and reproductive aspects of Pacific ocean perch (*Sebastes alutus*) in the GOA. M.S. Thesis. Univ. of Alaska Fairbanks, Juneau AK. 154 p.

Literature

Ackley, D. R., and J. Heifetz. 2001. Fishing practices under maximum retainable bycatch rates in Alaska's groundfish fisheries. Alaska Fish. Res. Bull. 8(1): 22-44.

Ainley, D.G., W.J. Sydeman., R.H. Parrish., and W.H. Lenarz. 1993. Oceanic factors influencing distribution of young rockfish (Sebastes) in central California: A predator's perspective. CalCOFI Report 34: 133-139.

Allen, M.J., and G. B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Brodeur, R.D. 2001. Habitat-specific distribution of Pacific ocean perch (*Sebastes alutus*) in Pribilof Canyon, BS. Cont. Shelf Res. 21: 207-224.

Carlson, H.R., and R.E. Haight. 1976. Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fiords of southeast Alaska: their environment, growth, food habits, and schooling behavior. Trans. Am. Fish. Soc. 105:191-201.

Carlson, H.R., and R.R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp., in rocky coastal areas of Southeast Alaska. Mar. Fish. Rev. 43: 13-19.

Chikuni, S. 1975. Biological study on the population of the Pacific ocean perch in the North Pacific. Bull. Far Seas Fish. Res. Lab 12: 1-119.

Doyle, M.J. 1992. Patterns in distribution and abundance of ichthyoplankton off Washington, Oregon, and Northern California (1980-1987). U.S. Dep. Commer. NOAA NMFS AFSC Processed Rept. 92-14, 344 p.

Freese, J.L., and B.L. Wing. 2003. Juvenile red rockfish, Sebastes sp., associations with sponges in the GOA. Mar. Fish. Rev. 65:38-42 (in press).

Gillespie, G.E., R.D. Stanley, and B.M. Leaman. 1992. Early life history of rockfishes in British Columbia; preliminary results of the first year of investigation. Proc. 1992 W. Groundfish Conf. Alderbrook Inn Resort, Union, WA, Jan 27-30, 1992.

Gharrett, A.J., Z. Li, C.M. Kondzela, and A.W. Kendall. 2002. Final report: species of rockfish (*Sebastes* spp.) collected during ABL-OCC cruises in the GOA in 1998-2002. (Unpubl. manuscr. available from the NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau AK 99801.)

Gunderson, D.R. 1971. Reproductive patterns of Pacific ocean perch (*Sebastodes alutus*) off Washington and British Columbia and their relation to bathymetric distribution and seasonal abundance. J. Fish. Res. Bd. Can. 28: 417-425.

Gunderson, D.R., and M.O. Nelson. 1977. Preliminary report on an experimental rockfish survey conducted off Monterey, California and in Queen Charlotte Sound, British Columbia during August-September, 1976. Prepared for Feb. 15-16, 1977, Interagency Rockfish Survey Coordinating Committee Meeting, NWAFC, Seattle, WA. Unpubl. manuscr. 82 p.

Hanselman, D.H., J. Heifetz., J. Fujioka., and J. Ianelli. 2003. GOA Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA. North Pacific Fisheries Management Council. p. 429-479.

Hanselman, D.H., T.J. Quinn., II, J. Heifetz., D. Clausen., and C. Lunsford. 2001. Spatial inferences from adaptive cluster sampling of GOA rockfish. *In* Spatial Processes and Management of Marine Populations. University of Alaska Sea Grant, PO Box 755040 203 O'Neill Bldg. Fairbanks AK 99775-5040, [URL http //www.uaf.alaska.edu/seagrant/].

Hobson, E.S., J.R. Chess., and D.F. Howard. 2001. Interannual variation in predation on first-year Sebastes spp. by three northern California predators. Fish. Bull. 99: 292-302.

Ito, D.H. 1982. A cohort analysis of Pacific ocean perch stocks from the GOA and BS regions. U.S. Dep. Commer., NWAFC Processed Rept. 82-15, 157 p.

Ito, D.H., and J.N. Ianelli. 1996. Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI regions, p.331-359. North Pacific Fishery Management Council, 605 W. 4th. Ave., Suite 306, Anchorage, AK 99501-2252.

Kendall, A.W., and W.H. Lenarz. 1986. Status of early life history studies of northeast Pacific rockfishes. Proc. Int. Rockfish Symp. Oct. 1986, Anchorage Alaska; p. 99-117.

Krieger, K.J. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fish. Bull., U.S. 91:87-96.

Krieger, K.J., and B.L. Wing. 2002. Megafauna associations with deepwater corals (Primnoa spp) in the GOA. Hydrobiologia 471: 8.

Leaman, B.M. 1991. Reproductive styles and life history variables relative to exploitation and management of Sebastes stocks. Environmental Biology of Fishes 30: 253-271.

Li, Z. 2004. Phylogenetic relationships and identification of juveniles of the genus Sebastes. University of Alaska-Fairbanks, School of Fisheries and Ocean Sciences. M.S. thesis.

Love, M.S., M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. U. of Calif. Press, Berkeley. 405 p.

Lunsford, C.R. 1999. Distribution patterns and reproductive aspects of Pacific ocean perch (*Sebastes alutus*) in the GOA. M.S. Thesis. Univ. of Alaska Fairbanks, Juneau AK. 154 p.

Lunsford, C.R., L. Haldorson, J.T. Fujioka, and T.J. Quinn II. 2001. Distribution patterns and survey design considerations of Pacific ocean perch (*Sebastes alutus*) in the GOA. Spatial Processes and Management of Marine Populations, Alaska Sea Grant College Program. Lowell Wakefield Fisheries Symposium. Anchorage, AK., AK-SG-01- 02.

Major, R.L., and H.H. Shippen. 1970. Synopsis of biological data on Pacific ocean perch, *Sebastodes alutus*. FAO Fisheries Synopsis No. 79, NOAA Circular 347, 38 p.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dep. Commer. NOAA Tech. Rept. NMFS 80, 652 p.

Matthews, K.R., J.R. Candy, L.J. Richards, and C.M. Hand. 1989. Experimental gill net fishing on trawlable and untrawlable areas off northwestern Vancouver Island, from the MV Caledonian, August 15-28, 1989. Can. Manuscr. Rep. Fish. Aquat. Sci. 2046, 78 p.

Mattson, C.R., and B.L. Wing. 1978. Ichthyoplankton composition and plankton volumes from inland coastal waters of southeast Alaska, April-November 1972. U.S. Dep. Commer., NOAA Tech. Rept. NMFS SSRF-723, 11 p.

Moser, H.G. 1996. SCORPAENIDAE: scorpionfishes and rockfishes. *In*: Moser, H.G., editor. The early stages of fishes in the California Current region, p. 733-795. CalCOFI Atlas No.33. 1505 p.

NOAA (National Oceanic and Atmospheric Administration). 1990. Pacific ocean perch, *Sebastes alutus*. *In*: West coast of North America coastal and ocean zones strategic assessment: data atlas. Invertebrate and fish volume, Plate 3.2.20. U.S. Dep. Commer. NOAA. OMA/NOS, Ocean Assessments Division, Strategic Assessment Branch.

Seeb, L.W. 1993. Biochemical identification of larval rockfishes of the genus *Sebastes*. Final Report Contract #43ABNF001082. U.S. Dept. Commer. NOAA/NMFS NWAFC/RACE Division, Seattle, WA. 28 p.

Seeb, L.W., and A.W. Kendall, Jr. 1991. Allozyme polymorphisms permit the identification of larval and juvenile rockfishes of the genus *Sebastes*. Environmental Biology of Fishes 30:191-201.

Stark, J.W., and D.M. Clausen. 1995. Data report: 1990 GOA bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-49. 221 p.

Westrheim, S.J. 1970. Survey of rockfishes, especially Pacific ocean perch, in the northeast Pacific Ocean, 1963-66. J. Fish. Res. Bd. Canada 27: 1781-1809.

Westrheim, S.J. 1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32: 2399-2411.

Wing, B.L. 1985. Salmon stomach contents from the Alaska troll logbook program, 1977-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-91. 41 p.

Wing, B.L., C. Derrah, and V. O'Connell. 1997. Ichthyoplankton in the eastern GOA, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-376, 42 p.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U. S. Dep. Commer., NOAA Tech. Memo. NMFS - AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the AI in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

Yang, M-S. 2003. Food habits of the important groundfishes of the AI in 1994 and 1997. National Marine Fisheries Service. AFSC Processed report 2003-07: 233 pp.

Yang, M-S., and M.W. Nelson. 2000. Food habits of the commercially important groundfishes in the GOA in 1990, 1993, and 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-112, 174 p.

SPECIES: GOA Pacific Ocean Perch

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	Internal incubation; ~90 d	NA	Winter-spring	NA	NA	NA	NA	NA
Larvae	U;2 months (?)	U; assumed to be micro-zooplankton	Spring-summer	ICS, MCS, OCS, USP, LSP, BSN	P	NA	U	U
Post-larvae/ early juvenile	U; 2 months to ?	U	Summer to ?	LSP, BSN	Epipelagic	NA	U	U
Juveniles	<1 year (?) to 10 years	Calanoid copepods (young juv.); Euphausiids (older juv.)	All year	ICS, MCS, OCS, USP	D	R (<age 3); CB,G,?M, ?SM,?MS (>age 3)	U	U
Adults	10 to 84 years of age (98 years in AI)	Euphausiids	Insemination (fall); Fertilization, incubation (winter); Larval release (spring); Feeding in shallower depths (summer)	OCS, USP	D, SD, P	CB, G,?M, ?SM,?MS	U	Eggs

Habitat Description for Shortraker Rockfish (*Sebastes borealis*) and Rougheye Rockfish (*Sebastes aleutianus*)

Management Plan and Area GOA

Life History and General Distribution

Shortraker and rougheye rockfish are found around the arc of the north Pacific from southern California to northern Japan, including the BS (Mecklenburg et al. 2002). Both species are demersal. Rougheye rockfish inhabit depths ranging from 82 to 2,953 feet (25 to 900 m), and shortraker rockfish range from 328 to 3,937 feet (100 to 1,200 m) (Mecklenburg et al. 2002). However, survey and commercial fishery data indicate that the fish are most abundant along a narrow band of the continental slope at depths of 984 to 1,640 feet (300 to 500 m) (Ito 1999), where both shortraker and rougheye rockfish often co-occur in the same haul. Within this habitat, shortraker and rougheye rockfish tend to have a relatively even distribution when compared with the highly aggregated and patchy distribution of many other rockfish such as Pacific ocean perch[1]. Similar to other *Sebastes*, the fish appear to be viviparous (the eggs develop internally and receive at least some nourishment from the mother), with internal fertilization and the release of live young. Though relatively little is known about their biology and life history, both species appear to be K-selected with late maturation, slow growth, extreme longevity, and low natural mortality. Rougheye rockfish attain maturity relatively late in life, at about 20 years of age (McDermott 1994). Age of maturity for shortraker rockfish is unknown, but is presumably similar to that of rougheye rockfish. Both species are among the largest *Sebastes* species in the north Pacific, attaining sizes of up to 47 inches (120 cm) for shortraker and 38 inches (97 cm) for rougheye rockfish (Mecklenburg et al. 2002). Shortraker and rougheye rockfish are estimated to attain ages in excess of 100 years, and one ageing laboratory has reported ages up to 157 years for shortraker and 205 years for rougheye (Chilton and Beamish 1982, Munk 2001). Natural mortality for both species is low, estimated to be on the order of 0.01 to 0.04 (Archibald et al. 1981, McDermott 1994, Nelson and Quinn 1987, Clausen et al. 2003).

Fishery

Although shortraker and rougheye rockfish are found as far south as southern California, commercial quantities are primarily harvested from Washington north to Alaska waters. Shortraker and rougheye rockfish are presently managed as bycatch-only species in Alaska and are taken by both trawl and longline gear. In recent years, trawling has accounted for about 60 percent of the catch and longlining about 40 percent (Clausen et al. 2003). Commercial harvests usually occur on the slope from 984 to 1,640 feet (300 to 500 m) deep. Both species are associated with soft to rocky habitats along the continental slope, although boulders and steeply sloping terrain appear to be a desirable habitat feature for both species (Krieger 1992, Krieger and Ito 1999). Trawling in such habitats often requires specialized fishing skills to avoid gear damage and to keep the trawl in the proper fishing configuration. One study estimated age at recruitment for rougheye rockfish to be 30 years (Nelson and Quinn 1987), and it is probably on the order of 20+ years for shortraker rockfish. Shortraker and rougheye rockfish are often caught as bycatch in trawl fisheries for Pacific ocean perch and in longline fisheries for sablefish and halibut.

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[1] Clausen, D. M., and J. T. Fujioka. Variability in trawl survey catches of shortraker rockfish, rougheye rockfish, and Pacific ocean perch, and possible implications for survey design. Presentation at 2002 Western Groundfish Conference, Ocean Shores, WA, February 12-14, 2002.

Relevant Trophic Information

Rougheye rockfish in Alaska feed primarily on shrimps (especially pandalids), and various fish species such as myctophids are also consumed (Yang and Nelson 2000; Yang 2003). However, smaller juvenile rougheye rockfish (less than 12 inches [30 cm] fork length) in the GOA also consume a substantial amount of smaller invertebrates such as amphipods, mysids, and isopods (Yang and Nelson 2000). The diet of shortraker rockfish in the GOA is not well known; however, based on a very small sample size in the Yang and Nelson (2000) study, the diet appears to be mostly squid, shrimp, and deepwater fish such as myctophids. A food study in the AI with a larger sample size of shortraker rockfish also found myctophids, squid, and shrimp to be major prey items (Yang 2003). In addition, gammarid amphipods, mysids, and miscellaneous fish were important food items in some years. It is uncertain what constitute the main predators on both species.

Approximate Upper Size Limit of Juvenile Fish (in cm): Length at 50 percent sexual maturity has been estimated to be about 45 cm fork length for female shortraker rockfish and about 44 cm fork length for female rougheye rockfish (McDermott 1994). For both species, the largest immature females were about 50 to 55 cm. For either species, there is no information on male size at maturity or on maximum size of juvenile males.

Habitat and Biological Associations

Egg/Spawning: The timing of reproductive events is apparently protracted. One study indicated that vitellogenesis was present for 4 to 5 months and lasted from about July until late October and November (McDermott 1994). This study also reported that parturition (i.e., larval release) occurred mainly in February through August for shortraker rockfish and December through April for rougheye rockfish. There is no information as to when males inseminate females or if migrations for spawning/breeding occur.

Larvae: Information on larval shortraker and rougheye rockfish is very limited. Larval shortraker rockfish have been identified in pelagic plankton tows in coastal Southeast Alaska (Gray et al. 2004), and it is likely that larval rougheye rockfish are also pelagic. Larval studies are hindered because the larvae at present can be positively identified only by genetic analysis, which is both expensive and labor-intensive.

Post-larvae and early young-of-the year: One study used genetics to identify two specimens of shortraker rockfish and one of rougheye rockfish in these life stages from samples collected in epipelagic waters far offshore in the GOA (Gharrett et al. 2002). This limited information is the only documentation of habitat preferences for these life stages.

Juveniles: Little information is available regarding the habitats and biological associations of juvenile shortraker and rougheye rockfish. This is especially true for small juvenile shortraker rockfish, as only a few specimens less than 14 inches (35 cm) fork length have been caught in the GOA. Juvenile shortraker rockfish are presumably demersal, as there have been no known catches in pelagic trawls or in off-bottom sampling gear. In contrast, juvenile rougheye rockfish 6 to 16 inches (15 to 40 cm) fork length are frequently caught in GOA bottom trawl surveys (Clausen et al. 2003). They are generally found at shallower, more inshore areas than adults. These areas range from inshore fiords to offshore waters of the continental shelf. Other than the fact that they have been taken on trawlable bottom, however, habitat preferences for juvenile rougheye rockfish are unknown.

Adults: Adult shortraker and rougheye rockfish are demersal and are concentrated at depths of 984 to 1,640 feet (300 to 500 m) along the continental slope. Observations from a manned submersible indicate that these fish occur over a wide range of habitats (Krieger 1992, Krieger and Ito 1999, Krieger and Wing

2002). Soft substrates of sand or mud usually had the highest densities, whereas hard substrates of bedrock, cobble, or pebble usually had the lowest adult densities (Krieger and Ito 1999). Habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders (Krieger 1992, Krieger and Ito 1999). One of the submersible studies found shortraker and rougheye rockfish had a strong association with *Primnoa* spp. coral growing on boulders: less than 1 percent of the observed boulders had coral, but 85 percent of the "large" rockfish (which included redbanded rockfish along with shortraker and rougheye) were next to boulders with coral (Krieger and Wing 2002).

Additional Information Sources

Larvae: Art Kendall, AJALA Enterprises, La Conner, WA.

Literature

Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102 p.

Clausen, D.M., J.T. Fujioka, and J. Heifetz. 2003. Shortraker/rougheye and other slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 531-572. Council, 605 W 4th Ave, Suite 306 Anchorage, AK 99501.

Gharrett, A.J., Z. Li, C.M. Kondzela, and A.W. Kendall. 2002. Final report: species of rockfish (*Sebastes* spp.) collected during ABL-OCC cruises in the GOA in 1998-2002. (Unpubl. manuscr. available from the NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau AK 99801).

Gray, A.K., A.W. Kendall, B.L. Wing, M.G. Carls, J. Heifetz, Z. Li, and A.J. Gharrett. 2004. Identification of larval rockfish (*Sebastes* spp.) collected in Southeast Alaska coastal waters (1997-2000) using restriction site analysis of the mitochondrial ND3/ND4 region. Unpubl. manuscr. 22 p. (Available from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau AK 99801).

Krieger, K. 1992. Shortraker rockfish, *Sebastes borealis*, observed from a manned submersible. Mar. Fish. Rev., 54(4): 34-37.

Krieger, K.J., and D.H. Ito. 1999. Distribution and abundance of shortraker rockfish, *Sebastes borealis*, and rougheye rockfish, *Sebastes aleutianus*, determined from a manned submersible. Fish. Bull. 97: 264-272.

Krieger, K.J., and B.L. Wing. 2002. Megafauna associations with deepwater corals (*Primnoa* spp.) in the GOA. Hydrobiologia 471: 83-90.

Ito, D.H. 1999. Assessing shortraker and rougheye rockfishes in the GOA: addressing a problem of habitat specificity and sampling capability. PhD. Dissertation. Univ. Washington, Seattle. 205 p.

McDermott, S.F. 1994. Reproductive biology of rougheye and shortraker rockfish, *Sebastes aleutianus* and *Sebastes borealis*. Masters Thesis. Univ. Washington, Seattle.76 p.

Mecklenburg, C.W., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. Am. Fish. Soc., Bethesda, Maryland. 1,037 p.

Munk, K.M. 2001. Maximum ages of groundfishes off Alaska and British Columbia and considerations of age determination. Alaska Fish. Res. Bull. 8(1): 12-21.

Nelson, B.D., and T.J. Quinn. 1987. Population parameters of rougheye rockfish (*Sebastes aleutianus*). *In* Proc. Int. Rockfish Symp. pp. 209-228. Univ. Alaska Sea Grant Report No. 87-2. Anchorage, AK.

Yang, M-S., and M.W. Nelson. 2000. Food habits of the commercially important groundfishes in the GOA in 1990, 1993, and 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-112, 174 p.

Yang, M-S. 2003. Food habits of the important groundfishes in the AI in 1994 and 1999. AFSC Proc. Rep 2003-07. 233 p. (Available from NMFS, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115).

SPECIES: Shortraker (SR) and Rougheye (RE) Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	N/A	N/A	N/A	N/A	N/A	N/A	
Larvae	U	U	Parturition: SR: Feb-Aug RE: Dec-Apr	U	Pelagic	N/A	U	
Post-larvae/ early juvenile	< 6 months	U	Summer	LSP, BSN	Epipelagic	N/A	U	
Juveniles	Up to 20 years of age	Shrimp Mysids Amphipods Isopods	U	SR: U RE: ICS, MCS, OCS	SR: U, probably D RE: D	SR: U RE: U, but trawlable	U	
Adults	20 to >100 years of age	Shrimp Squid Myctophids	Year-round?	USP	D	M, S, R, SM, CB, MS, G, C steep slopes and boulders	U	Observed associated with *Primnoa* coral

Habitat Description for Northern Rockfish

(*Sebastes polyspinis*)

Management Plan and Area GOA

Life History and General Distribution

Northern rockfish range from northern British Columbia through the GOA and AI to eastern Kamchatka, including the BS. The species is most abundant from about Portlock Bank in the central GOA to the western end of the AI. Within this range, adult fish appear to be concentrated at discrete, relatively shallow offshore banks of the outer continental shelf. Typically, these banks are separated from land by an intervening stretch of deeper water. The preferred depth range is ~75 to 150 m in the GOA. Information available at present suggests the fish are mostly demersal, as very few have been caught in pelagic trawls. In common with many other rockfish species, northern rockfish tend to have a localized, patchy distribution, even within their preferred habitat, and most of the population occurs in aggregations. Most of what is known about northern rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on northern rockfish is extremely sparse. The fish are assumed to be viviparous, as other *Sebastes* appear to be, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring, and is mostly completed by summer. Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage is unknown, but the fish apparently metamorphose to a pelagic juvenile stage, which also has been described. There is no information on when the juveniles become benthic or what habitat they occupy. Older juveniles are found on the continental shelf, generally at locations inshore of the adult habitat.

Northern rockfish is a slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50 percent maturity (12.8 years for females in the GOA), and an old maximum age of 72 years in Alaska (maximum reported age in the GOA is 44 years). No information on fecundity is available.

Fishery

Northern rockfish are caught almost exclusively with bottom trawls. Age at 50 percent recruitment is unknown. The fishery in the GOA in recent years has mostly occurred in the summer months, especially July, due to management regulations. Catches are concentrated of live relatively shallow, offshore banks of the outer continental shelf: which include Portlock Bank, Albatross Bank, the “Snakehead” south of Kodiak Island, Shumagin Bank, and Davidson Bank. Of these, the Snakehead has been the most productive. Outside of these banks, catches are generally sparse. The majority of the catch in the GOA comes from depths of 75 to 125 m.

The major bycatch species in the GOA northern rockfish trawl fishery in 1994-96 included (in descending order by percent bycatch rate): light dusky rockfish, “other slope rockfish”, and Pacific ocean perch. Of these, light dusky rockfish was by far the most common bycatch, having a bycatch rate as high as 34 percent, depending on the year.

Relevant Trophic Information

Although no comprehensive food study of northern rockfish has been done, smaller studies have ~~all~~ shown euphausiids to be the predominant food item of adults in both the GOA and AI. Copepods, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities.

Predators of northern rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

Approximate Upper Size Limit of Juvenile Fish (in cm): For GOA: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring.

Larvae: No information known.

Juveniles: No information known for small juveniles (<20 cm), except that juveniles apparently undergo a pelagic phase immediately after metamorphosis from the larval stage. Larger juveniles have been taken in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds. Substrate preference of these larger juveniles is unknown.

Adults: Commercial fishery and research survey data have consistently indicated that adult northern rockfish in the GOA are primarily found on offshore banks of the outer continental shelf at depths of 75 to 150 m. Preferred substrate in this habitat has not been documented, but observations from trawl surveys suggest that large catches of northern rockfish are often associated with hard or rough bottoms. For example, some of the largest catches in the trawl surveys have occurred in hauls in which the net hung-up on the bottom or was torn by a rough substrate. Generally, the fish appear to be demersal, and most of the population occurs in large aggregations. There is no information on seasonal migrations. Northern rockfish often co-occur with light dusky rockfish.

Additional Information Sources

Eggs and Larvae: None at present.

Older juveniles and adults: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, David Clausen.

Literature

Ackley, D.R., and J. Heifetz. 2001. Fishing practices under maximum retainable bycatch rates in Alaska's groundfish fisheries. Alaska Fish. Res. Bull. 8(1): 22-44.

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Clausen, D.M., and J. Heifetz. 2003. The northern rockfish, *Sebastes polyspinis*, in Alaska: commercial fishery, distribution, and biology. Unpubl. manuscr. (submitted for publication to Mar. Fish. Rev. Avail. from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau AK 99801).

Heifetz, J., D.L. Courtney, D.M. Clausen, D. Hanselman, J.T. Fujioka, and J.N. Ianelli. 2002. Slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 295-382. Council, 605 W 4th Ave, Suite 306 Anchorage, AK 99501.

Kendall, A.W. 1989. Additions to knowledge of *Sebastes* larvae through recent rearing. NWAFC Proc. Rept. 89-21. 46 p.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of Northeast Pacific fishes. U.S. Dep. Commer. NOAA Tech. Rept. NMFS 80, 652 p.

Stark, J.W., and D.M. Clausen. 1995. Data report: 1990 GOA bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-49. 221 p.

Westrheim, S.J., and H. Tsuyuki. 1971. Taxonomy, distribution, and biology of the northern rockfish, *Sebastes polyspinis*. J. Fish. Res. Bd. Can. 28: 1621-1627.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the AI in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

SPECIES: Northern Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	From end of larval stage to ?	U	All year	U	?P	U	U	U
Late Juveniles	to 13 years	U	All year	MCS, OCS	D	U	U	U
Adults	13 to 44 years of age (maximum of 72 years in AI)	Euphausiids	U, except that larval release is probably in the spring in the GOA	OCS,	D	CB, R	U	Often co-occur with light dusky rockfish

Habitat Description for Light Dusky Rockfish

(*Sebastes ciliatus*)

Previously, the taxonomy of dusky rockfish was unclear. Two varieties occur which are now believed to be distinct species: an inshore, shallow water, dark-colored variety; and a lighter-colored variety found in deeper water offshore. A taxonomic study is soon to be completed that will describe the light variety as a new species. To avoid confusion, and because the light variety appears to be more abundant and is the object of a directed trawl fishery, this discussion of essential habitat will deal only with "light" dusky rockfish.

Management Plan and Area GOA

Life History and General Distribution

Light dusky rockfish range from Dixon Entrance at the US/Canada boundary, around the arc of the GOA, and westward throughout the AI. They are also found in the EBS north to about Zhemchug Canyon west of the Pribilof Islands. In the northwest Pacific, dusky rockfish are reported to range southwestward to Japan, but it is unknown which variety this refers to. Their distribution south of Dixon Entrance in Canadian waters is likewise uncertain; dusky rockfish have been reported as far south as Johnstone Strait, Vancouver Island, but it is likely these were of the dark variety. The center of abundance for light dusky rockfish appears to be the GOA. Adult light dusky rockfish have a very patchy distribution, and are usually found in large aggregations at specific localities of the outer continental shelf. These localities are often relatively shallow offshore banks. Because the fish are taken with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no particular evidence of a pelagic tendency based on the information available at present. Most of what is known about light dusky rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on light dusky rockfish is extremely sparse. The fish are assumed to be viviparous, as are other *Sebastes*, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring, and is probably completed by summer. Another, older source, however, lists parturition as occurring "after May." Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage, and whether a pelagic juvenile stage occurs, are unknown. There is no information on habitat and abundance of young juveniles (<25 cm fork length), as catches of these have been virtually nil in research surveys. Even the occurrence of older juveniles has been very uncommon in surveys, except for one year. In this latter instance, older juveniles were found on the continental shelf, generally at locations inshore of the adult habitat.

Light dusky rockfish is a slow growing species, with a low rate of natural mortality estimated at 0.09. However, it appears to be faster growing than many other rockfish species. Maximum age is 51 to 59 years. Estimated age at 50 percent maturity for females is 11.3 years. No information on fecundity is available.

Fishery

Light dusky rockfish are caught almost exclusively with bottom trawls. A precise estimate of age at 50 percent recruitment is not available, but has been roughly estimated to be about 10 years based on length frequency information from the fishery. The fishery in the GOA in recent years has mostly occurred in the summer months, especially July, due to management regulations. Catches are concentrated at a number of relatively shallow, offshore banks of the outer continental shelf, especially the “W” grounds west of Yakutat, and Portlock Bank. Other fishing grounds include Albatross Bank, the “Snakehead” south of Kodiak Island, and Shumagin Bank. Outside of these banks, catches are generally sparse. Most of the catch appears to be taken at depths of 100 to 200 m.

The major bycatch species in the GOA light dusky rockfish trawl fishery in 1994-96 included (in descending order by percent bycatch rate) northern rockfish and Pacific ocean perch.

Relevant Trophic Information

Although no comprehensive food study of light dusky rockfish has been done, one smaller study in the GOA showed euphausiids to be the predominate food item of adults. Larvaceans, cephalopods, pandalid shrimp, and hermit crabs were also consumed.

Predators of light dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

Approximate Upper Size Limit of Juvenile Fish (in cm): For GOA: 47 cm for females (size at 50 percent maturity is 43 cm); unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring, and may extend into summer.

Larvae: No information known.

Juveniles: No information known for small juveniles <25 cm fork length. Larger juveniles have been taken infrequently in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds. A manned submersible study in the eastern Gulf observed juvenile (<40 cm) light dusky rockfish associated with *Primnoa* spp. coral.

Adults: Commercial fishery and research survey data indicate that adult light dusky rockfish are primarily found on offshore banks of the outer continental shelf at depths of 100 to 200 m. Type of substrate in this habitat has not been documented, but it may be rocky. During submersible dives on the outer shelf (40 to 50 m) in the eastern Gulf, adult light dusky rockfish were observed in association with rocky habitats and in areas with extensive sponge beds where the fish were observed resting in large vase sponges (pers. Comm. V. O’Connell). Light dusky rockfish are the most highly aggregated of the rockfish species caught in GOA trawl surveys. Outside of these aggregations, the fish are sparsely distributed. Because the fish are generally taken only with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no evidence of a pelagic tendency based on the information available at present. There is no information on seasonal migrations. Light dusky rockfish often co-occur with northern rockfish.

Additional Information Sources

Eggs, Larvae, and Juveniles: None at present.

Adults: Rebecca Reuter, c/o NMFS, Alaska Fisheries Science Center, REFM Division.

Literature

Ackley, D.R., and J. Heifetz. 2001. Fishing practices under maximum retainable bycatch rates in Alaska's groundfish fisheries. Alaska Fish. Res. Bull. 8(1): 22-44.

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U. S. Dep. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Clausen, D.M., C.R. Lunsford, and J. Fujioka. 2002. Pelagic shelf rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p.383-417. Council, 605 W. 4th. Ave., Suite 306, Anchorage, AK 99501-2252.

Kendall, A.W. 1989. Additions to knowledge of *Sebastes* larvae through recent rearing. NWAFC Proc. Rept. 89-21. 46 p.

Krieger, K.J., and B.L. Wing. 2002. Megafauna associations with deepwater corals (*Primnoa* spp.) in the GOA. Hydrobiologia 471: 83-90.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dep. Commer. NOAA Tech. Rept. NMFS 80, 652 p.

Reuter, R.F. 1999. Describing dusky rockfish (Sebastes ciliatus) habitat in the GOA using historical data. M.S. Thesis, Calif. State Univ., Hayward CA. 83 p.

Stark, J.W., and D.M. Clausen. 1995. Data report: 1990 GOA bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-49. 221 p.

Westrheim, S.J. 1973. Preliminary information on the systematics, distribution, and abundance of the dusky rockfish, *Sebastes ciliatus*. J. Fish. Res. Bd. Can. 30: 1230-1234.

Westrheim, S.J. 1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32: 2399-2411.

SPECIES: Light Dusky Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	U	U	All year	U	U	U	U	U
Late Juveniles	Up to 11 years	U	U	ICS, MCS, OCS	D	CB, R, G	U	Observed associated with *Primnoa* coral
Adults	11 up to 51-59 years.	Euphausiids	U, except that larval release may be in the spring in the GOA	OCS, USP	D,	CB, R, G	U	Observed associated with large vase-type sponges

Habitat Description for Yelloweye Rockfish
(*Sebastes ruberrimus*)
and
Other Demersal Rockfishes

Management Plan and Area GOA

Yelloweye rockfish *Sebastes ruberrimus* (primary species, described below)
Quillback rockfish, *Sebastes maliger*
Rosethorn rockfish, *Sebastes helvomaculatus*
Tiger rockfish*, Sebastes nigrocinctus*
Canary rockfish, *Sebastes pinniger*
China rockfish, *Sebastes nebulosus*
Copper rockfish, *Sebastes caurinus*

Life History and General Distribution

These species are distributed from Ensendada, northern Baja California to Umnak Island and Unalaska Island, Aleutians in depths from 60 to 1,800 feet but commonly in 300 to 600 feet in rocky, rugged habitat (Allen and Smith 1988, Eschmeyer et al. 1983). Little is known about the young of the year and settlement. Young juveniles between 2.5 and 10 cm have been observed in areas of high and steep relief, in depths deeper than 15 m. Subadult and adult fish are generally solitary, occurring in rocky areas and high relief with refuge space, particularly overhangs, caves and crevices (O'Connell and Carlile 1993). Yelloweye are ovoviviparous. Parturition occurs in southeast Alaska between April and July with a peak in May (O'Connell 1987). Fecundity ranges from 1,200,000 to 2,700,000 eggs per season (Hart 1942, O'Connell unpublished data). Yelloweye feed on a variety of prey, primarily fishes (including other rockfishes, herring, and sandlance) as well as caridean shrimp and small crabs. Yelloweye are a K-selected species with late maturation, slow growth, extreme longevity, and low natural mortality. They reach a maximum length of about 91 cm and growth slows considerably after age 30. Approximately 50 percent are mature at 45 cm and 22 years, natural mortality (M) is estimated to be 0.02, and maximum age reported is 118 years (O'Connell and Fujioka 1991, O'Connell and Funk 1987).

Fishery

Demersal shelf rockfish are the target of a directed longline fishery and are the primary bycatch species in the longline fishery for Pacific halibut. They recruit into the fishery at about age 18 to 20 at a length between 45 and 50 cm. The commercial fishery grounds are usually areas of rocky bottom between 20 and 100 fm. The directed fishery now occurs between November and March both because of higher winter prices and limitations imposed due to the halibut IFQ regulations.

Relevant Trophic Information:

Yelloweye rockfish eat a large variety of organisms, primarily fishes included small rockfishes, herring and sandlance as well as caridean shrimp and small crabs (Rosenthal et al 1988). They also opportunistically consume lingcod eggs. Young rockfishes are in turn eaten by a variety of predators including lingcod, large rockfish, salmon, and halibut.

Approximate Upper Size Limit of Juvenile Fish (in cm): Length at 50 percent sexual maturity is 45 cm for females and 50 cm for males.

Habitat and Biological Associations

Young juveniles between 2.5 (1 inch) and 10 cm (4 inches) have been observed in areas of high relief (vertical walls, cloud sponges, fjord-like areas) in depths deeper than 15 m (Christiansen, Jeff, The Seattle Aquarium, personal communication). Subadult (late juveniles) and adult fish are generally solitary, occurring in rocky areas and high relief with refuge spaces particularly overhangs, caves and crevices (O'Connell and Carlile 1993). Not infrequently an adult yelloweye rockfish will cohabitate a cave or refuge space with a tiger rockfish. Habitat specific density data shows an increasing density with increasing habitat complexity: deep water boulder fields consisting of very large boulders have significantly higher densities than other rock habitats (O'Connell and Carlile 1993). Although yelloweye do occur over cobble and sand bottoms, generally this is when foraging and often these areas directly interface with a rock wall or outcrop.

Additional Information Sources

NMFS, Alaska Fisheries Science Center.

Literature

Hart, J.L. 1942. New Item. Red snapper fecundity. Fish. Res. Board. Can. Pac. Progr. Rep. 52: 18.

O'Connell, V.M. 1987. Reproductive seasons for some *Sebastes* species in southeast Alaska. Alaska Department of Fish and Game Information Leaflet No. 263. Juneau, AK.

O'Connell, V.M., and D.C Carlile. 1993. Habitat-specific density of adult yelloweye rockfish *Sebastes ruberrimus* in the eastern GOA. Fishery Bull. 91:304-309.

O'Connell, V.M., and J.T. Fujioka. 1991. Demersal Shelf Rockfishes. *In* Loh-Lee Low (ed.), Status of living marine resources off Alaska as assessed in 1991, p. 46-47. NOAA Tech. Memo. NMFS F/NWC-211, Northwest Fish. Sci. Cent., Auke Bay AK 95 P.

O'Connell, V.M., and F.C. Funk. 1987. Age and growth of yelloweye rockfish (*Sebastes ruberrimus*) landed in southeast Alaska. *In* B.R. Melteff (ed.), Proceedings of the International Rockfish Symposium. p 171-185. Alaska Sea Grant Report No. 87-2.

Rosenthal, R.J., V. Moran-O'Connell, and M.C. Murphy. 1988. Feeding ecology of ten species of rockfishes (Scorpaenidae) from the GOA. Calif. Fish and Game 74(1):16-37.

SPECIES: Yelloweye Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	na							
Larvae	<6 mo	Copepod	Spring/ Summer	U	N?	U	U	
Early Juveniles	to 10 years	U		ICS, MCS, OCS, BAY, IP	D	R, C	U	
Late Juveniles	10 to 18 years	U		ICS, MCS, OCS, BAY, IP	D	R, C	U	
Adults	At least 118 years	Fish, shrimp, crab	Parturition: Apr-Jul	ICS, MCS, OCS, USP, BAY, IP	D	R, C, CB	U	

Other Rockfishes:

Species	Range/Depth	Maximum Age	Trophic	Parturition	Known Habitat
Quillback	Kodiak Island to San Miguel Island, CA To 274 m (commonly 12-76 m)	At least 32 50 percent SM=30 cm	Main prey = crustaceans, herring, Sandlance	Spring (Mar-Jun)	Juveniles have been observed at the margins of kelp beds, adults occur over rock bottom, or over cobble/sand next to reefs
Copper	Shelikof St to central Baja, CA Shallow to 183 m (commonly to 122 m)	At least 31 years 50 percent SM=5 yr	Crustaceans Octopi Small fishes	Mar-Jul	Juveniles have been observed near eelgrass beds and in kelp, in areas of mixed sand and rock. Adults are in rocky bays and shallow coastal areas, generally less exposed than the other DSR
Tiger	Kodiak Is and Prince William Sound to Tanner-Cortes Banks, CA From 33 to 183 m	To 116 years	Invertebrates, primarily crustaceans	Early spring	Juveniles and adults in rocky areas: most frequently observed in boulder areas, generally under overhangs.
China	Kachemak Bay to San Miguel Island, CA To 128 m	To 72 years	Invertebrates, Brittle stars are significant component of diet	Apr-Jun	Juveniles have been observed in shallow kelp beds, adults in rocky reefs and boulder fields. Some indications that adults have a homesite.
Rosethorn	Kodiak Is to Guadalupe Is, Baja, CA To 25 m to 549 m	To 87 years Mature 7-10 years		Feb-Sept (May)	Observed over rocky habitats and in rock pavement areas with large sponge cover
Canary	Shelikof St to Cape Colnett, Baja, CA To 424 m (commonly to 137 m)	To 75 years 50 percent sm = 9	Macroplankton and small fishes		Occur over rocky and sand/cobble bottoms, often hovering in loose schools over soft bottom near rock outcrops. Schools often associate with schools of yellowtail and silvergrey.

Habitat Description for Thornyhead Rockfish

(Sebastolobus spp.)

Management Plan and Area GOA

Life History and General Distribution

Thornyheads of the northeastern Pacific Ocean comprise two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). The longspine thornyhead is not common in the GOA. The shortspine thornyhead is a demersal species which inhabits deep waters from 93 to 1,460 m from the BS to Baja California. This species is common throughout the GOA, EBS and AI. The population structure of shortspine thornyheads, however, is not well defined. Thornyheads are slow-growing and long-lived with maximum age in excess of 50 years and maximum size greater than 75 cm and 2 kg. Thornyheads spawn buoyant masses of eggs during the late winter and early spring that resemble bilobate "balloons" which float to the surface. Juvenile shortspine thornyheads have a pelagic period of about 14 to 15 months and settle out at about 22 to 27 mm. Fifty percent of female shortspine thornyheads are sexually mature at about 21 cm and 12 to 13 years of age.

Fishery

Trawl and longline gear are the primary methods of harvest. The bulk of the fishery occurs in late winter or early spring through the summer. In the past, this species was seldom the target of a directed fishery. Today thornyheads are one of the most valuable of the rockfish species, with most of the domestic harvest exported to Japan. Thornyheads are taken with some frequency in the longline fishery for sablefish and cod and is often part of the bycatch of trawlers concentrating on pollock and Pacific ocean perch.

Relevant Trophic Information

Shortspine thornyheads prey mainly on epibenthic shrimp and fish. Yang (1993, 1996) showed that shrimp were the top prey item for shortspine thornyheads in the GOA; whereas, cottids were the most important prey item in the AI region. Differences in abundance of the main prey between the two areas might be the main reason for the observed diet differences. Predator size might by another reason for the difference since the average shortspine thornyhead in the AI area was larger than that in the GOA (33.4 cm vs 29.7 cm).

Approximate Upper Size Limit of Juvenile Fish (in cm): Female shortspine thornyheads appear to be mature at about 21 to 22 cm.

Habitat and Biological Associations

Egg/Spawning: Eggs float in masses of various sizes and shapes. Frequently the masses are bilobed with the lobes 15 cm to 61 cm in length, consisting of hollow conical sheaths containing a single layer of eggs in a gelatinous matrix. The masses are transparent and not readily observed in the daylight. Eggs are 1.2 to 1.4 mm in diameter with a 0.2 mm oil globule. They move freely in the matrix. Complete hatching time is unknown but is probably more than 10 days.

Larvae: Three day-old larvae are about 3 mm long and apparently float to the surface. It is believed that the larvae remain in the water column for about 14 to 15 months before settling to the bottom.

Juveniles: Very little information is available regarding the habitats and biological associations of juvenile shortspine thornyheads

Adults: Adults are demersal and can be found at depths ranging from about 90 to 1,500 m. Groundfish species commonly associated with thornyheads include: arrowtooth flounder (*Atheresthes stomias*), Pacific ocean perch (*Sebastes alutus*), sablefish *(Anoplopoma fimbria*), rex sole (*Glyptocephalus zachirus*), Dover sole (*Microstomus pacificus*), shortraker rockfish (*Sebastes borealis*), rougheye rockfish (*Sebastes aleutianus*), and grenadiers (family Macrouridae). Two congeneric thornyhead species, the longspine thornyhead (*Sebastolobus altivelis*) and a species common off of Japan, *S. Macrochir*, are infrequently encountered in the GOA.

Additional Information Sources

NMFS, Alaska Fisheries Science Center.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Aton, M. 1981. GOA bottomfish and shellfish resources. U.S. Dep. Commer. Tech. Memo. NMFS F/NWC-10, 51 p.

Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102 p.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 230-270. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Ianelli, J.N., D.H. Ito, and M. Martin. 1996. Thornyheads (*Sebastolobus sp.*). *In* Stock Assessment and fishery evaluation report for the groundfish resources of the GOA, p. 303-330. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Jacobson, L.D. 1993. Thornyheads. *In* Status of living marine resources off the Pacific coast of the United States for 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-26, 35-37 p.

Kramer, D.E., and V.M. O'Connell. 1986. Guide to northeast Pacific rockfishes, Genera *Sebastes* and *Sebastolobus*. Marine Advisory Bulletin No. 25: 1-78. Alaska Sea Grant College Program, University of Alaska.

Low, L.L. 1994. Thornyheads. *In* Status of living marine resources off Alaska, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-27, 56-57 p.

Sigler, M.F., and H.H. Zenger, Jr. 1994. Relative abundance of GOA sablefish and other groundfish based on the domestic longline survey, 1989. NOAA Tech. Memo. NMFS-AFSC-40.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the AI in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

SPECIES: Thornyhead Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	U	Spawning: Late winter and early spring	U	P	U	U	
Larvae	<15 Months	U	Early spring through summer	U	P	U	U	
Juveniles	> 15 months when settling to bottom occurs (?)	U Shrimp, Amphipods, Mysids, Euphausiids?	U	MCS, OCS, USP	D	M, S, R, SM, CB, MS, G	U	
Adults	U	Shrimp Fish (cottids), Small crabs	Year-round?	MCS, OCS, USP, LSP	D	M, S, R, SM, CB, MS, G	U	

Habitat Description for Atka Mackerel

(*Pleurogrammus monopterygius*)

Management Plan and Area GOA

Life History and General Distribution

Atka mackerel are distributed from the GOA to the Kamchatka Peninsula, and they are most abundant along the Aleutians. Adult Atka mackerel occur in large localized aggregations usually at depths less than 200 m and generally over rough, rocky, and uneven bottom near areas where tidal currents are swift. Associations with corals and sponges have been observed for AI Atka mackerel. Adults are semi-demersal, displaying strong diel behavior with vertical movements away from the bottom occurring almost exclusively during the daylight hours, presumably for feeding, and little to no movement at night. Spawning is demersal in moderately shallow waters and peaks in June through September, but may occur intermittently throughout the year. Female Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Eggs develop and hatch at depth in 40 to 45 days, releasing planktonic larvae that have been found up to 800 km from shore. Little is known of the distribution of young Atka mackerel before their appearance in trawl surveys and the fishery at about age 2 to 3 years. R-traits are as follows: young age at maturity (approximately 50 percent are mature at age 3), fast growth rates, high natural mortality (M=0.3), and young average and maximum ages (about 5 and 14 years, respectively). K-selected traits indicate low fecundity (only about 30,000 eggs/female/year, large egg diameters (1 to 2 mm) and male nest-guarding behavior).

Fishery

The fishery consists of bottom trawls, which recruit at about age 3, and it is conducted in the AI and western GOA at depths between from 70 to 225 m, in trawlable areas on rocky, uneven bottom, along edges, and in the lee of submerged hills during periods of high current. Currently, the fishery occurs on reefs west of Kiska Island, south and west of Amchitka Island, in Tanaga Pass and near the Delarof Islands, and south of Seguam and Umnak Islands. Historically the fishery occurred east into the GOA as far as Kodiak Island (through the mid-1980s), but is no longer conducted there.

Relevant Trophic Information

Atka mackerel are important food for Steller sea lions in the AI, particularly during summer, and for other marine mammals (minke whales, Dall's porpoise, and northern fur seals). Juveniles are eaten by thick billed murres, tufted puffins, and short-tailed shearwaters. The main groundfish predators are Pacific halibut, arrowtooth flounder, and Pacific cod.

Approximate Upper Size Limit of Juvenile Fish (in cm): The estimated size is 35 cm.

Habitat and Biological Associations

<u>*Egg/Spawning*</u>: Adhesive eggs are deposited in nests built and guarded by males on rocky substrates or on kelp in moderately shallow water.

<u>Larvae/Juveniles</u>: Planktonic larvae have been found up to 800 km from shore, usually in the upper water column (neuston), but little is known of the distribution of Atka mackerel until they are about 2 years old and start to appear in the fishery and surveys.

<u>Adults</u>: Adults occur in localized aggregations usually at depths less than 200 m and generally over rough, rocky, and uneven bottom near areas where tidal currents are swift. Associations with corals and sponges have been observed for AI Atka mackerel. Adults are semi-demersal/pelagic during much of the year, but they migrate annually to moderately shallow waters where the males become demersal during spawning; females move between nesting and offshore feeding areas.

Additional Information Sources

NMFS, Alaska Fishery Science Center, FOCI program, Sandra Lowe.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the AI, Alaska, after a ban on salmon driftnets. U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, AI Unit, PSC 486, Box 5251, FPO AP 96506-5251, Adak, Alaska.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western GOA during spring. Fishery Bulletin 93: 231-253.

Fritz, L.W. 1993. Trawl locations of walleye pollock and Atka mackerel fisheries in the BS, AI, and GOA from 1977-1992. AFSC Processed Report 93-08, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 pp.

Gorbunova, N.N. 1962. Razmnozhenie I razvite ryb semeistva terpugovykh (Hexagrammidae) (Spawning and development of greenlings (family Hexagrammidae). Tr. Inst. Okeanol., Akad. Nauk SSSR 59:118-182. In Russian. (Trans. by Isr. Program Sci. Trans., 1970, p. 121-185 in T.S. Rass (editor), Greenlings: taxonomy, biology, interoceanic transplantation; available from the U.S. Dep. Commer., Natl. Tech. Inf. Serv., Springfield, VA., as TT 69-55097).

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal Callorhinus ursinus, in the eastern north Pacific Ocean and EBS. NOAA Tech. Rept. NMFS SSRF-779. USDOC, NOAA, NMFS, 49 pp.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dep. Commerce., NOAA Tech. Rept NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Lee, J.U. 1985. Studies on the fishery biology of the Atka mackerel *Pleurogrammus monopterygius* (Pallas) in the north Pacific Ocean. Bull. Fish. Res. Dev. Agency, 34, pp.65-125.

Levada, T.P. 1979. Comparative morphological study of Atka mackerel. Pac. Sci. Res. Inst. Fish. Oceanogr. (TINRO), Vladivostok, U.S.S.R., Unpublished manuscript.

Levada, T.P. 1979. Some data on biology and catch of Atka mackerel. Pac. Sci. Res. Inst. Fish. Oceanogr. (TINRO), Vladivostok, U.S.S.R., Unpublished manuscript.

Lowe, S.A., and L.W. Fritz. 1996. Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Lowe, S.A., and L.W. Fritz. 1996. Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the GOA as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

McDermott, S.F., and S.A. Lowe. 1997. The reproductive cycle and sexual maturity of Atka mackerel (*Pleurogrammus monopterygius*) in Alaskan waters. Fishery Bulletin 95: 321-333.

Morris, B.F. 1981. An assessment of the living marine resources of the central BS and potential resource use conflicts between commercial fisheries and Petroleum development in the Navarin Basin, Proposed sale No. 83. Anchorage, AK: USDOC, NOAA, NMFS, Environmental Assessment Division.

Musienko, L.N. 1970. Razmnozheine I razvitie ryb Beringova morya (Reproduction and development of BS fishes). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Koz. Okeanogr. 70: 161-224 In P.A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, Avail. Natl. Tech. Info. Serv., Springfield, VA as TT 74-50127.

Nichol, D.G., and D.A. Somerton. 2002. Diurnal vertical migration of the Atka mackerel *Pleurogrammus monopterygius* as shown by archival tags. Mar Ecol Prog Ser 239: 193-207.

National Marine Fisheries Service (NMFS). 2004. Website: Resources Assessment and Conservation Engineering Field Videos—Underwater Habitat Footage, Alaska Fisheries Science Center. http://www.afsc.noaa.gob/race/media/videos/vids_habitat.htm.

NMFS. 1995. Status review of the Unites States Steller sea lion (*Eumetopias jubatus*) population. National Marine Mammal Laboratory, Alaska Fishery Science Center, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115.

Orlov, A.M. 1996. The role of mesopelagic fishes in feeding of Atka mackerel in areas of the North Kuril islands. Publ. Abstract in Role of forage fishes in marine ecosystems. Symposium held Nov 1996, AK Sea Grant, U. Alaska, Fairbanks.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Sinclair E.H., and T.K. Zeppelin. 2002. Seasonal and spatial differences in diet in the western stock of Steller sea lions (*Eumetopias jubatus*). Journal of Mammalogy 83(4).

Stone, R. 2004. Depth distribution, fisheries interactions, and habitat of deep-sea corals in the AI off of Alaska-Preliminary research data presented at American Association for the Advancement of Science. Seattle, Washington. NOAA Fisheries. Alaska Fisheries Science Center. Auke Bay Laboratory.

Waldron, K.D. 1978. Ichthyoplankton of the EBS, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1996. Trophic role of Atka mackerel in the AI. Publ. Abstract in Role of forage fishes in marine ecosystems. Symposium held Nov 1996, AK Sea Grant, U. Alaska, Fairbanks.

Zolotov, O.G. 1993. Notes on the reproductive biology of *Pleurogrammus monopterygius* in Kamchatkan waters. J. of Ichthy. 33(4), pp. 25-37.

SPECIES: Atka Mackerel

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	40 to 45 days	NA	summer	IP,ICS	D	GR,R,K	U	develop 3-20˚C optimum 9-13˚C
Larvae	up to 6 mos	U copepods?	fall-winter	U	U N?	U	U	2-12˚C optimum 5-7˚C
Juveniles	½ to 2 years of age	U copepods & euphausiids?	all year	U	U	U	U	3-5˚C
Adults	3+ years of age	copepods euphausiids meso-pelagic fish (myctophids)	spawning (May-Oct) non-spawning (Nov-Apr) tidal/diurnal, year-round?	ICS and MCS, IP MCS and OCS, IP ICS,MCS, OCS,IP	D (males) SD females SD/D all sexes D when currents high/day SD slack	GR,R,K	F,E	3-5˚C all stages >17 ppt only

Habitat Description for Capelin

(*osmeridae*)

Management Plan and Area GOA

Species Representative:

Capelin (*Mallotus villosus*)

Life History and General Distribution

Capelin is a short-lived marine (neritic), pelagic, filter-feeding schooling fish distributed along the entire coastline of Alaska and the BS, and south along British Columbia to the Strait of Juan de Fuca; circumpolar. In the North Pacific, capelin grow to a maximum of 25 cm and 5 years of age. Spawn at ages 2 to 4 in spring and summer (May to August; earlier in south, later in north) when about 11 to 17 cm on coarse sand, fine gravel beaches, especially in Norton Sound, northern Bristol Bay, along the Alaska Peninsula and near Kodiak. Age at 50 percent maturity is 2 years. Fecundity is 10,000 to 15,000 eggs per female. Eggs hatch in 2 to 3 weeks. Most capelin die after spawning. Larvae and juveniles are distributed on inner-mid shelf in summer (rarely found in waters deeper than about 200 m), and juveniles and adults congregate in fall in mid-shelf waters east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands, and north into the Gulf of Anadyr. They are distributed along outer shelf and under ice edge in winter. Larvae, juveniles, and adults have diurnal vertical migrations following scattering layers – night near surface, at depth during the day. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Fishery

Capelin are not a target species in groundfish fisheries of BSAI or GOA, but are caught as bycatch (up to several hundred tons per year in the 1990s) principally during the yellowfin sole trawl fishery in Kuskokwim and Togiak Bays in spring in the BSAI; almost all are discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Capelin are important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a, Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise and fin, sei, humpback, and beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987, Wespestad 1987). Smelts are also found in the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot, and salmon throughout the North Pacific Ocean and the BS (Allen 1987, Yang 1993, Livingston, in prep.).

Approximate Upper Size Limit of Juvenile Fish (in cm): 13 cm

Habitat and Biological Associations

Egg/Spawning: Spawn adhesive eggs (about 1 mm in diameter) on fine gravel or coarse sand (0.5 to 1 mm grain size) beaches intertidally to depths of up to 10 m in May-July in Alaska (later to the north in Norton Sound). Hatching occurs in 2 to 3 weeks. Most intense spawning when coastal water temperatures are 5 to 9ºC.

Larvae: After hatching, 4 to 5 mm larvae remain on the middle-inner shelf in summer; distributed pelagically; centers of distribution are unknown, but have been found in high concentrations north of Unimak Island, in the western GOA, and around Kodiak Island.

Juveniles: In fall, juveniles are distributed pelagically in mid-shelf waters (50 to 100 m depth; -2 to 3ºC), and have been found in highest concentrations east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Adults: Found in pelagic schools in inner-mid shelf in spring-fall, feed along semi-permanent fronts separating inner, mid, and outer shelf regions (~50 and 100 m). In winter, found in concentrations under ice-edge and along mid-outer shelf.

Additional Information Sources

Paul Anderson, NMFS/RACE, Kodiak, AK.
Jim Blackburn, ADFG, Kodiak, AK.
Mark W. Nelson, NMFS/REFM, Seattle, WA.

Literature

Allen, M.J. 1987. Demersal fish predators of pelagic forage fishes in the southeastern BS. Pp. 29-32 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Crawford, T.W. 1981. Vertebrate prey of *Phocoenoides dalli* (Dall's porpoise), associated with the Japanese high seas salmon fishery in the North Pacific Ocean. M.S. Thesis, Univ. Washington, Seattle, 72 p.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western GOA during spring. Fishery Bulletin 93: 231-253.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Fritz, L.W., V.G. Wespestad, and J.S. Collie. 1993. Distribution and abundance trends of forage fishes in the BS and GOA. Pp. 30-44 In Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. AK-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Frost, K.J., and L. Lowry. 1987. Marine mammals and forage fishes in the southeastern BS. Pp. 11-18 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Hunt, G.L., Jr., B. Burgeson, and G.A. Sanger. 1981a. Feeding ecology of seabirds of the EBS. Pp 629-647 In D.W. Hood and J.A. Calder (eds.), The EBS Shelf: Oceanography and Resources, Vol. II. U.S. Dept. Commerce., NOAA, OCSEAP, Office of Marine Pollution Assessment, Univ. WA Press, Seattle, WA.

Hunt, G.L., Jr., Z. Eppley, B. Burgeson, and R. Squibb. 1981b. Reproductive ecology, foods and foraging areas of seabirds nesting on the Pribilof Islands, 1975-79. Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, RU-83, U.S. Dept. Commerce., NOAA, OCSEAP, Boulder, CO.

Kawakami, T. 1980. A review of sperm whale food. Sci. Rep. Whales Res. Inst. Tokyo 32: 199-218.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dep. Commerce., NOAA Tech. Rept NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Livingston, P.A. In prep. Groundfish utilization of walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*) and capelin (*Mallotus villosus*) resources in the GOA. In preparation.

Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the GOA: a resource assessment for the GOA/Cook Inlet Proposed Oil and Gas Lease Sale 88. U.S. Dept. Commerce., NOAA, NMFS.

Murphy, E.C., R.H. Day, K.L. Oakley, and A.A. Hoover. 1984. Dietary changes and poor reproductive performances in glaucous-winged gulls. Auk 101: 532-541.

Naumenko, E.A. 1996. Distribution, biological condition, and abundance of capelin (*Mallotus villosus socialsis)* in the BS. Pp. 237-256 *In* O.A. Mathisen and K.O. Coyle (eds.), Ecology of the BS: a review of Russian literature. Alaska Sea Grant Report No. 96-01, Alaska Sea Grant College Program, U. Alaska, Fairbanks, AK 99775-5040. 306 p.

Pahlke, K.A. 1985. Preliminary studies of capelin Mallotus villosus in Alaska waters. Alaska Dept. Fish Game, Info. Leaf. 250, 64 p.

Perez, M.A., and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fish. Bull., U.S. 84: 957-971.

Pitcher, K.W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the GOA. Fish. Bull., U.S. 78: 544-549.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the EBS, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

Wespestad, V.G. 1987. Population dynamics of Pacific herring (*Clupea palasii*), capelin (*Mallotus villosus*), and other coastal pelagic fishes in the EBS. Pp. 55-60 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.

SPECIES: Capelin

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	2 to 3 weeks to hatch	na	May-August	BCH (to 10 m)	D	S,CB		5-9˚C peak spawning
Larvae	4 to 8 months?	Copepods phytoplankton	summer/fall/ winter	ICS-MCS	N,P	U NA?	U	
Juveniles	1.5+ years up to age 2	Copepods Euphausiids	all year	ICS-MCS	P	U NA?	U F? Ice edge in winter	
Adults	2 years ages 2-4+	Copepods Euphausiids polychaetes small fish	spawning (May-August)	BCH (to 10 m)	D,SD	S,CB		
			non-spawning (Sep-Apr)	ICS-MCS-OCS	P	NA?	F Ice edge in winter	-2 - 3˚C Peak distributions in EBS?

Habitat Description for Eulachon

(*osmeridae*)

Management Plan and Area GOA

Species Representative:

Eulachon, candlefish *(Thaleichthys pacificus*)

Life History and General Distribution

Eulachon is a short-lived anadromous, pelagic schooling fish distributed from the Pribilof Islands in the EBS, throughout the GOA, and south to California. Consistently found pelagically in Shelikof Strait (hydroacoustic surveys in late winter-spring) and between Unimak Island and the Pribilof Islands (bycatch in groundfish trawl fisheries) from the middle shelf to over the slope. In the North Pacific, eulachon grow to a maximum of 23 cm and 5 years of age. They spawn at ages 3 to 5 in spring and early summer (April to June) when they are about 14 to 20 cm in rivers on coarse sandy bottom. Their age at 50 percent maturity is 3 years. Fecundity equals ~25,000 eggs per female. Eggs adhere to sand grains and other substrates on river bottom. Eggs hatch in 30 to 40 days in BC at 4 to 7ºC. Most eulachon die after first spawning. Larvae drift out of rivers and develop at sea. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Fishery

Eulachon and candlefish are not target species in groundfish fisheries of BSAI or GOA, but are caught as bycatch (up to several hundred tons per year in the 1990s) principally by midwater pollock fisheries in Shelikof Strait (GOA), on the east side of Kodiak (GOA), and between the Pribilof Islands and Unimak Island on the outer continental shelf and slope (EBS); almost all are discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Eulachon may be important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance, and juvenile pollock (Hunt et al. 1981a, Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise and fin, sei, humpback, and beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987, Wespestad 1987). Smelts are also found in the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot, and salmon throughout the North Pacific Ocean and the BS (Allen 1987; Yang 1993; Livingston, in prep.).

Approximate Upper Size Limit of Juvenile Fish (in cm): 14 cm

Habitat and Biological Associations

Egg/Spawning: Anadromous; return to spawn in spring (May to June) in rivers; demersal eggs adhere to bottom substrate (sand, cobble, etc.). Hatching occurs in 30 to 40 days.

Larvae: After hatching, 5 to 7 mm larvae drift out of river and develop pelagically in coastal marine waters; centers of distribution are unknown.

Juveniles and Adults: Distributed pelagically in mid-shelf to upper slope waters (50 to 1,000 m water depth), and have been found in highest concentrations between the Pribilof Islands and Unimak Island on the outer shelf, and in Shelikofeast of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Additional Information Sources

Paul Anderson, NMFS/RACE, Kodiak, AK.
Jim Blackburn, ADFG, Kodiak, AK.
Mark W. Nelson, NMFS/REFM, Seattle, WA.

Literature

Allen, M.J. 1987. Demersal fish predators of pelagic forage fishes in the southeastern BS. Pp. 29-32 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Crawford, T.W. 1981. Vertebrate prey of *Phocoenoides dalli* (Dall's porpoise), associated with the Japanese high seas salmon fishery in the North Pacific Ocean. M.S. Thesis, Univ. Washington, Seattle, 72 p.

Fritz, L.W., V.G. Wespestad, and J.S. Collie. 1993. Distribution and abundance trends of forage fishes in the BS and GOA. Pp. 30-44 In Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. AK-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Frost, K.J., and L. Lowry. 1987. Marine mammals and forage fishes in the southeastern BS. Pp. 11-18 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Hunt, G.L., Jr., B. Burgeson, and G.A. Sanger. 1981a. Feeding ecology of seabirds of the EBS. Pp 629-647 In D.W. Hood and J.A. Calder (eds.), The EBS Shelf: Oceanography and Resources, Vol. II. U.S. Dept. Commerce., NOAA, OCSEAP, Office of Marine Pollution Assessment, Univ. WA Press, Seattle, WA.

Hunt, G.L., Jr., Z. Eppley, B. Burgeson, and R. Squibb. 1981b. Reproductive ecology, foods and foraging areas of seabirds nesting on the Pribilof Islands, 1975-79. Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, RU-83, U.S. Dept. Commerce., NOAA, OCSEAP, Boulder, CO.

Kawakami, T. 1980. A review of sperm whale food. Sci. Rep. Whales Res. Inst. Tokyo 32: 199-218.

Livingston, P.A. In prep. Groundfish utilization of walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*) and capelin (*Mallotus villosus*) resources in the GOA. In preparation.

Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the GOA: a resource assessment for the GOA/Cook Inlet Proposed Oil and Gas Lease Sale 88. U.S. Dept. Commerce., NOAA, NMFS.

Perez, M.A., and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fish. Bull., U.S. 84: 957-971.

Pitcher, K.W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the GOA. Fish. Bull., U.S. 78: 544-549.

Sanger, G.A. 1983. Diets and food web relationships of seabirds in the GOA and adjacent marine regions. Outer Continental Shelf Environmental Assessment Program, Final Reports of Principal Investigators 45: 631-771.

Wespestad, V.G. 1987. Population dynamics of Pacific herring (*Clupea palasii*), capelin (*Mallotus villosus*), and other coastal pelagic fishes in the EBS. Pp. 55-60 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.

SPECIES: Eulachon (Candlefish)

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	30 to 40 days	na	April-June	Rivers-FW	D	S (CB?)		4 - 8˚C for egg development
Larvae	1 to 2 months ?	Copepods phytoplankton mysids, larvae	summer/fall	ICS ?	P?	U NA?	U	
Juveniles	2.5+ years up to age 3	Copepods Euphausiids	all year	MCS-OCS-USP	P	U NA?	U F?	
Adults	3 years ages 3 to 5+		spawning (May-June)	Rivers-FW	D	S (CB?)		
		Copepods Euphausiids	non-spawning (July-Apr)	MCS-OCS-USP	P	NA?	F?	

Habitat Description for Sculpins

(*cottidae*)

Management Plan and Area GOA

Species Representatives:

Yellow Irish lord (*Hemilepidotus jordani)*
Red Irish lord (*Hemilepidotus hemilepidotus*)
Butterfly sculpin (*Hemilepidotus papilio*)
Bigmouth sculpin (*Hemitripterus bolini*)
Great sculpin (*Myoxocephalus polyacanthocephalus*)
Plain sculpin (*Myoxocephalus jaok*)

Life History and General Distribution:

Cottidae (sculpins) is a large circumboreal family of demersal fishes inhabiting a wide range of habitats in the north Pacific Ocean and BS. Most species live in shallow water or in tidepools, but some inhabit the deeper waters (to 1,000 m) of the continental shelf and slope. Most species do not attain a large size (generally 10 to 15 cm), but those that live on the continental shelf and are caught by fisheries can be 30 to 50 cm; the cabezon is the largest sculpin and can be as long as 100 cm. Most sculpins spawn in the winter. All species lay eggs, but in some genera, fertilization is internal. The female commonly lays demersal eggs amongst rocks where they are guarded by males. Egg incubation duration is unknown; larvae were found across broad areas of the shelf and slope all year-round in ichthyoplankton collections from the southeast BS and GOA. Larvae exhibit diel vertical migration (near surface at night and at depth during the day). Sculpins generally eat small invertebrates (e.g., crabs, barnacles, mussels), but fish are included in the diet of larger species; larvae eat copepods.

Yellow Irish lords: They are distributed from subtidal areas near shore to the edge of the continental shelf (down to 200 m) throughout the BS, AI, and eastward into the GOA as far as Sitka, AK; up to 40 cm in length. 12 to 26 mm larvae collected in spring on the western GOA shelf.

Red Irish lords: They are distributed from rocky, intertidal areas to about 100 m depth on the middle continental shelf (most shallower than 50 m), from California (Monterey Bay) to Kamchatka; throughout the BS and GOA; rarely over 30 cm in length. Spawns masses of pink eggs in shallow water or intertidally. Larvae were 7 to 20 mm long in spring in the western GOA.

Butterfly sculpins: They are distributed primarily in the western north Pacific and northern BS, from Hokkaido, Japan, Sea of Okhotsk, Chukchi Sea, to southeast BS and in AI; depths of 20 to 250 m, most frequent 50 to 100 m.

Bigmouth sculpin: They are distributed in deeper waters offshore, between about 100 to 300 m in the BS, AI, and throughout the GOA; up to 70 cm in length.

Great sculpin: They are distributed from the intertidal to 200 m, but may be most common on sand and muddy/sand bottoms in moderate depths (50 to 100 m); up to 80 cm in length. They are found throughout the BS, AI, and GOA, but may be less common east of Prince William Sound. *Myoxocephalus* spp. larvae ranged in length from 9 to 16 mm in spring ichthyoplankton collections in the western GOA.

Plain sculpin: They are distributed throughout the BS and GOA (not common in the AI) from intertidal areas to depths of about 100 m, but most common in shallow waters (<50 m); up to 50 cm in length. *Myoxocephalus* spp. larvae ranged in length from 9 to 16 mm in spring ichthyoplankton collections in the western GOA.

Fishery

Sculpins are not a target of groundfish fisheries of BSAI or GOA, but sculpin bycatch (second to skates in weight amongst the other species) has ranged from 6,000 to 11,000 metric tons (mt) per year in the BSAI from 1992 to 1995, and 500 to 1,400 mt per year in the GOA. Bycatch occurs principally in bottom trawl fisheries for flatfish, Pacific cod, and pollock, but also while longlining for Pacific cod; almost all is discarded. Annual sculpin bycatch in the BSAI ranges between 1 and 4 percent of annual survey biomass estimates; however, little is known of the species distribution of the bycatch.

Relevant Trophic Information

Sculpin feed on bottom invertebrates (e.g., crabs, barnacles, mussels, and other molluscs); larger species eat fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown

Habitat and Biological Associations

Egg/Spawning: Lay demersal eggs in nests guarded by males; many species in rocky shallow waters near shore.

Larvae: Distributed pelagically and in neuston across broad areas of shelf and slope, but predominantly on inner and middle shelf; have been found year-round.

Juveniles and Adults: Sculpins are demersal fish and live in a broad range of habitats from rocky intertidal pools to muddy bottoms of the continental shelf and in rocky, upper slope areas. Most commercial bycatch occurs on middle and outer shelf areas used by bottom trawlers for Pacific cod and flatfish.

Additional Information Sources

NMFS, Alaska Fisheries Science Center, Sarah Gaichas.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western GOA during spring. Fishery Bulletin 93: 231-253.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dep. Commerce., NOAA Tech. Rept NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the EBS, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

SPECIES: Sculpins

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	na	winter?	BCH,ICS (MSC-OSC?)	D	R (others?)	U	
Larvae	U	copepods	all year?	ICS-MSC,OCS,US	N,P	na?	U	
Juveniles and Adults	U	bottom invertebrates (crabs, molluscs, barnacles) and small fish	all year	BCH,ICS, MSC, OSC, USP	D	R, S, M, SM	U	

Habitat Description for Sharks

Management Plan and Area GOA

Species Representatives:

Lamnidae: Salmon shark (*Lamna ditropis*)
Squalidae: Sleeper shark (*Somniosus pacificus*)
Spiny dogfish (*Squalus acanthias*)

Life History and General Distribution:

Sharks of the order Squaliformes (which includes the two families Lamnidae and Squalidae) are the higher sharks with five gill slits and two dorsal fins. The Lamnidae are large, ovoviviparous (with small litters, 1 to 4; embryos nourished by intrauterine cannibalism), widely migrating sharks which are highly aggressive predators (salmon and white sharks). The Lamnidae are partly warm-blooded; the heavy trunk muscles are warmer than water for greater power and efficiency. Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the GOA (where they occur all year and are probably most abundant in Alaska waters), the BS, and off Japan. In groundfish fishery and survey data, they occur chiefly on outer shelf/upper slope areas in the BS, but near the coast to the outer shelf in the GOA, particularly near Kodiak Island. They are not commonly seen in AI. They are believed to eat primarily fish, including salmon, sculpins, and gadids and can be up to 3 m in length.

The Pacific sleeper shark is distributed from California around the Pacific rim to Japan and in the BS principally on the outer shelf and upper slope (but has been observed nearshore), generally demersal (but also seen near surface). Other members of the Squalidae are ovoviviparous, but fertilization and development of sleeper sharks are not known; adults are up to 8 m in length. They are voracious, omnivorous predators of flatfish, cephalopods, rockfish, crabs, seals, and salmon; they may also prey on pinnipeds. In groundfish fishery and survey data, they occur chiefly on outer shelf/upper slope areas in the BS, but near coast to the outer shelf in the GOA, particularly near Kodiak Island.

Spiny dogfish (or closely related species?) are widely distributed through the Atlantic, Pacific, and Indian Oceans. In the north Pacific, they may be most abundant in the GOA, but are also common in the BS. They are pelagic species and are found at surface and to depths of 700 m; they are mostly found at 200 m or less on shelf and neritic; they are often found in aggregations. They are ovoviviparous, with litter size proportional to the size of the female, from 2 to 9; gestation may be 22 to 24 months. Young are 24 to 30 cm at birth, with growth initially rapid, then it slows dramatically. Maximum adult size is about 1.6 m and 10 kg; maximum age is about 40 years. Fifty percent of females are mature at 94 cm and 29 years old; males are mature at 72 cm and 19 years old. Females give birth in shallow coastal waters, usually from September to January. Dogfish eat a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus). Tagging experiments indicate local indigenous populations in some areas and widely migrating groups in others. They may move inshore in summer and offshore in winter.

Fishery

Sharks are not a target of groundfish fisheries of BSAI or GOA, but shark bycatch has ranged from 300 to 700 mt per year in the BSAI from 1992 to 1995; 500 to 1,400 mt per year in the GOA principally by pelagic trawl fishery for pollock, longline fisheries for Pacific cod and sablefish, and bottom trawl fisheries for pollock, flatfish, and cod; almost all are discarded. Little is known of shark biomass in BSAI or GOA.

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown for salmon sharks and sleeper sharks; for spiny dogfish: 94 cm for females, 72 cm for males.

Habitat and Biological Associations

Egg/Spawning: Salmon sharks and spiny dogfish are ovoviviparous; reproductive strategy of sleeper sharks is not known. Spiny dogfish give birth in shallow coastal waters, while salmon sharks probably give birth offshore and pelagic.

Juveniles and Adults: Spiny dogfish are widely dispersed throughout the water column on shelf in the GOA, and along outer shelf in the EBS; apparently they are not as commonly found in the AI and are not commonly found at depths >200 m.

Salmon sharks are found throughout the GOA, but are less common in the EBS and AI; they are epipelagic and are found primarily over shelf/slope waters in the GOA and on the outer shelf in the EBS.

Sleeper sharks are widely dispersed on shelf/upper slope in the GOA and along the outer shelf/upper slope only in the EBS; they are generally demersal and may be less commonly found in the AI.

Additional Information Source

NMFS, Alaska Fisheries Science Center, Sarah Gaichas.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

SPECIES: Sharks

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs and Larvae								
Juveniles and Adults Salmon shark	U	fish (salmon, sculpins and gadids)	all year	ICS, MSC. OCS, US in GOA; OCS, US in BSAI	P	NA	U	
Sleeper shark	U	omnivorous; flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	D	U	U	
Spiny dogfish	40 years	fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus)	all year	ICS, MSC, OCS in GOA; OCS in BSAI give birth ICS in fall/winter?	P	U	U	Euhaline 4-16˚C

Habitat Description for Skates

(Rajidae)

Management Plan and Area GOA

Species Representatives:

Alaska skate (*Bathyraja parmifera*)
Aleutian skate (*Bathyraja aleutica*)
Bering skate (*Bathyraja interrupta*)

Life History and General Distribution:

Skates (Rajidae) that occur in the BSAI and GOA are grouped into two genera: *Bathyraja* sp., or soft-nosed species (rostral cartilage slender and snout soft and flexible), and *Raja* sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). Skates are oviparous; fertilization is internal, and eggs (one to five or more in each case) are deposited in horny cases for incubation. Adults and juveniles are demersal and feed on bottom invertebrates and fish. Adult distributions from survey are Alaska skate: mostly 50 to 200 m on shelf in EBS and AI (AI), less common in the GOA (GOA); Aleutian skate: throughout EBS and AI, but less common in GOA, mostly 100 to 350 m; Bering Skate: throughout EBS and GOA, less common in AI, mostly 100 to 350 m. Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. BSAI skate biomass estimate more than doubled between 1982 to 1996 from bottom trawl survey; it may have decreased in the GOA and remained stable in the AI in the 1980s.

Fishery

Until 2003, skates were not a target of groundfish fisheries of BSAI or GOA, but were caught as bycatch (13,000 to 17,000 mt per year in the BSAI from 1992 to 1995; 1,000 to 2,000 mt per year in the GOA) principally by the longline Pacific cod and bottom trawl pollock and flatfish fisheries; almost all were discarded. Skate bycatches in the EBS groundfisheries ranged between 1 and 4 percent of the annual EBS trawl survey biomass estimates from 1992 to 1995.

Starting in 2003, a directed fishery for skates developed in the GOA centered around Kodiak Island. It is prosecuted primarily on longline vessels less than 60 feet long, with some additional targeting by trawlers using large mesh nets. The primary target species appears to be Raja binoculata, followed by Raja rhina, but this is difficult to determine given that there is almost no observer coverage of the fishery. As of late July 2003, over 2,000 tons of skates had been landed. The market price per pound of skates is comparable to that of cod so the fishery is expected to continue and perhaps expand.

Relevant Trophic Information: Skates feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown

Habitat and Biological Associations

Egg/Spawning: Skates deposit eggs in horny cases on shelf and slope.

Juveniles and Adults: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown. Adults found across wide areas of shelf and slope; surveys found most skates at depths <500 m in the GOA and EBS, but >500 m in the AI. In the GOA, most skates found between 4-7˚C, but data are limited.

Additional Information Source

NMFS, Alaska Fisheries Science Center, Sarah Gaichas

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Teshima, K., and T.K. Wilderbuer. 1990. Distribution and abundance of skates in the EBS, AI region, and the GOA. Pp. 257-267 *in* H.L. Pratt, Jr., S.H. Gruber, and T. Taniuchi (eds.)., Elasmobranchs as living resources: advances in the biology, ecology, systematics and the status of the fisheries. U.S. Dep. Commerce., NOAA Technical Report 90.

SPECIES: Skates

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	na	U	MCS,OCS, USP	D	U	U	
Larvae	na	na	na	na	na	na	na	
Juveniles	U	Invertebrates small fish	all year	MCS,OCS, USP	D	U	U	
Adults	U	Invertebrates small fish	all year	MCS,OCS, USP	D	U	U	

Habitat Description for Squid

(*Cephalopoda, Teuthida*)

Management Plan and Area GOA

Species Representatives:

Gonaditae:
  Red or magistrate armhook squid (*Berryteuthis magister*)
Onychoteuthidae:
  Boreal clubhook squid (*Onychoteuthis banksii borealjaponicus)*
  Giant or robust clubhook squid (*Moroteuthis robusta*);
Sepiolidae:
  Eastern Pacific bobtail squid (*Rossia pacifica*).

Life History and General Distribution:

Squid are members of the molluscan class *Cephalopoda*, along with octopus, cuttlefish, and nautiloids. In the BSAI and GOA, gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities >30 ppt. Fertilization is internal, and development is direct ("larval" stages are only small versions of adults). The eggs of inshore neritic species are often enveloped in a gelatinous matrix attached to rocks, shells, or other hard substrates, while the eggs of some offshore oceanic species are extruded as large, sausage-shaped drifting masses. Little is known of the seasonality of reproduction, but most species probably breed in spring-early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2 to 3 years, but the giant *Moroteuthis robusta* clearly lives longer.

B magister is widely distributed in the boreal north Pacific from California, throughout the BS, to Japan in waters 30 to 1,500 m deep; adults are most often found at mesopelagic depths or near bottom on shelf, rising to the surface at night; juveniles are widely distributed across shelf, slope, and abyssal waters in meso- and epipelagic zones, and they rise to the surface at night. They migrate seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. Maximum size for females is 50 cm mantle length (ML); for males, maximum size is 40 cm ML. Spermatophores are transferred into the mantle cavity of the female, and eggs are laid on the bottom on the upper slope (200 to 800 m). Fecundity is estimated at 10,000 eggs/female. Spawning of eggs occurs from February to March in Japan, but apparently year-round in the BS. Eggs hatch after 1 to 2 months of incubation; development is direct. Adults are gregarious prior to and most die after mating.

O. banksii borealjaponicus, an active, epipelagic species, is distributed in the north Pacific from the Sea of Japan, throughout the AI and south to California, but is absent from the Sea of Okhotsk and is not common in the BS. Juveniles can be found over shelf waters at all depths and near shore. Adults apparently prefer the upper layers over slope and abyssal waters; they are diel migrators and gregarious. Development includes a larval stage; maximum size is about 55 cm.

M. robusta, a giant squid, lives near the bottom on the slope and mesopelagically over abyssal waters; it is rare on the shelf. It is distributed in all oceans and is found in the BS, AI, and GOA. Mantle length can be up to 2.5 m long, with tentacles, at least 7 m, but most are about 2 m long.

R. pacifica is a small (maximum length with tentacles of less than 20 cm) demersal, neritic and shelf, boreal species, distributed from Japan to California in the North Pacific and in the BS in waters of about 20 to 300 m depth. Other *Rossia* spp. deposit demersal egg masses.

Fishery

Squid are not currently a target of groundfish fisheries of BSAI or GOA. A Japanese fishery catching up to 9,000 mt of squid annually existed until the early 1980s for *B. magister* in the BS and *O. banksii borealjaponicus* in the AI. Since 1990, annual squid bycatch has been about 1,000 mt or less in the BSAI and between 30 to 150 mt in the GOA; in the BSAI, almost all squid bycatch is in the midwater pollock fishery near the continental shelf break and slope, while in the GOA, trawl fisheries for rockfish and pollock (again mostly near the edge of the shelf and on the upper slope) catch most of the squid bycatch.

Relevant Trophic Information

The principal prey items of squid are small forage fish pelagic crustaceans (e.g., euphausiids and shrimp) and other cephalopods; cannibalism is not uncommon. After hatching, small planktonic zooplankton (copepods) are eaten. Squid are preyed upon by marine mammals, seabirds, and, to a lesser extent by fish, and they occupy an important role in marine food webs worldwide. Perez (1990) estimated that squids comprise over 80 percent of the diets of sperm whales, bottlenose whales, and beaked whales and about half of the diet of Dall's porpoise in the EBS and AI. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break (e.g., Buldir Island, Pribilof Islands) are also known to feed heavily on squid (Hatch et al. 1990, Byrd et al. 1992, Springer 1993). In the GOA, only about 5 percent or less of the diets of most groundfish consisted of squid (Yang 1993). However, squid play a larger role in the diet of salmon (Livingston and Goiney 1983).

Approximate Upper Size Limit of Juvenile Fish (in cm): For *B. magister*, approximately 20 cm ML for males, 25 cm ML for females; both at approximately 1 year of age.

Habitat Narrative for *B. magister*

<u>*Egg/Spawning*</u>: Eggs are laid on the bottom on the upper slope (200 to 800 m); incubate for 1 to 2 months.

<u>*Young Juveniles*</u>: Distributed epipelagically (top 100 m) from the coast to open ocean.

<u>*Old Juveniles and Adults*</u>: Distributed mesopelagically (most from 150 to 500 m) on the shelf (summer only?), but mostly in outer shelf/slope waters (to lesser extent over the open ocean). They migrate to slope waters to mate and spawn demersally.

Additional Information Sources

NMFS, Alaska Fisheries Science Center, Sarah Gaichas
NMFS, Alaska Fisheries Science Center, Beth Sinclair

Literature

Arkhipkin, A.I., V.A. Bizikov, V.V. Krylov, and K.N. Nesis. 1996. Distribution, stock structure, and growth of the squid *Berryteuthis magister* (Berry, 1913) (Cephalopoda, Gonatidae) during summer and fall in the western BS. Fish. Bull. 94: 1-30.

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the AI, Alaska, after a ban on salmon driftnets. U. S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, AI Unit, PSC 486, Box 5251, FPO AP 96506-5251, Adak, Alaska.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK.

Hatch, S.A., G.V. Byrd, D.B. Irons, and G.L. Hunt, Jr. 1990. Status and ecology of kittiwakes in the North Pacific. Proc. Pacific Seabird Group Symposium, Victoria, B.C., 21-25 February 1990.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS F/NWC-54, 81 p.

Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, USA. 351 pp.

Perez, M. 1990. Review of marine mammal population and prey information for BS ecosystem studies. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS F/NWC-186, 81 p.

Sobolevsky, Ye. I. 1996. Species composition and distribution of squids in the western BS. Pp. 135-141 *In* O.A. Mathisen and K.O. Coyle (eds.), Ecology of the BS: a review of Russian literature. Alaska Sea Grant Rept 96-01, U. Alaska, Fairbanks, AK 99775.

Springer, A. 1993. Report of the seabird working group. pp. 14-29 In Is it food? Addressing marine mammal and seabird declines: a workshop summary. Alaska Sea Grant Report 93-01, Univ. Alaska, Fairbanks, AK, 99775.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

SPECIES: Berryteuthis Magister (Red Squid)

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	1 to 2 months	NA	varies	USP,LSP	D	M,SM, MS	U	
Young juveniles	4 to 6 months	zooplankton		All shelf, slope, BSN	P,N	NA	UP,F?	
Older Juveniles and Adults	1 to 2 years (may be up to 4 years)	euphausiids, shrimp, small forage fish, and other cephalopods	summer winter	All shelf, USP,LSP,BSN OS,USP,LSP,BSN	SP SP	U U	UP,F? UP,F?	Euhaline waters, 2-4˚C

Habitat Description for Octopus

Management Plan and Area GOA

Species Representatives:

Octopoda: Octopus *(Octopus gilbertianus; O. dofleini*)
Vampyromorpha: Pelagic octopus (*Vampyroteuthis infernalis*)

Life History and General Distribution:

Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish, and nautiloids. In the BSAI and GOA, the most commonly encountered octopods are the shelf demersal species *O. gilbertianus* and *O. dofleini*, and the bathypelagic finned species, *V. infernalis*. Octopods, like other cephalopods are dioecious, with fertilization of eggs (usually within the mantle cavity of the female) requiring transfer of spermatophores during copulation. Octopods probably do not live longer than about 2 to 4 years, and females of some species (e.g., *O. vulgaris*) die after brooding their eggs on the bottom.

O. gilbertianus is a medium-size octopus (up to 2 m in total length) distributed across the shelf (to 500 m depth) in the eastern and western BS (where it is the most common octopus), AI, and GOA (endemic to the North Pacific). Little is known of its reproductive or trophic ecology, but eggs are laid on the bottom and tended by females. It lives mainly among rocks and stones.

O. dofleini is a giant octopus (up to 10 m in total length, though mostly about 3 to 5 m) distributed in the southern boreal region from Japan and Korea, through the AI, GOA, and south along the Pacific coast of North America to California. Inhabits the sublittoral to upper slope. Egg length is 6 to 8 mm, and they are laid on the bottom. Copulation may occur in late fall and winter, but oviposition is the following spring; each female lays several hundred eggs.

V. infernalis is a relatively small (up to about 40 cm total length) bathypelagic species, living at depths well below the thermocline; they may be most commonly found at 700 to 1,500 m. They are found throughout the world's oceans. Eggs are large (3 to 4 mm in diameter) and are shed singly into the water. Hatched juveniles resemble adults, but with different fin arrangements, which change to the adult form with development. Little is known of their food habits, longevity, or abundance.

Fishery

Octopus are not currently a target of groundfish fisheries of BSAI or GOA. Bycatch has ranged between 200 to 1,000 mt in the BSAI and 40 to 100 mt in the GOA, chiefly in the pot fishery for Pacific cod and bottom trawl fisheries for cod and flatfish, but sometimes in the pelagic trawl pollock fishery. Directed octopus landings have been less than 8 mt/year from 1988 to 1995. Age/size at 50 percent recruitment is unknown. Most of the bycatch occurs on the outer continental shelf (100 to 200 m depth), chiefly north of the Alaska Peninsula from Unimak Island. To Port Moller and northwest to the Pribilof Islands; also around Kodiak Island and many of the AI.

Relevant Trophic Information

Octopus are eaten by pinnipeds (principally Steller sea lions, and spotted, bearded, and harbor seals) and a variety of fishes, including Pacific halibut and Pacific cod (Yang 1993). When small, octopods eat planktonic and small benthic crustaceans (mysids, amphipods, copepods). As adults, octopus eat benthic crustaceans (crabs) and molluscs (clams).

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown

Habitat Narrative for *Octopus* spp.:

Egg/Spawning: Occurs on shelf; eggs are laid on bottom, maybe preferentially among rocks and cobble.

Young Juveniles: Are semi-demersal; are widely dispersed on shelf, upper slope.

Old Juveniles and Adults: Are demersal; are widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud.

Additional Information Source

NMFS, Alaska Fisheries Science Center, Sarah Gaichas.

Literature

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, USA. 351 pp.

Perez, M. 1990. Review of marine mammal population and prey information for BS ecosystem studies. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS F/NWC-186, 81 p.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

SPECIES: *Octopus dofleini*, *O. gilbertianus*

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U (1 to 2 months?)	NA	spring-summer?	U (IS, MS?)	D	R, G?	U	Euhaline waters
Young juveniles	U	zooplankton	summer-fall	U (IS, MS, OS, USL?)	D,SD	U	U	Euhaline waters
Older Juveniles and Adults	U (2 to 3 years? for *O. gilbertianus*; older for	crustaceans, molluscs	all year	IS, MS, OS, USL	D?	R, G, S, MS	U	Euhaline waters

APPENDIX F.2

ESSENTIAL FISH HABITAT ASSESSMENT REPORT

for the Groundfish Resources of the

Bering Sea and Aleutian Islands Regions

April 2005

NOAA Fisheries
NMFS Alaska Region
709 West 9th Street
Juneau, AK 99802

NOAA Fisheries
National Marine Fisheries Service

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Introduction

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to require the description and identification of Essential Fish Habitat (EFH) in Fishery Management Plans (FMPs), adverse impacts on EFH, and actions to conserve and enhance EFH. National Marine Fisheries Service (NMFS) developed guidelines to assist Fishery Management Councils in fulfilling the requirements set forth by the Act.

Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

With respect to type, the information available for almost all species is primarily broad geographic distributions based on specific samples from surveys and fisheries, which have not been linked with habitat characteristics. Furthermore, NMFS' ability to precisely define the habitat (and its location) of each life stage of each managed groundfish species in terms of its oceanographic (temperature, salinity, nutrient, current), trophic (presence of food, absence of predators), and physical (depth, substrate, latitude, and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions for each species and life stage is restricted primarily to their position in the water column (e.g., demersal, pelagic), broad biogeographic and bathymetric areas (e.g., 100 to 200 m zone, south of the Pribilof Islands and throughout the Aleutian Islands [AI]) and occasional references to known bottom type associations.

Identification of EFH for some species included historical range information. Traditional knowledge and sampling data have indicated that fish distributions may contract and expand due to a variety of factors including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution.

Background

In preparation of the 1999 EFH Environmental Assessment, EFH Technical Teams, consisting of scientific stock assessment authors, compiled scientific information and prepared the 1999 Habitat Assessment Reports. These reports provided the scientific information baseline to describe EFH. Recent scientific evidence has not proved to change existing life history profiles of the federally managed species. However, where new information does exist, new data help fill information gaps in the region's limited habitat data environment.

Stock assessment authors used information contained in these summaries and personal knowledge, along with data contained in reference atlases (NOAA 1987, 1990; Council 1997a,b), fishery and survey data (Allen and Smith 1988, Wolotira et al. 1993, NOAA 1998), and fish identification books (Hart 1973, Eschmeyer and Herald 1983, Mecklenburg and Thorsteinson 2002), to describe EFH for each life stage using best scientific judgment and interpretation; see Table 1.

Species Profiles and Habitat Descriptions

FMPs must describe EFH in text, map EFH distributions, and include tables, which provide information on habitat and biological requirements for each life history stage of the species; see Tables 2 to 4.

Information contained in this report details life history information for federally managed fish species. This collection of scientific information is interpreted, then referenced to describe and delineate EFH for each species by life history stage using the geographic information system (GIS). EFH text and map descriptions are not compiled in this report due to differences in the characteristics of a species life history and the overall distribution of the species. Specific EFH text descriptions and maps are in Appendix D.

References

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dept. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Council (North Pacific Fishery Management Council). 1997a. Essential fish habitat assessment report for the groundfish resources of the BS and AI regions. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Council. 1997b. Essential fish habitat assessment report for the groundfish resources of the GOA region. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Eschmeyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes. Houghton Mifflin Co., Boston. 336 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180. Ottawa. 740 p.

Mecklenburg, Commerce., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fish Society. Bethsda, Maryland. 1037 p.

NOAA (National Oceanic and Atmospheric Administration). 1987. Bering, Chukchi, and Beaufort Seas. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dept. Commerce., NOAA, NOS.

NOAA. 1990. West coast of North America. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dept. Commerce., NOAA, NOS.

NOAA. 1998. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the BS, AI, and GOA regions based on groundfish fishery observer data. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-AFSC-88.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Table 1. Summary of Major References and Atlases

Species	References Allen and Smith 1988	NOAA 1987	NOAA 1990	Wolotira et al. 1993	NOAA 1998	Mecklenburg and Thorsteinson 2002
Walleye pollock	X	X	X	X	X	X
Pacific cod	X	X	X	X	X	X
Yellowfin sole	X	X		X	X	X
Greenland turbot	X	X		X	X	X
Arrowtooth flounder	X	X	X	X	X	X
Rock sole	X	X		X	X	X
Alaska plaice	X	X		X	X	X
Flathead sole	X	X	X	X	X	X
Sablefish	X		X	X	X	X
Pacific ocean perch	X		X	X	X	X
Shortraker-rougheye rockfish	X				X	X
Northern rockfish	X				X	X
Dusky rockfish	X				X	X
Thornyhead rockfish	X				X	X
Atka mackerel	X		X	X	X	X
Sculpins	X				X	X
Skates	X				X	X

Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.

Location
ICS = inner continental shelf (1-50 m)
MCS = middle continental shelf (50-100 m)
OCS = outer continental shelf (100-200 m)
USP = upper slope (200-1000 m)
LSP = lower slope (1000-3000 m)
BSN= basin (>3000 m)

BCH = beach (intertidal)
BAY = nearshore bays, give depth if appropriate (e.g., fjords)
IP = island passes (areas of high current), give depth if appropriate

Water column
D = demersal (found on bottom)
SD/SP =semi-demersal or semi-pelagic if slightly greater or less than 50 percent on or off bottom
P = pelagic (found off bottom, not necessarily associated with a particular bottom type)
N = neustonic (found near surface)

Bottom Type
M = mud S = sand R = rock
SM = sandy mud CB = cobble C = coral
MS = muddy sand G = gravel K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features
UP = upwelling G = gyres F = fronts E = edges
CL = thermocline or pycnocline

General
U = Unknown N/A = not applicable

Table 2. Summary of Habitat Associations for Groundfish in the BSAI

BSA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location							Physical Oceanography					Substrate													Structure										Community Associations												Oceanographic Properties			
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic																																															
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Walleye Pollock	M						x	x	x	x				x		x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x																								2-10			M
	J					x	x	x								x	x	x	x	x	x		x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x																								2-10			J
	L						x	x								x	x	x	x	x	x		x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x																											L
	E						x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x		x			x	x	x	x																																									E
Pacific Cod	M					x	x	x	x	x					x	x	x	x	x	x					x										x	x	x	x	x	x	x	x	x	x	x	x				x	x			x				x	x	x	x	x					x	x				M
	LJ					x	x								x	x	x	x	x	x					x										x	x	x	x	x	x	x	x	x	x	x	x				x	x			x				x	x	x	x	x					x	x				LJ
	EJ				x	x									x		x							x	x										x	x	x	x	x	x	x	x	x	x													x	x	x			x		x								EJ
	L					x	x	x																		x																																															L
	E					x	x	x																	x										x	x	x	x	x	x	x	x	x	x	x	x																								3-6	13-23	2-3	E
Atka Mackerel	M					x	x	x								x							x	x					x			x	x			x	x									x								x										x					3-5	>17		M
	J																																																																					3-5			J
	L																					x	x																																															2-12			L
	E					x										x									x												x									x																		x					3-20			E
Sablefish	M								x	x	x	x	x				x				x				x				x						x	x	x								x	x							x																			M
	LJ							x	x	x	x						x				x				x				x						x	x	x								x	x																											LJ
	EJ					x	x	x									x								x	x	x		x																																												EJ
	L						x	x	x	x	x	x	x	x								x	x						x																																												L
	E								x	x	x	x	x	x												x	x		x																																												E
Pacific Ocean Perch	M							x	x	x								x	x	x	x			x	x	x			x								x								x	x														x													M
	LJ					x	x	x	x																																																																	LJ
	EJ					x	x	x					x	x										x	x	x	x	x	x								x								x	x																											EJ
	L																						x	x		x	x		x																																													L
Flathead Sole	M					x	x	x	x																x								x		x	x	x			x		x																																M
	LJ					x	x	x																	x										x	x	x			x		x																																LJ
	EJ					x	x																		x											x	x																																							EJ
	L					x	x	x																		x					x									x																																		L
	E					x	x	x																		x																																																E
Yellowfin Sole	M					x	x																		x										x	x				x																																		M
	LJ					x	x																		x										x	x				x																																		LJ
	EJ					x																			x										x	x				x																																		EJ
	L					x	x																			x																																																L
	E					x	x																			x																																																E
Alaska Plaice	M					x	x	x																	x										x	x				x																																		M
	LJ					x	x	x																	x										x	x				x																																		LJ
	EJ					x	x																		x										x	x				x																																		EJ
	L					x	x	x																		x					x																																												L
	E					x	x	x																		x																																																E
Arrowtooth Flounder	M					x	x	x	x	x	x														x										x	x	x			x																																		M
	LJ					x	x	x																	x										x	x	x			x																																		LJ
	EJ					x	x																		x										x	x	x			x																																		EJ
	L					x	x	x	x	x																x					x																																											L
	E					x	x	x	x	x															x																																																	E
Rock Sole	M					x	x	x																	x										x	x				x																																		M
	LJ					x	x																		x										x	x				x																																		LJ
	EJ					x																			x										x	x				x																																		EJ
	L					x	x	x																		x					x																																											L
	E					x	x	x																	x																																																	E
Dover Sole	M					x	x	x	x	x	x	x													x										x	x			x																																			M
	LJ					x	x	x	x	x															x										x	x			x																																			LJ
	EJ					x	x																		x										x	x			x																																			EJ

Table 2. Summary of Habitat Associations for Groundfish in the BSAI

BSA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location							Physical Oceanography					Substrate													Structure										Community Associations												Oceanographic Properties			
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic																																														
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
	L					x	x	x	x	x																x					x																																										L
	E					x	x	x	x	x																x																																															E
Rex Sole	M					x	x	x	x	x															x										x	x				x																																	M
	LJ					x	x	x	x																x										x	x				x																																	LJ
	EJ					x	x																		x										x	x				x																																	EJ
	L					x	x	x	x																	x									x	x																																					L
	E					x	x	x	x																	x																																														E
Greenland Turbot	M							x	x	x	x														x										x	x	x		x																																		M
	LJ					x	x																		x										x	x			x																																		LJ
	EJ																								x										x	x			x																																		EJ
	L					x	x	x	x	x																x					x																																										L
	E					x	x	x	x	x																x																																														E
Shortraker/Rougheye Rockfish	M								x	x																x									x	x		x								x							x								x												M
	LJ					x	x	x	x								x	x	x	x	x																																																			LJ
	EJ												x	x									x																																																	EJ
	L																										x																																														L
Northern Rockfish	M						x	x										x							x																				x	x																												M
	LJ						x	x										x	x						x																																																	LJ
	EJ																									x																																															EJ
	L																																																																									L
Thornyhead Rockfish	M								x	x	x	x	x												x												x								x	x							x																					M
	LJ						x	x	x																x												x									x																												LJ
	EJ																									x																																															EJ
	L																									x																																															L
	E																									x																																															E
Light Dusky Rockfish	M							x	x									x		x	x				x												x								x	x																												M
	LJ						x	x										x		x					x																																				x												LJ
	EJ																																																																								EJ
	L																																																																									L
Sculpins	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x																												x																					M
	LJ																																																																									LJ
	EJ																																																																									EJ
	L																																																																									L
	E																																																																									E
Skates	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x																																																		M
	LJ																																																																									LJ
	EJ																																																																									EJ
	L																																																																									L
	E																																																																									E
Sharks	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x																																														M
	LJ																																																																									LJ
	EJ																																																																									EJ
	L																																																																									L
	E																																																																									E
Squid	M				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																									x																					M
	LJ																																																																									LJ
	EJ																																																																									EJ
	L																																																																									L
	E																																																																									E

Table 2. Summary of Habitat Associations for Groundfish in the BSAI

BSA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location							Physical Oceanography					Substrate													Structure										Community Associations												Oceanographic Properties			
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic																																															
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Octopus	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x				x	x	x																																													M
	LJ																																																																							LJ
	EJ																																																																							EJ
	L																																																																							L
	E																																																																							E
Eulachon	M						X	X	X								X									X			X			X	X																																								M
	LJ						X	X																		X			X			X	X																																								LJ
	EJ					X	X																			X			X			X																																								EJ
	L	X	X			X	X										X						X																																																	L
	E	X																																																																			4-8			E
Capelin	M						X	X									X									X			X			X	X																																					-2-3			M
	LJ						X	X																		X			X			X	X																																								LJ
	EJ					X	X																			X			X			X																																								EJ
	L		X			X	X										X						X																																																	L
	E			X											X																					X	X					X																													5-9			E
Sand Lance	M			X	X	X									X		X					X	X	X	X	X										X	X					X																																M
	LJ			X	X	X									X		X					X	X	X	X	X										X	X					X																																LJ
	EJ		X		X	X									X		X					X	X			X																																																EJ
	L		X			X									X		X					X	X			X																																																L
	E			X													X																																																									E

Table 3. Summary of Reproductive Traits for Groundfish in the BSAI

BSAI Groundfish		Reproductive Traits																										
		Age at Maturity				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	50%	100%	50%	100%	External	Internal	Oviparous	Ovoviviparous	Viviparous	Batch Spawner	Broadcast Spawner	Egg Case Deposition	Nest Builder	Egg/Young Guarder	Egg/Young Bearer	January	February	March	April	May	June	July	August	September	October	November	December
Walleye Pollock	M	4-5		4-5		x						x						x	x	x	x							
Pacific Cod	M	5		5		x						x					x	x	x	x	x							
Atka Mackerel	M	3.6		3.6		x								x	x						x	x	x	x	x	x		
Sablefish	M	57-61cm				x						x					x	x	x	x	x							
Pacific Ocean Perch	M	10.5		65cm			x			x	x														x	x	x	x
Flathead Sole	M	10				x											x	x	x	x								x
Yellowfin Sole	M	10.5				x					x										x	x	x					
Alaska Plaice	M	6-7				x													x	x	x							
Arrowtooth Flounder	M	5		4		x											x	x	x	x							x	x
Rock Sole	M	9				x					x						x	x	x									
Rex Sole	M	24cm		16cm		x												x	x	x	x	x	x					
Greenland Turbot	M	5-10				x											x	x	x							x	x	x
Dover Sole	M	33cm				x											x	x	x	x	x	x	x	x				
Shortraker/Rougheye Rockfish	M	20+					x			x	x												x	x	x	x	x	x
Northern Rockfish	M	13					x			x	x																	
Thornyhead Rockfish	M	12									x							x				x						
Dusky Rockfish	M	11					x			x	x																	
Sculpins	M					x									x													
Skates	M						x	x					x															
Sharks	M						x	x	x	x			x			x												
Squid	M						x				x																	
Octopus	M						x				x			x	x													
Eulachon	M	3	5	3	5	X		X			X									X	X	X						
Capelin	M	2	4	2	4	X		X			X										X	X	X	X				
Sand Lance	M	1	2	1	2	X		X			X						X	X									X	X

Table 4. Summary of Predator and Prey Relationships for Groundfish in the BSAI

BSAI Groundfish		Predator to																												
Species	**Life Stage**	**Algae**	**Plants**	**Plankton**	**Zooplankton**	**Diatoms**	**Sponges**	**Eusphausiid**	**Hydroids**	**Amphipoda**	**Copepods**	**Starfish**	**Polychaetes**	**Squid**	**Philodae (gunnels)**	**Bi-valves**	**Mollusks**	**Crustaceans**	**Ophiuroids (brittle stars)**	**Shrimps, mysidacae**	**Sand lance**	**Osmerid (eulachon)**	**Herring**	**Myctophid (lantern fishes)**	**Cottidae (sculpins)**	**Arrowtooth**	**Rockfish**	**Salmon**	**Pacific cod**	**Pollock**	**Halibut**
Walleye Pollock	M				x			x			x			x						x	x	x	x	x		x			x	x	x
	LJ				x			x			x			x						x	x	x	x	x		x			x	x	x
	EJ				x			x			x									x	x	x									
	L				x			x			x																				
	E																														
Pacific Cod	M							x		x			x							x										x	
	LJ							x		x			x							x										x	
	EJ							x		x			x							x											
	L			x	x						x																				
	E																														
Atka Mackerel	M							x			x													x							
	J							x			x																				
	L										x																				
	E																														
Sablefish	M							x	x	x	x		x	x				x		x		x	x		x	x		x	x	x	
	LJ							x	x	x	x		x	x				x		x		x	x		x	x		x	x	x	
	EJ							x		x	x		x	x	x			x		x			x					x			
	L				x						x																				
	E																														
Pacifc Ocean Perch	M							x																							
	LJ							x			x																				
	EJ																														
	L			x	x																										
Flathead Sole	M							x		x	x		x			x	x	x	x		x	x								x	
	LJ							x		x	x		x			x	x	x	x											x	
	EJ				x								x			x			x											x	
	L	x		x																											
	E																														
Yellowfin Sole	M							x		x			x			x		x		x					x					x	
	LJ							x		x			x			x		x		x					x						
	EJ				x																										
	L	x		x																											
	E																														
Arrowtooth Flounder	M												x	x				x	x	x			x	x						x	
	LJ												x					x	x	x			x	x						x	
	EJ				x																										
	L	x		x																											
	E																														
Rock Sole	M									x			x			x	x														
	LJ									x			x			x	x														
	EJ				x																										
	L	x		x																											
	E																														

BSAI Groundfish		Prey of																												
Species		**Jellyfish**	**Starfish**	**Chaetognaths (arrowworms)**	**Crab**	**Herring**	**Salmon**	**Pollock**	**Pacific cod**	**Ling cod**	**Rockfish**	**Rock Sole**	**Flathead Sole**	**Yellowfin sole**	**Arrowtooth flounder**	**Hailbut**	**Salmon Shark**	**Northern Fur Seal**	**Harbor Seal**	**Steller sea lion**	**Dalls Porpoise**	**Beluga whale**	**Killer Whale**	**Minke whale**	**Eagles**	**Murres**	**Puffin**	**Kittiwake**	**Gull**	**Terrerstrial Mammals**
Walleye Pollock	M								x						x	x	x	x	x	x										
	LJ							x	x						x	x		x	x	x				x		x	x	x		
	EJ							x	x						x	x		x	x	x				x		x	x	x		
	L							x	x						x	x								x		x	x	x		
	E																													
Pacific Cod	M															x	x	x		x		x	x	x						
	LJ															x	x	x		x		x	x	x						
	EJ															x	x	x				x	x	x			x			
	L																													
	E																													
Atka Mackerel	M								x						x	x			x	x	x			x						
	J																			x						x	x			
	L																													
	E																													
Sablefish	M																													
	LJ						x									x														
	EJ																													
	L																													
	E																													
Pacifc Ocean Perch	M															x														
	LJ																													
	EJ						x																							
	L																													
Flathead Sole	M								x				x		x	x														
	LJ																													
	EJ																													
	L																													
	E																													
Yellowfin Sole	M																													
	LJ								x							x														
	EJ								x							x														
	L																													
	E																													
Arrowtooth Flounder	M																													
	LJ							x	x																					
	EJ																													
	L																													
	E																													
Rock Sole	M																													
	LJ							x	x					x		x														
	EJ																													
	L																													
	E																													

Table 4. Summary of Predator and Prey Relationships for Groundfish in the BSAI

BSAI Groundfish

Predator to

Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Dover Sole	M												x				x	x													
	LJ												x				x	x													
	EJ																														
	L	x		x																											
	E																														
Rex Sole	M							x		x			x					x													
	LJ							x		x			x					x													
	EJ																														
	L	x		x																											
	E																														
Greenland Turbot	M												x					x	x	x			x	x						x	
	LJ																														
	EJ				x																										
	L	x		x																											
	E																														
Shortraker/Rougheye Rockfish	M													x						x				x							
	LJ																														
	EJ																														
	L																														
Northern Rockfish	M							x			x																				
	LJ																														
	EJ																														
	L																														
Thornyhead Rockfish	M																			x					x						
	LJ																														
	EJ																														
	L																														
	E																														
Light Dusky Rockfish	M							x																							
	LJ																														
	EJ																														
	L																														
Sculpins	M				x			x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x		x	x		
	LJ																														
	EJ																														
	L																														
	E																														
Skates	M									x		x	x					x		x	x		x		x	x	x	x	x	x	x
	LJ																														
	EJ																														
	L																														
	E																														
Sharks	M													x				x		x							x	x		x	x

Prey of

Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Dover Sole	M								x						x															
	LJ								x						x															
	EJ																													
	L																													
	E																													
Rex Sole	M								x						x															
	LJ								x						x															
	EJ																													
	L																													
	E																													
Greenland Turbot	M																													
	LJ																													
	EJ							x	x					x																
	L																													
	E																													
Shortraker/Rougheye Rockfish	M																													
	LJ																													
	EJ																													
	L																													
Northern Rockfish	M																													
	LJ																													
	EJ																													
	L																													
Thornyhead Rockfish	M																													
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	EJ																													
	L																													
	E																													
Light Dusky Rockfish	M																													
	LJ																													
	EJ																													
	L																													
Sculpins	M										x		x		x	x		x	x	x	x	x								
	LJ																													
	EJ																													
	L																													
	E																													
Skates	M																													
	LJ																													
	EJ																													
	L																													
	E																													
Sharks	M																													

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Table 4 - Diet Prey

Table 4. Summary of Predator and Prey Relationships for Groundfish in the BSAI

BSAI Groundfish		Predator to																														Prey of																												
Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
	LJ																															LJ																													
	EJ																															EJ																													
	L																															L																													
	E																															E																													
Squid	M							x			x									x	x	x	x									M	x					x	x	x	x	x	x	x			x		x	x	x	x	x		x		x	x	x		
	LJ																															LJ																													
	EJ																															EJ																													
	L																															L																													
	E																															E																													
Octopus	M																x	x	x													M									x			x	x		x		x	x	x		x								
	LJ																															LJ																													
	EJ																															EJ																													
	L																															L																													
	E																															E																													
Eulachon	M				X			X			X																					M						X	X	X							X		X	X	X	X					X	X			X
	LJ				X			X			X																					LJ						X	X	X							X		X	X	X	X					X	X			
	EJ				X			X			X																					EJ					X	X	X	X							X														
	L			X	X	X		X			X																					L					X	X	X	X							X														
	E																															E																													
Capelin	M				X			X			X		X							X												M						X	X	X						X	X		X	X	X	X					X	X			
	LJ				X			X			X																					LJ						X	X	X						X	X		X	X	X	X					X	X			
	EJ				X			X			X																					EJ					X	X	X	X						X	X														
	L			X	X	X		X			X																					L					X	X	X	X						X	X														
	E																															E																													
Sand Lance	M				X			X		X	X																					M						X	X	X						X	X		X	X	X	X					X	X			
	LJ				X			X		X	X																					LJ						X	X	X						X	X		X	X	X	X					X	X			
	EJ				X			X		X	X																					EJ					X	X	X	X						X	X														
	L			X	X	X		X		X	X																					L					X	X	X	X						X	X														
	E																															E																													

Habitat Description for

Walleye Pollock (*Theragra calcogramma)*

Management Plan and Area BSAI

The GOA is managed under the GOA Groundfish Fisheries Management Plan, and the EBS and AI pollock stocks are managed under the EBS and AI Groundfish Fisheries Management Plan. Pollock occur throughout the area covered by the FMP and straddle into the Canadian and Russian EEZ, international waters of the central BS, and into the Chukchi Sea.

Life History and General Distribution

Pollock is the most abundant species within the EBS comprising 75 to 80 percent of the catch and 60 percent of the biomass. In the GOA, pollock is the second most abundant groundfish stock comprising 25 to 50 percent of the catch and 20 percent of the biomass.

Four stocks of pollock are recognized for management purposes: GOA, EBS, AI, and Aleutian Basin. There appears to be a high degree of interrelationship among the EBS, AI, and Aleutian Basin stocks with suggestions of movement from one area to the others. There appears to be stock separation between the GOA stocks and stocks to the north.

The most abundant stock of pollock is the EBS stock which is primarily distributed over the EBS outer continental shelf from approximately 70 to 200 m. Information on pollock distribution in the EBS comes from commercial fishing locations, annual bottom trawl surveys, and triennial acoustic surveys.

The AI stock extends through the AI from 170ºW to the end of the AI (Attu Island), with the greatest abundance in the eastern Aleutians (170ºW to Seguam Pass). Most of the information on pollock distribution in the AI comes from triennial bottom trawl surveys. These surveys indicate that pollock are primarily located on the BS side of the AI and have a spotty distribution throughout the AI chain. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass is likely to be unavailable to bottom trawls. Also, many areas of the AI shelf are untrawlable due to rough bottom.

The third stock, Aleutian Basin, appears to be distributed throughout the Aleutian Basin which encompasses the U.S. EEZ, Russian EEZ, and international waters in the central BS. This stock appears to move throughout the Basin for feeding, but concentrates in deepwater near the continental shelf for spawning. The principal spawning location is near Bogoslof Island in the eastern AI, but data from pollock fisheries in the first quarter of the year indicate that there are other concentrations of deepwater spawning concentrations in the western AI. The Aleutian Basin spawning stock appears to be derived from migrants from the EBS shelf stock and possibly some western BS pollock. Recruitment to the stock occurs generally around age 5; very few pollock younger than age 5 have been found in the Aleutian Basin. Most of the pollock in the Aleutian Basin appear to originate from strong year classes.

The GOA stock extends from southeast Alaska to the AI (170ºW), with the greatest abundance in the western and central regulatory areas (147ºW to 170ºW). Most of the information on pollock distribution in the GOA comes from triennial bottom trawl surveys. These surveys indicate that pollock are distributed throughout the shelf regions of the GOA at depths less than 300 m. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls. The principal spawning location is in Shelikof Strait, but data from pollock fisheries and exploratory surveys indicate that there are other concentrations of spawning in the Shumagin Islands, the east side of Kodiak Island, and near Prince William Sound.

Peak pollock spawning occurs on the southeastern BS and eastern AI along the outer continental shelf around mid-March. North of the Pribilof Islands spawning occurs later (April to May) in smaller spawning aggregations. The deep spawning pollock of the Aleutian Basin appear to spawn slightly earlier, late February to early March. In the GOA, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area appears to 2 to 3 weeks earlier than in Shelikof Strait.

Spawning occurs in the pelagic zone and eggs develop throughout the water column (70 to 80 m in the BS shelf, 150 to 200 m in Shelikof Strait). Development is dependent on water temperature. In the BS, eggs take about 17 to 20 days to develop at 4º in the Bogoslof area and 25.5 days at 2º on the shelf. In the GOA, development takes approximately 2 weeks at ambient temperature (5ºC). Larvae are also distributed in the upper water column. In the BS, the larval period lasts approximately 60 days. The larvae eat progressively larger naupliar stages of copepods as they grow and then small euphausiids as they approach transformation to juveniles (~25 mm standard length). In the GOA, larvae are distributed in the upper 40 m of the water column and the diet is similar to BS larvae. FOCI survey data indicate larval pollock may utilize the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which reside in the colder bottom water.

At age 1 pollock are found throughout the EBS both in the water column and on bottom. Age 1 pollock from strong year-classes appear to be found in great numbers on the inner shelf, and further north on the shelf than weak year classes which appear to be more concentrated on the outer continental shelf. From age 2 to 3, pollock are primarily pelagic and then are most abundant on the outer and mid-shelf northwest of the Pribilof Islands. As pollock reach maturity (age 4) in the BS, they appear to move from the northwest to the southeast shelf to recruit to the adult spawning population. Strong year-classes of pollock persist in the population in significant numbers until about age 12, and very few pollock survive beyond age 16. The oldest recorded pollock was age 31.

Growth varies by area with the largest pollock occurring on the southeastern shelf. On the northwest shelf the growth rate is slower. A newly maturing pollock is around 40 cm.

Fishery

The EBS pollock fishery has, since 1990, been divided into two fishing periods: an “A season” occurring in January-March, and a “B season” occurring in August-October. The A season concentrates fishing effort on prespawning pollock in the southeastern BS. During the B season, fishing is still primarily in the southeastern BS, but some fishing also occurs on the northwestern shelf. Also during the B season catcher processor vessels are required to fish north of 56E N latitude because the area to the south is reserved for catcher vessels delivering to shoreside processing plants on Unalaska and Akutan.

Since 1992, the GOA pollock TAC has been apportioned spatially and temporally to reduce impacts on Steller sea lions. Although the details of the apportionment scheme have evolved over time, the general objective is to allocate the TAC to management areas based on the distribution of surveyed biomass and to establish three or four seasons between mid-January and autumn during which some fraction of the TAC can be taken. The Steller Sea Lion Protection Measures implemented in 2001 establish four seasons in the Central and Western GOA beginning January 20, March 10, August 25, and October 1, with 25 percent of the total TAC allocated to each season. Allocations to management areas 610, 620, and 630 are based on the seasonal biomass distribution as estimated by groundfish surveys. In addition, a new harvest control rule was implemented that requires a cessation of fishing when spawning biomass declines below 20 percent of unfished stock biomass.

In the GOA, approximately 90 percent of the pollock catch is taken using pelagic trawls. During winter, fishing effort usually targeted primarily on pre-spawning aggregations in Shelikof Strait and near the Shumagin Islands. The pollock fishery has a very low bycatch rate with discards averaging about 2 percent since 1998 (with the 1991-1997 average around 9 percent). Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery, the catch is almost exclusively pollock.

The EBS pollock fishery primarily harvests mature pollock. The age where fish are selected by the fishery roughly corresponds to the age at maturity (management guidelines are oriented towards conserving spawning biomass). Fishery selectivity increases to a maximum around age 6 to 8 and declines slightly. The reduced selectivity for older ages is due to pollock becoming increasingly demersal with age. Younger pollock form large schools and are semi-demersal, making them easier to locate for fishing vessels. Immature fish (ages 2 and 3) are usually caught in low numbers. Generally the catch of immature pollock increases when strong year-classes occur and the abundance of juveniles increase sharply. This occurred with the 1989 year-class, the second largest year-class on record. Juvenile bycatch increased sharply in 1991 and 1992 when this year-class was age 2 and 3. A secondary problem is that strong to moderate year-classes may reside in the Russian EEZ adjacent to the U.S. EEZ as juveniles. Russian catch-age data and anecdotal information suggest that juveniles may comprise a major portion of the catch. There is a potential for the Russian fishery to reduce subsequent abundance in the U.S. fishery.

The GOA pollock fishery also targets mature pollock. Fishery selectivity increases to a maximum around age 5 to 7 and then declines. In both the EBS and GOA, the selectivity pattern varies between years due to shifts in fishing strategy and changes in the availability of different age groups over time.

In response to continuing concerns over the possible impacts groundfish fisheries may have on rebuilding populations of Steller sea lions, NMFS and the Council have made changes to the Atka mackerel (mackerel) and pollock fisheries in the BSAI and GOA. These have been designed to reduce the possibility of competitive interactions with Steller sea lions. For the pollock fisheries, comparisons of seasonal fishery catch and pollock biomass distributions (from surveys) by area in the EBS led to the conclusion that the pollock fishery had disproportionately high seasonal harvest rates within critical habitat which could lead to reduced sea lion prey densities. Consequently, the management measures were designed to redistribute the fishery both temporally and spatially according to pollock biomass distributions. The underlying assumption in this approach was that the independently derived area-wide and annual exploitation rate for pollock would not reduce local prey densities for sea lions. Here NMFS examines the temporal and spatial dispersion of the fishery to evaluate the potential effectiveness of the measures.

Three types of measures were implemented in the pollock fisheries:

- Additional pollock fishery exclusion zones around sea lion rookery or haulout sites
- Phased-in reductions in the seasonal proportions of TAC that can be taken from critical habitat
- Additional seasonal TAC releases to disperse the fishery in time

Prior to the management measures, the pollock fishery occurred in each of the three major fishery management regions of the north Pacific ocean managed by the Council: the AI (1,001,780 km^2 inside the EEZ), the EBS (968,600 km^2), and the GOA (1,156,100 km^2). The marine portion of Steller sea lion critical habitat in Alaska west of 150°W encompasses 386,770 km^2 of ocean surface, or 12 percent of the fishery management regions.

Prior to 1999, 84,100 km^2, or 22 percent of critical habitat, was closed to the pollock fishery. Most of this closure consisted of the 10- and 20-nm radius all-trawl fishery exclusion zones around sea lion rookeries (48,920 km^2 or 13 percent of critical habitat). The remainder was largely management area 518 (35,180 km^2, or 9 percent of critical habitat), which was closed pursuant to an international agreement to protect spawning stocks of central BS pollock.

In 1999, an additional 83,080 km^2 (21 percent) of critical habitat in the AI was closed to pollock fishing along with 43,170 km^2 (11 percent) around sea lion haulouts in the GOA and EBS. Consequently, a total of 210,350 km^2 (54 percent) of critical habitat was closed to the pollock fishery. The portion of critical habitat that remained open to the pollock fishery consisted primarily of the area between 10 and 20 nm from rookeries and haulouts in the GOA and parts of the EBS foraging area.

The BSAI pollock fishery was also subject to changes in total catch and catch distribution. Disentangling the specific changes in the temporal and spatial dispersion of the EBS pollock fishery resulting from the sea lion management measures from those resulting from implementation of the 1999 American Fisheries Act (AFA) is difficult. The AFA reduced the capacity of the catcher/processor fleet and permitted the formation of cooperatives in each industry sector by 2000. Both of these changes would be expected to reduce the rate at which the catcher/processor sector (allocated 36 percent of the EBS pollock TAC) caught pollock beginning in 1999, and the fleet as a whole in 2000. Because of some of its provisions, the AFA gave the industry the ability to respond efficiently to changes mandated for sea lion conservation that otherwise could have been more disruptive to the industry.

In 2000, further reductions in seasonal pollock catches from BSAI sea lion critical habitat were realized by closing the entire AI region to pollock fishing and by phased-in reductions in the proportions of seasonal TAC that could be caught from the Sea Lion Conservation Area, an area which overlaps considerably with sea lion critical habitat. In 1998, over 22,000 t of pollock were caught in the Aleutian Island regions, with over 17,000 t caught in AI critical habitat. Since 1998 directed fishery removals of pollock have been prohibited.

Relevant Trophic Information

Juvenile pollock through newly maturing pollock primarily utilize copepods and euphausiids for food. At maturation and older ages, pollock become increasingly piscivorous, with pollock (cannibalism) a major food item in the BS. Most of the pollock that is cannibalized is age 0 to 1, and recent research suggests that this can regulate year-class size. Weak year-classes appear to be those located within the range of adults, while strong year-classes are those that are transported to areas outside the range of adult abundance.

Being the dominant species in the EBS, pollock is an important food source for other fish, marine mammals, and birds. On the Pribilof Islands hatching success and fledgling survival of marine birds has been tied to the availability of age 0 pollock to nesting birds.

Approximate Upper Size Limit of Juvenile Fish (in cm): The upper size limit for juvenile pollock in the EBS and GOA is about 38 to 42 cm. This is the size of 50 percent maturity. There is some evidence that this has changed over time.

Habitat and Biological Associations

Egg-Spawning: Pelagic on outer continental shelf generally over 100 to 200 m depth in Bering Sea. Pelagic on continental shelf over 100 to 200 m depth in GOA.

Larvae: Pelagic outer to mid-shelf region in BS. Pelagic throughout the continental shelf within the top 40 m in the GOA.

Juveniles: Age 0 appears to be pelagic, as is age 2 and 3. Age 1 pelagic and demersal with a widespread distribution and no known benthic habitat preference.

Adults: Adults occur both pelagically and demersally on the outer and mid-continental shelf of the GOA, EBS and AI. In the EBS few adult pollock occur in waters shallower than 70 m. Adult pollock also occur pelagically in the Aleutian Basin. Adult pollock range throughout the BS in both the U.S. and Russian waters, however, the maps provided for this document detail distributions for pollock in the U.S. EEZ and the basin.

Additional Information Sources

Eggs and Larvae: Jeff Napp, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA.

Shallow Water Concentrations: Bill Bechtol, Alaska Department of Fish and Game, 3298 Douglas Place, Homer, Alaska.

Literature

Bailey, K.M. 2000. Shifting control of recruitment of walleye pollock *Theragra chalcogramma* after a major climatic and ecosystem change. Mar. Ecol. Prog. Ser 198:215-224.

Bailey, K.M., P.J. Stabeno, and D.A. Powers. 1997. The role of larval retention and transport features in mortality and potential gene flow of walleye pollock. J. Fish. Biol. 51(Suppl. A):135-154.

Bailey, K.M., S.J. Picquelle, and S.M. Spring. 1996. Mortality of larval walleye pollock (*Theragra chalcogramma*) in the western GOA, 1988-91. Fish. Oceanogr. 5 (Suppl. 1):124-136.

Bailey, K.M., T.J. Quinn II, P. Bentzen, and W.S. Grant. 1999. Population structure and dynamics of walleye pollock, *Theragra chalcogramma*. Advances in Mar. Biol. 37: 179-255.

Bakkala, R.G., V.G. Wespestad, and L.L. Low. 1987. Historical trends in abundance and current condition of walleye pollock in the EBS. Fish. Res., 5:199_215.

Bates, R.D. 1987. Ichthyoplankton of the GOA near Kodiak Island, April-May 1984. NWAFC Proc. Rep. 87-11, 53 pp.

Brodeur, R.D., and M.T. Wilson. 1996. A review of the distribution, ecology and population dynamics of age-0 walleye pollock in the GOA. Fish. Oceanogr. 5 (Suppl. 1):148-166.

Brown, A.L., and K.M. Bailey. 1992. Otolith analysis of juvenile walleye pollock *Theragra chalcogramma* from the western GOA. Mar. Bio. 112:23-30.

Dorn, M., S. Barbeaux, M. Guttormsen, B. Megrey, A. Hollowed, E. Brown, and K. Spalinger. 2002. Assessment of Walleye Pollock in the GOA. In Stock assessment and fishery evaluation report for the groundfish resources of the GOA, 2002. North Pacific Fishery Management Council, Box 103136, Anchorage, AK 99510. 88p.

Grant, W.S., and F.M. Utter. 1980. Biochemical variation in walleye pollock *Theragra chalcogramma*: population structure in the southeastern BS and GOA. Can. J. Fish. Aquat. Sci. 37:1093-1100.

Guttormsen, M.A., C.D. Wilson, and S. Stienessen. 2001. Echo integration-trawl survey results for walleye pollock in the GOA during 2001. In Stock Assessment and Fishery Evaluation Report for GOA. Prepared by the GOA Groundfish Plan Team, North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510. North Pacific Fisheries Management Council, Anchorage, AK.

Hinckley, S. 1987. The reproductive biology of walleye pollock, *Theragra chalcogramma*, in the BS, with reference to spawning stock structure. Fish. Bull. 85:481-498.

Hollowed, A.B., J.N. Ianelli, and P. Livingston. 2000. Including predation mortality in stock assessments: a case study for GOA pollock. ICES J. Mar. Sci. 57:279-293.

Hughes, S.E., and G. Hirschhorn. 1979. Biology of walleye pollock, *Theragra chalcogramma*, in Western GOA. Fish. Bull., U.S. 77:263-274.

Ianelli, J.N. 2002. BS walleye pollock stock structure using morphometric methods. Tech. Report Hokkaido National Fisheries Research Inst. No. 5, 53_58.

Ianelli, J.N., S. Barbeaux, T. Honkalehto, G. Walters, and N. Williamson. 2002. BS-AI Walleye Pollock Assessment for 2003. In Stock assessment and fishery evaluation report for the groundfish resources of the EBS and Aleutian Island Region, 2002. North Pacific Fishery Management Council, Box 103136, Anchorage, AK 99510. 88 p.

Kendall, A.W., Jr., and S.J. Picquelle. 1990. Egg and larval distributions of walleye pollock *Theragra chalcogramma* in Shelikof Strait, GOA. U.S. Fish. Bull. 88(1):133-154.

Kim, S., and A.W. Kendall, Jr. 1989. Distribution and transport of larval walleye pollock (*Theragra chalcogramma*) in Shelikof Strait, GOA, in relation to water movement. Rapp. P.-v. Reun. Cons. int. Explor. Mer 191:127-136.

Livingston, P.A. 1991. Groundfish food habits and predation on commercially important prey species in the EBS from 1884-1986. U.S. Dept. Commerce, NOAA Tech Memo. NMFS F/NWC-207.

Meuter, F.J., and B.L. Norcross. 2002. Spatial and temporal patterns in the demersal fish community on the shelf and upper slope regions of the GOA. Fish. Bull. 100:559-581.

Mulligan, T.J., R.W. Chapman, and B.L. Brown. 1992. Mitochondrial DNA analysis of walleye pollock, *Theragra chalcogramma*, from the EBS and Shelikof Strait, GOA. Can. J. Fish. Aquat. Sci. 49:319-326.

Olsen, J.B., S.E. Merkouris, and J.E. Seeb. 2002. An examination of spatial and temporal genetic variation in walleye pollock (*Theragra chalcogramma*) using allozyme, mitochondrial DNA, and microsatellite data. Fish. Bull. 100:752-764.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Proc. Rep. 90-01, 162 pp.

Shima, M. 1996. A study of the interaction between walleye pollock and Steller sea lions in the GOA. Ph.D. dissertation, University of Washington, Seattle, WA 98195.

Stabeno, P.J., J.D. Schumacher, K.M. Bailey, R.D. Brodeur, and E.D. Cokelet. 1996. Observed patches of walleye pollock eggs and larvae in Shelikof Strait, Alaska: their characteristics, formation and persistence. Fish. Oceanogr. 5 (Suppl. 1): 81-91.

Wespestad V.G., and T.J. Quinn II. 1997. Importance of cannibalism in the population dynamics of walleye pollock. In: Ecology of Juvenile Walleye Pollock, *Theragra chalcogramma*. NOAA Technical Report, NMFS 126.

Wespestad, V.G. 1993. The status of BS pollock and the effect of the “Donut Hole” fishery. Fisheries 18(3)18-25.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-6, 184 pp.

SPECIES: Walleye Pollock

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14 d. at 5 C	None	Feb-Apr	OCS, UCS	P	N/A	G?	
Larvae	60 days	copepod naupli and small euphausiids	Mar-Jul	MCS, OCS	P	N/A	G? F	pollock larvae with jellyfish
Juveniles	0.4 to 4.5 years	Pelagic crustaceans, copepods and euphausiids	August +	OCS, MCS, ICS	P, SD	N/A	CL, F	
Adults	4.5 to 16 years	Pelagic crustaceans and fish	Spawning Feb-Apr	OCS, BSN	P, SD	UNK	F UP	Increasingly demersal with age

Habitat Description for Pacific Cod

(Gadus macrocephalus)

Management Plan and Area BSAI

Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about lat. 34° N, with a northern limit of about lat. 63° N. Adults are demersal and form aggregations during the peak spawning season, which extends approximately from January through May. Pacific cod eggs are demersal and adhesive. Eggs hatch in about 15 to 20 days. Little is known about the distribution of Pacific cod larvae, which undergo metamorphosis at about 25 to 35 mm. Juvenile Pacific cod start appearing in trawl surveys at a fairly small size, as small as 10 cm in the EBS. Pacific cod can grow to be more than 1 m in length, with weights exceeding 10 kg. Natural mortality is believed to be somewhere between 0.3 and 0.4. Approximately 50 percent of Pacific cod are mature by ages 5 to 6. The maximum recorded age of a Pacific cod from the BSAI or GOA is 19 years.

Fishery

The fishery is conducted with bottom trawl, longline, pot, and jig gear. The age at 50 percent recruitment varies between gear types and regions. In the BSAI, the age at 50 percent recruitment is 6 years for trawl gear, 4 years for longline, and 5 years for pot gear. In the GOA, the age at 50 percent recruitment is 5 years for trawl gear and 6 years for longline and pot gear. More than 100 vessels participate in each of the three largest fisheries (trawl, longline, pot). The trawl fishery is typically concentrated during the first few months of the year, whereas fixed-gear fisheries may sometimes run, intermittently, at least, throughout the year. Bycatch of crab and halibut sometimes causes the Pacific cod fisheries to close prior to reaching the TAC. In the BSAI, trawl fishing is concentrated immediately north of Unimak Island, whereas the longline fishery is distributed along the shelf edge to the north and west of the Pribilof Islands. In the GOA, the trawl fishery has centers of activity around the Shumagin Islands and south of Kodiak Island, while the longline fishery is located primarily in the vicinity of the Shumagin Islands.

Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the BSAI and GOA are polychaete, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, fishery discards, and yellowfin sole. Small Pacific cod feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod include halibut, salmon shark, northern fur seals, sea lions, harbor porpoises, various whale species, and tufted puffin.

Approximate Upper Size Limit of Juvenile Fish (in cm): The estimated size at 50 percent maturity is 67 cm.

Habitat and Biological Associations

Egg/Spawning: Spawning takes place in the sublittoral-bathyal zone (40 to 290 m) near bottom. Eggs sink to the bottom after fertilization, and are somewhat adhesive. Optimal temperature for incubation is

3 to 6°C, optimal salinity is 13 to 23 ppt, and optimal oxygen concentration is from 2 to 3 ppm to saturation. Little is known about the optimal substrate type for egg incubation.

Larvae: Larvae are epipelagic, occurring primarily in the upper 45 m of the water column shortly after hatching, moving downward in the water column as they grow.

Juveniles: Juveniles occur mostly over the inner continental shelf at depths of 60 to 150 m.

Adults: Adults occur in depths from the shoreline to 500 m. Average depth of occurrence tends to vary directly with age for at least the first few years of life, with mature fish concentrated on the outer continental shelf. Preferred substrate is soft sediment, from mud and clay to sand.

Additional Information Sources

Larvae/juveniles: NMFS, Alaska Fisheries Science Center, FOCI Program, Ann Matarese.

Literature

Albers, W.D., and P.J. Anderson. 1985. Diet of Pacific cod, *Gadus macrocephalus*, and predation on the northern pink shrimp, *Pandalus borealis*, in Pavlof Bay, Alaska. Fish. Bull., U.S. 83:601-610.

Alderdice, D.F., and C.R. Forrester. 1971. Effects of salinity, temperature, and dissolved oxygen on early development of the Pacific cod (*Gadus macrocephalus*). J. Fish. Res. Board Can. 28:883-902.

Bakkala, R.G. 1984. Pacific cod of the EBS. Int. N. Pac. Fish. Comm. Bull. 42:157-179.

Dunn, J.R., and A.C. Matarese. 1987. A review of the early life history of northeast Pacific gadoid fishes. Fish. Res. 5:163-184.

Forrester, C.R., and D.F. Alderdice. 1966. Effects of salinity and temperature on embryonic development of Pacific cod (*Gadus macrocephalus*). J. Fish. Res. Board Can. 23:319-340.

Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in Alaska and Pacific Coast regions, 1975-81. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS F/NWC-44. 50 p.

Ketchen, K.S. 1961. Observations on the ecology of the Pacific cod (*Gadus macrocephalus*) in Canadian waters. J. Fish. Res. Board Can. 18:513-558.

Livingston, P.A. 1989. Interannual trends in Pacific cod, *Gadus macrocephalus*, predation on three commercially important crab species in the EBS. Fish. Bull., U.S. 87:807-827.

Livingston, P.A. 1991. Pacific cod. *In* P.A. Livingston (editor), Groundfish food habits and predation on commercially important prey species in the EBS from 1984 to 1986, p. 31-88. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS F/NWC-207.

Matarese, A.C., A.W. Kendall Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dept. Commerce, NOAA Tech. Rep. NMFS 80. 652 p.

Moiseev, P.A. 1953. Cod and flounders of far eastern waters. Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 40. 287 p. (Transl. from Russian: Fish. Res. Board Can. Transl. Ser. 119.)

National Oceanic and Atmospheric Administration (NOAA). 1987. Bering, Chukchi, and Beaufort Seas--Coastal and ocean zones strategic assessment: Data Atlas. U.S. Dept. Commerce, NOAA, National Ocean Service.

NOAA. 1990. West coast of North America--Coastal and ocean zones strategic assessment: Data Atlas. U.S. Dept. Commerce, NOAA, National Ocean Service and National Marine Fisheries Service.

Phillips, A.C., and J.C. Mason. 1986. A towed, self-adjusting sld sampler for demersal fish eggs and larvae. Fish. Res. 4:235-242.

Rugen, W.C., and A.C. Matarese. 1988. Spatial and temporal distribution and relative abundance of Pacific cod (*Gadus macrocephalus*) larvae in the western GOA. NWAFC Proc. Rep. 88-18. Available from Alaska Fish. Sci. Center, 7600 Sand Point Way NE., Seattle, WA 98115-0070.

Thompson, G.G., and M.W. Dorn. 2002. Assessment of the Pacific cod stock in the EBS and AI area. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI regions, Plan Team for the Groundfish Fisheries of the BS and AI (editor), p. 121-205. Available from North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Thompson, G.G., H.H. Zenger, and M.W. Dorn. 2002. Assessment of the Pacific cod stock in the GOA. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, Plan Team for the GOA (editor), p. 89-167. Available from North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Westrheim, S.J. 1996. On the Pacific cod (*Gadus macrocephalus*) in British Columbia waters, and a comparison with Pacific cod elsewhere, and Atlantic cod (*G. morhua*). Can. Tech. Rep. Fish. Aquat. Sci. 2092. 390 p.

SPECIES: Pacific Cod

Life Stage	Duration or Age	Diet/Prey	Season/ ime	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15 to 20 days	NA	winter-spring	ICS, MCS, OCS	D	M, SM, MS, S	U	optimum 3-6°C optimum salinity 13-23 ppt
Larvae	U	copepods (?)	winter-spring	U	P (?), N (?)	U	U	
Early Juveniles	to 2 years	small invertebrates (mysids, euphausiids, shrimp)	all year	ICS, MCS	D	M, SM, MS, S	U	
Late Juveniles	to 5 years	pollock, flatfish, fishery discards, crab	all year	ICS, MCS, OCS	D	M, SM, MS, S	U	
Adults	5+ yr	pollock, flatfish, fishery discards, crab	spawning (Jan-May) non-spawning (Jun-Dec)	ICS, MCS, OCS ICS, MCS, OCS	D	M, SM, MS, S,G	U	

Habitat Description for Yellowfin Sole

(Limanda aspera)

Management Plan and Area BSAI

Life History and General Distribution

Yellowfin sole are distributed in North American waters from off British Columbia, Canada, (approximately lat. 49° N) to the Chukchi Sea (about lat. 70° N) and south along the Asian coast to about lat. 35° N off the South Korean coast in the Sea of Japan. Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the EBS shelf. From over-winter grounds near the shelf margins, adults begin a migration onto the inner shelf in April or early May each year for spawning and feeding. A protracted and variable spawning period may range from as early as late May through August occurring primarily in shallow water. Fecundity varies with size and was reported to range from 1.3 to 3.3 million eggs for fish 25 to 45 cm long. Eggs have been found to the limits of inshore ichthyoplankton sampling over a widespread area to at least as far north as Nunivak Island. Larvae have been measured at 2.2 to 5.5 mm in July and 2.5 to 12.3 mm from late August to early September. The age or size at metamorphosis is unknown. Upon settlement in nearshore areas, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and burrowing for protection. Juveniles are separate from the adult population, remaining in shallow areas until they reach approximately 15 cm. The estimated age of 50 percent maturity is 10.5 years (approximately 29 cm) for females based on samples collected in 1992 and 1993. Natural mortality rate is believed to range from 0.12 to 0.16.

Fishery

Yellowfin sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 6, and they are fully selected at age 13. Historically, the fishery has occurred throughout the mid and inner BS shelf during ice-free conditions, although much effort has been directed at the spawning concentrations in nearshore northern Bristol Bay. They are caught as bycatch in Pacific cod, bottom pollock, and other flatfish fisheries and are caught with these species and Pacific halibut in yellowfin sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, skates, and Pacific halibut, mostly on fish ranging from 7 to 25 cm standard length.

Approximate Upper Size Limit of Juvenile Fish (in cm): 27 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime spawning and feeding on sandy substrates of the EBS shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding mainly on bivalves, polychaete, amphipods and echiurids. Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures, feeding diminishes.

Literature

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Bakkala, R.G., V.G. Wespestad, and L.L. Low. 1982. The yellowfin sole (*Limanda aspera*) resource of the EBS--Its current and future potential for commercial fisheries. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-33, 43 p.

Fadeev, N.W. 1965. Comparative outline of the biology of fishes in the southeastern part of the BS and condition of their resources. [In Russ.] Tr. Vses. Nauchno-issled. Inst.Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled Inst. Morsk. Rybn. Khoz. Okeanogr. 53):121-138. (Trans. By Isr. Prog. Sci. Transl., 1968), p 112-129. In P.A. Moiseev (Editor), Soviet Fisheries Investigations in the northeastern Pacific, Pt. IV. Avail. Natl. Tech. Inf. Serv., Springfield, VA as TT 67-51206.

Kashkina, A.A. 1965. Reproduction of yellowfin sole (*Limanda aspera*) and changes in its spawning stocks in the EBS. Tr. Vses. Nauchno-issled, Inst. Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled. Inst. Rbn. Khoz. Okeanogr. 53):191-199. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 182-190. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part IV. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT67-51206.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Moles, A., and B. L. Norcross. 1995. Sediment preference in juvenile Pacific flatfishes. Netherlands J. Sea Res. 34(1-3):177-182 (1995).

Musienko, L.N. 1963. Ichthyoplankton of the BS (data of the BS expedition of 1958-59). Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 50)239-269. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 251-286. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part I. Avail. Natl. Tech. Inf. Serv., Springfield, VA, as TT67-51203.

Musienko, L.N. 1970. Reproduction and Development of BS. Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72)161-224. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1972, p. 161-224. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part V. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT71-50127.

Nichol, D.G. 1994. Maturation and Spawning of female yellowfin sole in the EBS. Preceding of the International North Pacific Flatfish Symposium, Oct. 26-28, 1994, Anchorage, AK. Alaska Sea Grant Program.

Wakabayashi, K. 1986. Interspecific feeding relationships on the continental shelf of the EBS, with special reference to yellowfin sole. Int. N. Pac. Fish. Comm. Bull. 47:3-30.

Waldron, K.D. 1981. Ichthyoplankton. In D.W. Hood and J.A. Calder (Editors), The EBS shelf: Oceanography and resources, Vol. 1, p. 471-493. U.S. Dept. Commer., NOAA, Off. Mar. Poll. Asess., U.S. Gov. Print. Off., Wash., D.C.

Wilderbuer, T.K., G.E. Walters, and R.G. Bakkala. 1992. Yellowfin sole, Pleuronectes asper, of the EBS: Biological Characteristics, History of Exploitation, and Management. Mar. Fish. Rev. 54(4) p 1-18.

SPECIES: Yellowfin Sole

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs		NA	summer	BAY BCH	P			
Larvae	2 to 3 months?	U phyto/zoo plankton?	summer autumn?	BAY BCH ICS	P			
Early Juveniles	to 5.5 years	polychaete bivalves amphipods echiurids	all year	BAY ICS OCS	D	S[1]		
Late Juveniles	5.5 to 10 years	polychaete bivalves amphipods echiurids	all year	BAY ICS OCS	D	S[1]		
Adults	10+ years	polychaete bivalves amphipods echiurids	spawning/ feeding May-August non-spawning Nov.-April	BAY BEACH ICS MCS OCS	D	S[1]	ice edge	

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Greenland Turbot

(Reinhardtius hippoglossoides)

Management Plan and Area BSAI

Life History and General Distribution

Greenland turbot has an amphiboreal distribution, occurring in the North Atlantic and North Pacific, but not in the intervening Arctic Ocean. In the North Pacific, species abundance is centered in the EBS and, secondly, in the Aleutians. On the Asian side, they occur in the Gulf of Anadyr along the BS coast of Russia, in the Okhotsk Sea, around the Kurile Islands, and south to the east coast of Japan to northern Honshu Island (Hubbs and Wilimovsky 1964, Mikawa 1963, Shuntov 1965). Adults exhibit a benthic lifestyle, living in deep waters of the continental slope, but they are known to have a tendency to feed off the sea bottom. During their first few years as immature fish, they inhabit relatively shallow continental shelf waters (<200 m) until about age 4 or 5 before joining the adult population (200 to 1,000 m or more, Templeman 1973). Adults appear to undergo seasonal shifts in depth distribution moving deeper in winter and shallower in summer (Chumakov 1970, Shuntov 1965). Spawning is reported to occur in winter in the EBS and may be protracted starting in September or October and continuing until March with an apparent peak period in November to February (Shuntov 1970, Bulatov 1983). Females spawn relatively small numbers of eggs with fecundity ranging from 23,900 to 149,300 for fish 83 cm and smaller in the BS (D'yakov 1982).

Eggs and early larval stages are benthypelagic (Musienko 1970). In the Atlantic Ocean, larvae (10 to 18 cm) have been found in benthypelagic waters which gradually rise to the pelagic zone in correspondence to absorption of the yolk sac which is reported to occur at 15 to 18 mm with the onset of feeding (Pertseva-Ostroumova 1961 and Smidt 1969). The period of larval development extends from April to as late as August or September (Jensen 1935) which results in an extensive larval drift and broad dispersal from the spawning waters of the continental slope. Metamorphosis occurs in August or September at about 7 to 8 cm in length at which time the demersal life begins. Juveniles are reported to be quite tolerant of cold temperatures to less than 0ºC (Hognestad 1969) and have been found on the northern part of the BS shelf in summer trawl surveys (Alton et al. 1988).

The age of 50 percent maturity is estimated to range from 5 to 10 years (D'yakov 1982, 60 cm used in stock assessment). A natural mortality rate of 0.18 has been used in the most recent stock assessments (Ianelli et al. 2002).

Fishery

Greenland turbot are caught in bottom trawls and on longlines both as a directed fishery and in the pursuit of other bottom-dwelling species (primarily sablefish). Recruitment begins at about 50 and 60 cm in the trawl and longline fisheries, respectively. The fishery operates on the continental slope throughout the EBS and on both sides of the AI. Bycatch primarily occurs in the sablefish directed fisheries and also to a smaller extent in the Pacific cod fishery.

Relevant Trophic Information

Groundfish predators include Pacific cod, pollock and yellowfin sole, mostly on fish ranging from 2 to 5 cm standard length (probably age 0).

Approximate Upper Size Limit of Juvenile Fish (in cm): 59 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for up to 9 months until metamorphosis occurs, usually with a widespread distribution inhabiting shallow waters. Juveniles live on continental shelf until about age 4 or 5 feeding primarily on euphausiids, polychaete and small walleye pollock.

Adults: Inhabit continental slope waters with annual spring/fall migrations from deeper to shallower waters. Diet consists of walleye pollock and other miscellaneous fish species.

Literature

Alton, M.S., R.G. Bakkala, G.E. Walters, and P.T. Munro. 1988. Greenland turbot, *Reinhardtius hippoglossoides*, of the EBS and AI. U.S. Dept. Commer., NOAA Tech. Rpt. NMFS 71, 31 p.

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Bulatov, O.A. 1983. Distribution of eggs and larvae of Greenland halibut, *Reinhardtius hippoglossoides*, (Pleuronectidae) in the EBS. J. Ichthyol. [Engl. Transl. Vopr. Ikhtiol.] 23(1):157-159.

Chumakov, A.K. 1970. The Greenland halibut, *Reinhardtius hippoglossoides*, in the Iceland area-The halibut fisheries and tagging. Tr. Polyarn. Nauchno-Issled. Proektn. Inst. Morsk. Rybn. Khoz. 1970:909-912.

D'yakov, Yu.P. 1982. The fecundity of the Greenland halibut, *Reinhardtius hippoglossoides* (Pleuronectidae), from the BS. J. Ichthyol. [Engl. Trans. Vopr. Ikhtiol.] 22(5):59-64.

Hognestad, P.T. 1969. Notes on Greenland halibut, *Reinhardtius hippoglossoides*, in the eastern Norwegian Sea. Fiskeridir. Skr. Ser. Havunders. 15(3):139-144.

Hubbs, C.L., and N.J. Wilimovsky. 1964. Distribution and synonymy in the Pacific Ocean and variation of the Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum). J. Fish. Res. Board Can. 21:1129-1154.

Ianelli, J.N., C. Minte-Vera, T.K. Wilderbuer, and T.M. Sample. 2002. Greenland turbot. *In* Appendix A Stock Assessment and fishery evaluation report for the groundfish resources of the BSAI Regions. Pp. 255-282. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Jensen, A.S. 1935. (*Reinhardtius hippoglossoides*) its development and migrations. K. dan. Vidensk. Selsk. Skr. 9 Rk., 6:1-32.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way, NE., Seattle, WA 98115.

Mikawa, M. 1963. Ecology of the lesser halibut, *Reinhardtius hippoglossoides matsuurae* Jordan and Snyder. Bull. Tohoku Reg. Fish. Res. Lab. 29:1-41.

Musienko, L.N. 1970. Reproduction and Development of BS. Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72)161-224. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1972, p. 161-224. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part V. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT71-50127.

Pertseva-Ostroumova, T.A. 1961. The reproduction and development of far eastern flounders. Izdatel'stvo Akad. Nauk. SSSR, 483 p. [Transl. By Fish. Res. Board Can., 1967, Transl. Ser. 856, 1003 p.]

Shuntov, V.P. 1965. Distribution of the Greenland halibut and arrowtooth halibuts in the North Pacific. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 53):155-163. [Transl. In Soviet Fisheries Investigation in the Northeastern Pacific, Part IV, p. 147-156, by Israel Prog. Sci. Transl., 1972, avail. Natl. Tech. Inf. Serv., Springfield, VA as TT71-50127.]

Templeman, W. 1973. Distribution and abundance of the Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum), in the Northwest Atlantic. Int. Comm. Northwest Atl. Fish. Res. Bull. 10:82-98.

SPECIES: Greenland turbot

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	OCS MCS	SD, SP			
Larvae	8 to 9 months	U phyto/zoo plankton?	Spring summer	OCS ICS MCS	P			
Juveniles	1 to 5 years	euphausiids polychaets small pollock	all year	ICS MCS OCS USP	D, SD	M/S+M[1]		
Adults	5+ years	pollock small fish	spawning Nov-February non-spawning March-October	OCS USP LSP USP LSP	D, SD	M/S+M[1]		

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Arrowtooth Flounder

(Atheresthes stomias)

Management Plan and Area BSAI

Life History and General Distribution

Arrowtooth flounder are distributed in North American waters from central California to the EBS on the continental shelf and upper slope.

Adults exhibit a benthic lifestyle and occupy separate winter and summer distributions on the EBS shelf. From over-winter grounds near the shelf margins and upper slope areas, adults begin a migration onto the middle and outer shelf in April or early May each year with the onset of warmer water temperatures. A protracted and variable spawning period may range from as early as September through March (Rickey 1994, Hosie 1976). Little is known of the fecundity of arrowtooth flounder. Larvae have been found from ichthyoplankton sampling over a widespread area of the EBS shelf in April and May and also on the continental shelf east of Kodiak Island during winter and spring (Waldron and Vinter 1978, Kendall and Dunn 1985). The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach the 10 to 15 cm range (Martin and Clausen 1995). The estimated length at 50 percent maturity is 28 cm for males (4 years) and 37 cm for females (5 years) from samples collected off the Washington coast (Rickey 1994). The natural mortality rate used in stock assessments differs by sex and is estimated at 0.2 for females and 0.32 to 0.35 for males (Turnock et al. 2002, Wilderbuer and Sample 2002).

Fishery

Arrowtooth flounder are caught in bottom trawls usually in pursuit of other higher value bottom-dwelling species. Historically have been undesirable to harvest due to a flesh softening condition caused by protease enzyme activity. Recruitment begins at about age 3 and females are fully selected at age 10. They are caught as bycatch in Pacific cod, bottom Pollock, sablefish and other flatfish fisheries by both trawls and longline.

Relevant Trophic Information

Arrowtooth flounder are very important as a large, aggressive and abundant predator of other groundfish species. Groundfish predators include Pacific cod and pollock, mostly on small fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): Males 27 cm and females 37 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, juveniles usually inhabit shallow areas until about 10 cm in length.

Adults: Widespread distribution mainly on the middle and outer portions of the continental shelf, feeding mainly on walleye pollock and other miscellaneous fish species when arrowtooth flounder attain lengths greater than 30 cm. Wintertime migration to deeper waters of the shelf margin and upper continental slope to avoid extreme cold water temperatures and for spawning.

Literature

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180, 740 p.

Hosie, M.J. 1976. The arrowtooth flounder. Oregon Dep. Fish. Wildl. Info. Rep. 76-3, 4 p.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U.S. Dept. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A.. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA Bottom Trawl Survey. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv., NOAA Tech. Mem. NMFS-AFSC-59, 217 p.

Rickey, M.H. 1994. Maturity, spawning, and seasonal movement of arrowtooth flounder, *Atheresthes stomias*, off Washington. Fish. Bull. 93:127-138 (1995).

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2002. Arrowtooth flounder. *InAppendix B* Stock Assessment and Fishery Evaluation Report for the groundfish resources of the GOA, Pages 199-228. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. U.S. Dept. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv. Seattle, WA, Processed rep., 88 p.

Wilderbuer, T.K., and T.M. Sample. 2002. Arrowtooth flounder. *In* Appendix A Stock Assessment and Fishery Evaluation Report for the groundfish resources of the BSAI, Pages 283-320. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

SPECIES: Arrowtooth Flounder

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter, spring?	ICS MCS OCS	P			
Larvae	2 to 3 months?	U phyto/zoo plankton?	Spring summer?	BAY ICS MCS OCS	P			
Early Juveniles	to 2 years	euphausiids crustaceans amphipods pollock	all year	ICS MCS	D	GMS[1]		
Late Juveniles	males 2 to 4 years females 2 to 5 years	euphausiids crustaceans amphipods pollock	all year	ICS MCS OCS USP	D	GMS[1]		
Adults	males - 4+ years females- 5+ years	pollock misc. fish Gadidae sp. Euphausiids	spawning Nov-March non-spawning April-Oct.	MCS OCS USP	D	GMS[1]	ice edge (EBS)	

[1] Pers. Comm., Dr. Robert McConnaughey

Habitat Description for Rock Sole

(Lepidopsetta bilineatus)

Management Plan and Area BSAI

Life History and General Distribution

Rock sole are distributed from California waters north into the GOA and BS to as far north as the Gulf of Anadyr. The distribution continues along the AI westward to the Kamchatka Peninsula and then southward through the Okhotsk Sea to the Kurile Islands, Sea of Japan, and off Korea. Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central GOA, and in the southeastern BS (Alton and Sample 1975). Two forms were recently found to exist in Alaska by Orr and Matarese (2000), a southern rock sole (*L. bilineatus*) and a northern rock sole (*L. polyxystra*). Adults exhibit a benthic lifestyle and, in the EBS, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Rock sole spawn during the winter to early spring period of December to March. Soviet investigations in the early 1960s established two spawning concentrations: an eastern concentration north of Unimak Island at the mouth of Bristol Bay and a western concentration eastward of the Pribilof Islands between 55°30' and 55°0' N and approximately 165°2' W (Shubnikov and Lisovenko, 1964). Rock sole spawning in the eastern and western BS was found to occur at depths from 125 to 250 m, close to the shelf/slope break. Spawning females deposit a mass of eggs which are demersal and adhesive (Alton and Sample 1975). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11ºC to about 25 days at 2.9ºC (Forrester 1964). Newly hatched larvae are pelagic and have occurred sporadically in EBS plankton surveys (Waldron and Vinter 1978). Kamchatka larvae are reportedly 20 mm in length when they assume their side-swimming, bottom-dwelling form (Alton and Sample 1975). Norcross et al. (1996) found newly settled larvae in the 40 to 50 mm size range. Forrester and Thompson (1969) report that by age 1 they are found with adults on the continental shelf during summer.

In the springtime, after spawning, rock sole begin actively feeding and commence a migration to the shallow waters of the continental shelf. This migration has been observed on both the eastern (Alton and Sample, 1975) and western (Shvetsov 1978) areas of the BS. During this time they spread out and form much less dense concentrations than during the spawning period. Summertime trawl surveys indicate that most of the population can be found at depths from 50 to 100 m (Armistead and Nichol 1993). The movement from winter/spring to summer grounds is in response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,00 eggs for fish 42 cm long. Larvae are pelagic, but their occurrence in plankton surveys in the EBS are rare (Musienko 1963). Juveniles are separate from the adult population, remaining in shallow areas until they reach age 1 (Forrester 1969). The estimated age of 50 percent maturity is 9 years (approximately 35 cm) for southern rock sole females and 7 years for northern rock sole females (Stark and Somerton 2002). Natural mortality rate is believed to range from 0.18 to 0.20.

Fishery

Rock sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 4 and they are fully selected at age 11. Historically, the fishery has occurred throughout the mid and inner BS shelf during ice-free conditions and on spawning concentrations north of the Alaska Peninsula during winter for their high-value roe. They are caught as bycatch in Pacific cod, bottom Pollock, yellowfn sole, and other flatfish fisheries and are caught with these species and Pacific halibut in rock sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, walleye pollock, skates, Pacific halibut and yellowfin sole, mostly on fish ranging from 5 to 15 cm standard length.

Approximate Upper Size Limit of Juvenile Fish (in cm): 34 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, juveniles inhabit shallow areas at least until age 1.

Adults: Summertime feeding on primarily sandy substrates of the EBS shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding on bivalves, polychaete, amphipods and miscellaneous crustaceans. Wintertime migration to deeper waters of the shelf margin for spawning and to avoid extreme cold water temperatures, feeding diminishes.

Literature

Alton, M.S., and T.M. Sample. 1976. Rock sole (Family Pleuronectidae) p. 461-474. *In*: Demersal fish and shellfish resources in the BS in the baseline year 1975. Principal investigators Walter T. Pereyra, Jerry E. Reeves, and Richard Bakkala. U.S. Dept. Comm., Natl. Oceanic Atmos. Admin., Natl. Mar. Serv., Northwest and Alaska Fish Center, Seattle, WA. Processed Rep., 619 p.

Armistead, C.E., and D.G. Nichol. 1993. 1990 Bottom Trawl Survey of the EBS Continental Shelf. U.S. Dept. Commer., NOAA Tech. Mem. NMFS-AFSC-7, 190 p.

Auster, P.J., R.J. Malatesta, R.W. Langton, L.Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Forrester, C.R. 1964. Demersal Quality of fertilized eggs of rock sole. J. Fish. Res. Bd. Canada, 21(6), 1964. P. 1531.

Forrester, C.R., and J.A. Thompson. 1969. Population studies on the rock sole, *Lepidopsetta bilineata*, of northern Hecate Strait British Columbia. Fish. Res. Bd. Canada, Tech. Rep. No. 108, 1969. 104 p.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Musienko, L.N. 1963. Ichthyoplankton of the BS (data of the BS expedition of 1958-59). Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 50)239-269. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 251-286. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part I. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT67-51203.

Norcross, B.L., B.A. Holladay, S.C. Dressel, and M. Frandsen. 1996. Recruitment of juvenile flatfishes in Alaska: habitat preference near Kodiak Island. U. Alaska, Coastal Marine Institute, OCS study MMS 96-003. Vol. 1.

Orr, J.M., and A.C. Matarese. 2000. Revision of the genus *Lepidipsetta* Gill, 1862 (Teleostei: Pleuronectidae) based on larval and adult morphology, with a description of a new species from the North Pacific Ocean and BS. Fish. Bull. 98:539-582 (2000).

Shubnikov, D.A., and L.A. Lisovenko. 1964. Data on the biology of rock sole in the southeastern BS. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 49 (Izv. Tikookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 51) : 209-214. (Transl. In Soviet Fisheries Investigations in the Northeast Pacific, Part II, p. 220-226, by Israel Program Sci. Transl., 1968, available Natl. Tech. Inf. Serv., Springfield, VA, as TT 67-51204).

Shvetsov, F.G. 1978. Distribution and migrations of the rock sole, *Lepidopsetta bilineata*, in the regions of the Okhotsk Sea coast of Paramushir and Shumshu Islands. J. Ichthol., 18 (1), 56-62, 1978.

Stark, J. W., and D.A. Somerton. 2002. Maturation, spawning and growth of rock sole off Kodiak Island in the GOA. J. Fish. Biology (2002)61, 417-431.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. U.S. Dept. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv. Seattle, WA, Processed rep., 88 p.

SPECIES: Rock Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	OCS	D			
Larvae	2 to 3 months?	U phyto/zoo plankton?	winter/spring	OCS MCS ICS	P			
Early Juveniles	to 3.5 years	polychaete bivalves amphipods misc. crust.	all year	BAY ICS	D	S[1] G		
Late Juveniles	to 9 years	polychaete bivalves amphipods misc. crust.	all year	BAY ICS MCS OCS	D	S[1] G		
Adults	9+ years	polychaete bivalves amphipods misc. crust.	feeding May-September spawning Dec.-April	MCS ICS OCS	D	S[1] G	ice edge	

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Alaska Plaice

(*Pleuronectes quadrituberculatus*)

Management Plan and Area BSAI

Alaska plaice were formerly a constituent of the "other flatfish" management category, Alaska plaice were split out in recent years and are managed as a separate stock.

Life History and General Distribution

Alaska plaice inhabit continental shelf waters of the North Pacific ranging from the GOA to the Bering and Chukchi Seas and in Asian waters as far south as Peter the Great Bay (Pertseva-Ostroumova 1961; Quast and Hall 1972). Adults exhibit a benthic lifestyle and live year round on the shelf and move seasonally within its limits (Fadeev 1965). From over-winter grounds near the shelf margins, adults begin a migration onto the central and northern shelf of the EBS, primarily at depths of less than 100 m. Spawning usually occurs in March and April on hard sandy ground (Zhang 1987). The eggs and larvae are pelagic and transparent and have been found in ichthyoplankton sampling in late spring and early summer over a widespread area of the continental shelf (Waldron and Favorite 1977).

Fecundity estimates (Fadeev 1965) indicate that female fish produce an average of 56 thousand eggs at lengths of 28 to 30 cm and 313 thousand eggs at lengths of 48 to 50 cm. The age or size at metamorphosis is unknown. The estimated length of 50 percent maturity is 32 cm from collections made in March and 28 cm from April, which corresponds to an age of 6 to 7 years. Natural mortality rate estimates range from 0.19 to 0.22 (Wilderbuer and Zhang 1999).

Fishery

Alaska plaice were caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 6 and they are fully selected at age 12. The fishery occurs throughout the mid and inner BS shelf during ice-free conditions. In recent years, catches have been low due to a lack of targeting, and they are now primarily caught as bycatch in Pacific cod, bottom pollock, yellowfin sole, and other flatfish fisheries. They are also caught with Pacific halibut in the directed fishery.

Relevant Trophic Information

Groundfish predators include Pacific halibut (Novikov, 1964) yellowfin sole, beluga whales, and fur seals (Salveson 1976).

Approximate Upper Size Limit of Juvenile Fish (in cm): 27 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime feeding on sandy substrates of the EBS shelf. Widespread distribution mainly on the middle, northern portion of the shelf, feeding on polychaete, amphipods and echiurids (Livingston and DeReynier 1996). Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures. Feeding diminishes until spring after spawning.

Literature

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Fadeev, N.W. 1965. Comparative outline of the biology of fishes in the southeastern part of the BS and condition of their resources. [In Russ.] Tr. Vses. Nauchno-issled. Inst.Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled Inst. Morsk. Rybn. Khoz. Okeanogr. 53):121-138. (Trans. By Isr. Prog. Sci. Transl., 1968), p. 112-129. In P.A. Moiseev (Editor), Soviet Fisheries Investigations in the northeastern Pacific, Pt. IV. Avail. Natl. Tech. Inf. Serv., Springfield, Va. As TT 67-51206.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Novikov, N.P. 1964. Basic elements of the biology of the Pacific Halibut (*Hippoglossoides stenolepis* Schmidt) in the BS. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 49 (Izv. Tikhookean. Nauchno-isslled. Inst. Morsk. Rybn. Khoz. Okeanogr. 51):167-204. (Transl. In Soviet Fisheries Investigations in the Northeast Pacific, Part II, p. 175-219, by Israel Program Sci. Transl., 1968, avail. Natl. Tech. Inf. Serv. Springfield, VA, as TT67-51204.)

Pertseva-Ostroumova, T.A. 1961. The reproduction and development of far eastern flounders. (Transl. By Fish. Res. Bd. Can. 1967. Transl. Ser. 856, 1003 p.).

Quast, J.C., and E.L. Hall. 1972. List of fishes of Alaska and adjacent waters with a guide to some of their literature. U.S. Dept. Commer. NOAA, Tech. Rep. NMFS SSRF-658, 48 p.

Salveson, S.J. 1976. Alaska plaice. In Demersal fish and shellfish resources of the EBS in the baseline year 1975 (eds. W.T. Pereyra, J.E. Reeves, and R.G. Bakkala). Processed Rep., 619 p. NWAFC, NMFS, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

Waldron, K.D., and F. Favorite. 1977. Ichthyoplankton of the EBS. In Environmental assessment of the Alaskan continental shelf, Annual reports of principal investigators for the year ending March 1977, Vol. IX. Receptors-Fish, littoral, benthos, p. 628-682. U.S. Dept. Comm., NOAA, and U.S. Dep. Int., Bur. Land. Manage.

Wilderbuer, T.K., and C.I. Zhang. 1999. Evaluation of the population dynamics and yield characteristics of Alaska plaice (Pleuronectes quadrituberculatus) in the EBS Fisheries Research 41 (1999) 183-200.

Zhang, C.I. 1987. Biology and Population Dynamics of Alaska plaice, Pleuronectes quadriterculatus, in the EBS. PhD. dissertation, University of Washington: p. 1-225.

SPECIES: Alaska Plaice

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	spring and summer	ICS MCS OCS	P			
Larvae	2 to 4 months?	U phyto/zoo plankton?	spring and summer	ICS MCS	P			
Juveniles	up to 7 years	polychaete amphipods echiurids	all year	ICS MCS	D	S+M[1]		
Adults	7+ years	polychaete amphipods echiurids	spawning March-May non-spawning and feeding June.-February	ICS MCS ICS MCS	D	S+M[1]	ice edge	

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Rex Sole

(Glyptocephalus zachirus)

Management Plan and Area BSAI

Rex sole are a constituent of the "other flatfish" management category in the BSAI where they are less abundant than in the GOA.

Other members of the "other flatfish" category include the following:

Dover sole (*Microstomus pacificus*)
Starry flounder (*Platichthys stellatus*)
Longhead dab (*Pleuronectes proboscidea*)
Butter sole (*Pleuronectes isolepis*)

Life History and General Distribution

Rex sole are distributed from Baja California to the BS and western AI (Hart 1973, Miller and Lea 1972), and are widely distributed throughout the GOA. Adults exhibit a benthic lifestyle and are generally found in water deeper than 300 m. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year. The spawning period off Oregon is reported to range from January through June with a peak in March and April (Hosie and Horton 1977). Spawning in the GOA was observed from February through July, with a peak period in April and May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets mainly in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over midshelf and slope areas (Kendall and Dunn 1985). Fecundity estimates from samples collected off the Oregon coast ranged from 3,900 to 238,100 ova for fish 24 to 59 cm (Hosie and Horton 1977). The age or size at metamorphosis is unknown Maturity studies from Oregon indicate that males were 50 percent mature at 16 cm and females at 24 cm. Juveniles less than 15 cm are rarely found with the adult population. The natural mortality rate used in recent stock assessments is 0.2 (Spencer et al. 2002).

Fishery

Rex sole are caught in bottom trawls mostly in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3 or 4. They are caught as bycatch in the Pacific ocean perch, Pacific cod, bottom pollock, and other flatfish fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate Upper Size Limit of Juvenile Fish (in cm): Males 15 cm and females 23 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for an unknown time until metamorphosis occurs; juvenile distribution is unknown.

Adults: Spring spawning and summer feeding on a combination of sand, mud, and gravel substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on polychaete, amphipods, euphausids and snow crabs.

Literature

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Hosie, M.J., and H.F. Horton. 1977. Biology of the rex sole, *Glyptocephalus zachirus*, in waters off Oregon. Fish. Bull. Vol. 75, No. 1, 1977, p. 51-60.

Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in the Alaska and Pacific coast regions. 50 p. NOAA Tech. Mem. NMFS F/NWC-44. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U.S. Dept. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. NOAA Tech. Mem. NMFS F/NWC-54, U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dep. Fish. Game, Fish. Bull. 157, 235 p.

Spencer, P.D., G.W. Walters, and T.K. Wilderbuer. 2002. Other flatfish. *In* Appendix A Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Region. Pp. 437-447. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

SPECIES: Rex Sole

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs		NA	Feb - May	ICS? MCS OCS	P			
Larvae	U	U phyto/zoo plankton?	spring summer	ICS? MCS OCS	P			
Juveniles	2 years	polychaete amphipods euphausiids Tanner crab	all year	MCS ICS OCS	D	G, S, M		
Adults	2+ years	polychaete amphipods euphausiids Tanner crab	spawning Feb-May non-spawning May-January	MCS, OCS USP MCS, OCS, USP	D	G, S, M		

Habitat Description for Dover Sole

(*Microstomus pacificus*)

Management Plan and Area BSAI

Life History and General Distribution

Dover sole are distributed in deep waters of the continental shelf and upper slope from northern Baja California to the BS and the western AI (Hart 1973, Miller and Lea 1972), and exhibit a widespread distribution throughout the GOA. Adults are demersal and are mostly found in water deeper than 300 m. The spawning period off Oregon is reported to range from January through May (Hunter et al. 1992). Spawning in the GOA has been observed from January through August, with a peak period in May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over mid-shelf and slope areas (Kendall and Dunn 1985). The age or size at metamorphosis is unknown, but the pelagic larval period is known to be protracted and may last as long as 2 years (Markle et al. 1992). Pelagic postlarvae as large as 48 mm have been reported and the young may still be pelagic at 10 cm (Hart 1973). Dover sole are batch spawners, and Hunter et al. (1992) concluded that the average 1 kg female spawns its 83,000 advanced yolked oocytes in about nine batches. Maturity studies from Oregon indicate that females were 50 percent mature at 33 cm total length. Juveniles less than 25 cm are rarely found with the adult population from bottom trawl surveys (Martin and Clausen 1995). The natural mortality rate used in recent stock assessments is 0.2 (Turnock et al. 1996).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 5. They are caught as bycatch in the rex sole, thornyhead and sablefish fisheries and are caught with these species and Pacific halibut in Dover sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate Upper Size Limit of Juvenile Fish (in cm): 32 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for up to 2 years until metamorphosis occurs, juvenile distribution is unknown.

Adults: Winter and spring spawning and summer feeding on soft substrates (combination of sand and mud) of the continental shelf and upper slope. Shallower summer distribution mainly on the middle to outer portion of the shelf and upper slope, feeding mainly on polychaete, annelids, crustaceans, and mollusks (Livingston and Goiney 1983).

Literature

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Hunter, J.R., B.J. Macewicz, N.C. Lo, and C.A. Kimbrell. 1992. Fecundity, spawning, and maturity of female Dove sole *Microstomus pacificus*, with an evaluation of assumptions and precision. Fish. Bull. 90:101-128(1992).

Hirschberger, W.A.. and G.B. Smith. 1983. Spawning of twelve groundfish species in the Alaska and Pacific coast regions. 50 p. NOAA Tech. Mem. NMFS F/NWC-44. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U.S. Dept. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. NOAA Tech. Mem. NMFS F/NWC-54, U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv.

Markle, D.F., P. Harris, and C. Toole. 1992. Metamorphosis and an overview of early-life-history stages in Dover sole *Microstomus pacificus*. Fish. Bull. 90:285-301.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA Bottom Trawl Survey. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv., NOAA Tech. Mem. NMFS-AFSC-59, 217 p.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dept. Fish. Game, Fish. Bull. 157, 235 p.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 1996. Flatfish. In Stock assessment and fishery evaluation Report for the groundfish resources of the GOA. p. 279-290. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

SPECIES: Dover Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	spring summer	ICS? MCS OCS UCS	P			
Larvae	up to 2 years	U phyto/zoo plankton?	all year	ICS? MCS OCS UCS	P			
Early Juveniles	to 3 years	polychaete amphipods annelids	all year	MCS? ICS?	D	S, M		
Late Juveniles	3 to 5 years	polychaete amphipods annelids	all year	MCS? ICS?	D	S, M		
Adults	5+ years	polychaete amphipods annelids mollus	ning July-January	MCS OCS UCS	D	S, M		

Habitat Description for Flathead Sole

(Hippoglossoides elassodon)

Management Plan and Area BSAI

Life History and General Distribution

Dover sole are distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the GOA and the BS, the Kuril Islands, and possibly the Okhotsk Sea (Hart 1973).

Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the EBS shelf and in the GOA. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year for feeding. The spawning period may begin as early as January, but is known to occur in March and April, primarily in deeper waters near the margins of the continental shelf. Eggs are large (2.75 to 3.75 mm) and females have egg counts ranging from about 72,000 (20 cm fish) to almost 600,000 (38 cm fish). Eggs hatch in 9 to 20 days depending on incubation temperatures within the range of 2.4 to 9.8°C (Forrester and Alderdice 1967) and have been found in ichthyoplankton sampling on the southern portion of the BS shelf in April and May (Waldron 1981). Larve absorb the yolk sac in 6 to 17 days, but the extent of their distribution is unknown. The age or size at metamorphosis is unknown, as well as the age at 50 percent maturity. Juveniles less than age 2 have not been found with the adult population, remaining in shallow areas. The natural mortality rate used in recent stock assessments is 0.2 (Spencer et al. 2002).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3. Historically, the fishery has occurred throughout the mid and outer BS shelf during ice-free conditions (mostly summer and fall). They are caught as bycatch in Pacific cod, bottom pollock, and other flatfish fisheries and are caught with these species and Pacific halibut in flathead sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder, and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length (Livingston and DeReynier 1996).

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown age at 50 percent maturity

Habitat and Biological Associations

<ins>*Larvae/Juveniles*</ins>: Planktonic larvae for an unknown time period until metamorphosis occurs, usually inhabiting shallow areas.

<u>*Adults*</u>: Winter spawning and summer feeding on sand and mud substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on ophiuroids, tanner crab, osmerids, bivalves, and polychaete (Pakunski 1990).

Literature

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on sea floor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Forrester, C.R., and D.F. Alderdice. 1967. Preliminary observations on embryonic development of the flathead sole (*Hippoglossoides elassodon*). Fish. Res. Board Can. Tech. Rep. 100: 20 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Miller, B.S. 1969. Life history observations on normal and tumor bearing flathead sole in East Sound, Orcas Island (Washington). Ph.D. Thesis. Univ. Wash. 131 p.

Pacunski, R.E. 1990. Food habits of flathead sole (*Hippoglossoides elassodon*) in the EBS. M.S. Thesis. Univ. Wash. 106 p.

Spencer, P.D., G.W. Walters, and T. K. Wilderbuer. 2002. Flathead sole. In Appendix A Stock Assessment and Fishery Evaluation Document for the Groundfish Resources of the BSAI Region. Pp. 361-408. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage AK 99501.

Waldron, K.D. 1981. Ichthyoplankton. In D.W. Hood and J.A. Calder (Editors), The EBS shelf: Oceanography and resources, Vol. 1, p. 471-493. U.S. Dept. Commer., NOAA, Off. Mar. Poll. Asess., U.S. Gov. Print. Off., Wash., D.C.

Walters, G.E., and T.K. Wilderbuer. 1996. Flathead sole. *In* Stock assessment and fishery evaluation Report for the groundfish resources of the BSAI Regions. p. 279-290. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

SPECIES: Flathead Sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	ICS MCS OCS	P			
Larvae	U	U phyto/zoo plankton?	spring summer	ICS MCS OCS	P			
Early Juveniles	to 2 years	polychaete bivalves ophiuroids	all year	MCS ICS	D	S+M[1]		
Late Juveniles	3 years	polychaete bivalves ophiuroids pollock and Tanner crab	all year	MCS ICS OCS	D	S+M[1]		
Adults	U	polychaete bivalves ophiuroids pollock and Tanner crab	spawning Jan-April non-spawning May-December	MCS OCS ICS	D	S+M[1]	ice edge	

[1] Pers. Comm. Dr. Robert McConnaughey

Habitat Description for Sablefish

(*Anoplopoma fimbria*)

Management Plan and Area BSAI

Life History and General Distribution

Sablefish are distributed from Mexico through the GOA to the Aleutian Chain, BS; along the Asian coast from Sagami Bay, and along the Pacific sides of Honshu and Hokkaido Islands and the Kamchatkan Peninsula. Adult sablefish occur along the continental slope, shelf gulleys, and in deep fjords such as Prince William Sound and southeast Alaska, at depths generally greater than 200 m. Adults are assumed to be demersal. Spawning or very ripe sablefish are observed in late winter or early spring along the continental slope. Eggs are apparently released near the bottom where they incubate. After hatching and yolk adsorption, the larvae rise to the surface where they have been collected with neuston nets. Larvae are oceanic through the spring and by late summer, small pelagic juveniles (10 to 15 cm) have been observed along the outer coasts of Southeast Alaska, where they apparently move into shallow waters to spend their first winter. During most years, there are only a few places where juveniles have been found during their first winter and second summer. It is not clear if the juvenile distribution is highly specific or appears so because sampling is highly inefficient and sparse. During the occasional times of large year-classes, the juveniles are easily found in many inshore areas during their second summer. They are typically 30 to 40 cm in length during their second summer, after which they apparently leave the nearshore bays. One or 2 years later, they begin appearing on the continental shelf and move to their adult distribution as they mature.

Fishery

The major fishery for sablefish in Alaska uses longlines, however sablefish are valuable in the trawl fishery as well. Sablefish enter the longline fishery at 4 to 5 years of age, perhaps slightly younger in the trawl fishery. The longline fishery takes place March 1 and November 15. The take of the trawl share of sablefish occurs primarily in association with openings for other species, such as the July rockfish openings, where they are taken as allowed bycatch. Deeper dwelling rockfish, such as shortraker, rougheye, and thornyhead rockfish are the primary bycatch in the longline sablefish fishery. Halibut and rattails (Albatrossia pectoralis and Corphaenoides acrolepis) also are taken. By regulation, there is no directed trawl fishery for sablefish; however, directed fishing standards have allowed some trawl hauls to target sablefish, where the bycatch is similar to the longline fishery, in addition, perhaps, to some deep dwelling flatfish.

Relevant Trophic Information

Larval sablefish feed on a variety of small zooplankton ranging from copepod naupli to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e., euphausiids).

The older demersal juveniles and adults appear to be opportunistic feeders, with food ranging from a variety of benthic invertebrates, benthic fishes, squid, mesopelagic fishes, jellyfish, and fishery discards. Gadid fish (mainly pollock) comprise a large part of the sablefish diet. Nearshore residence during their second year provides the opportunity to feed on salmon fry and smolts during the summer months.

Young of the year sablefish are commonly found in the stomachs of salmon taken in the southeast Alaska troll fishery during the late summer.

Approximate Upper Size Limit of Juvenile Fish (in cm): Size of 50 percent maturity: BS: males 65 cm, females 67 cm; AI: males 61 cm, females 65 cm; GOA: males 57 cm, females 65 cm. At the end of the second summer (~1.5 years old) they are 35 to 40 cm in length.

Habitat and Biological Associations

Egg/Spawning - Unknown
Larvae - Unknown
Juveniles - Unknown
Adults - Other than depth, none is noted

Additional Information Sources

Eggs and Larvae: NMFS, Alaska Fisheries Science Center, FOCI Program, Art Kendall, NMFS Auke Bay Lab, Bruce Wing.

Juveniles: ADFG groundfish surveys: Jim Blackburn, ADFG, Kodiak, AK; Paul Anderson, NMFS/RACE, Kodiak, AK.

Kendall, A.W., and A.C. Materese. Biology of eggs, larvae, and epipelagic juveniles of sablefish, Anoplopoma fimbria, in relation to their potential use in management. Mar. Fish. Rev. 49(1)1-13.

Smith, G.B., G.E. Walters, P.A. Raymore, Jr., and W.A. Hischberger. 1984. Studies of the distribution and abundance of juvenile groundfish in the northwestern GOA, 1980-82: Part I, Three-year comparisons. NOAA Tech. Memo. NMFS F/NWC-59. 100 p.

Walters, G.E., G.B. Smith, P.A. Raymore, and W.A. Hirschberger. 1985. Studies of the distribution and abundance of juvenile groundfish in the northwestern GOA, 1980-82: Part II, Biological characteristics in the extended region. NOAA Tech. Memo. NMFS F/NWC-77. 95 p.

Wing, B.L., and D.J. Kamikawa. 1995. Distribution of neustonic sablefish larvae and associated ichthyoplankton in the eastern GOA, May 1990. NOAA Tech. Memo. NMFS-AFSC-53.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and Zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dept. Commer., NOAAS Tech. Rept. NMFS 66, 151 p.

Boehlert, G.W., and M.M. Yoklavich. 1985. Larval and juvenile growth of sablefish, Anoplopoma fimbria, as determined from otolith increments. Fish. Bull. 83:475-481.

Grover, J.J., and B.L. Olla. 1986. Morphological evidence for starvation and prey size selection of sea-caught larval sablefish, Anoplopoma fimbria. Fish. Bull. 84:484-489.

Grover, J.J., and B.L. Olla. 1987. Effects of and El Niño event on the food habits of larval sablefish, Anoplopoma fimbria, off Oregon and Washington. Fish. Bull. 85: 71-79.

Grover, J.J., and B.L. Olla. 1990. Food habits of larval sablefish, Anoplopoma fimbria from the BS. Fish. Bull. 88:811-814.

Hunter, J.R., B.J. Macewiccz, and C.A. Kimbrell. 1989. Fecundity and other aspects of the reproduction of Sablefish, Anoplopoma fimbria, in Central California Waters. Calif. Coop. Fish. Invst. Rep. 30: 61-72.

Kendall, A.W., Jr., and A.C. Matarese. 1984. Biology of eggs, larvae, and epipelagic juveniles of sablefish, Anoplopoma fimbria, in relation to their potential use in management. Mar. Fish. Rev. 49(1):1-13.

Mason, J.C., R.J. Beamish, and G.A. McFralen. 1983. Sexual maturity, fecundity, spawning, and early life history of sablefish (Anoplopoma fimbria) off the Pacific coast of Canada. Can. J. Fish. Aquat. Sci. 40:2121-2134.

McFarlane, G.A., and R.J. Beamish. 1992. Climatic influence linking copepod production with strong year-classes in sablefish, Anoplopoma fimbria. Can. J. Fish. Aquat. Sci. 49:743-753.

Moser, H.G., R.L. Charter, P.E. Smith, N.C.H. Lo., D.A. Ambrose, C.A. Meyer, E.M. Sanknop, and W. Watson. 1994. Early life history of sablefish, Anoplopoma fimbria, off Washington, Oregon, and California with application to biomass estimation. Calif. Coop. Oceanic Fish. Invest. Rep. 35:144-159.

Rutecki, T.L., and E.R. Varosi. 1993. Distribution, age, and growth of juvenile sablefish in Southeast Alaska. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Rutecki, T.L., and E.R. Varosi. 1993. Migrations of Juvenile Sablefish in Southeast Alaska. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Sasaki, T. 1985. Studies on the sablefish resources in the North Pacific Ocean. Bulletin 22, (1-108), Far Seas Fishery Laboratory. Shimizu, 424, Japan.

Sigler, M.F., E.R. Varosi, and T.R. Rutecki. 1993. Recruitment curve for sablefish in Alaska based on recoveries of fish tagged as juveniles. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Sigler, M.F., T.L. Rutecki, D.L. Courtney, J.F. Karinen, and M-S. Yang. 2001. Young-of-the-year sablefish abundance, growth, and diet. Alaska Fisheries Research Bulletin 8(1): 57-70.

NOAA (National Oceanic and Atmospheric Administration). 1990. Sablefish, Anoplopoma fimbria. Pl 3.2.22. In: West Coast of North America Coastal and Ocean Zones Strategic Assessment Data Atlas. Invertebrate and Fish Volume. U.S. Dept. Commer. NOAA. OMA/NOS, Ocean Assessment Division, Strategic Assessment Branch.

Wing, B.L. 1985. Salmon Stomach contents from the Alaska Troll Logbook Program, 1977-84. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-91, 41 p.

Wing, B.L. 1997. Distribution of sablefish, Anoplopoma fimbria, larvae in the eastern GOA: Neuston-net tows versus oblique tows. In: M. Wilkins and M. Saunders (editors), Proc. Int. Sablefish Symp., April 3-4, 1993, p. 13-25. U.S. Dept. Commer., NOAA Tech. Rep. 130.

Wing, B.L.. and D.J. Kamikawa. 1995. Distribution of neustonic sablefish larvae and associated ichthyoplankton in the eastern GOA, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-53, 48 p.

Wing, B.L., C. Derrah, and V. O'Connell. 1997. Ichthyoplankton in the eastern GOA, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-376, 42 p.

Wolotera, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. NOAA Tech. Memo. NMFS-AFSC-22. 150 p.

SPECIES: BSAI Sablefish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14 to 20 days	NA	late winter-early spring: Dec-Apr	USP, LSP, BSN	P, 200-3000 m	NA	U	
Larvae	up to 3 months	copepod nauplii, small copepodites, etc	spring-summer: Apr-July	MCS, OCS, USP, LSP, BSN	N, neustonic near surface	NA	U	
Early Juveniles	to 3 years	small prey fish, sandlance, salmon, herring, etc		OCS, MCS, ICS, during first summer, then obs in BAY, IP, till end of 2nd summer; not obs'd till found on shelf	P when offshore during first summer, then D, SD/SP when inshore	NA when pelagic. The bays where observed were soft bottomed, but not enough obs. to assume typical.	U	
Late Juveniles	3 to 5 years	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	all year	continental slope, and deep shelf gulleys and fjords.	caught with bottom tending gear. presumably D	varies	U	
Adults	5 years to 35+	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	apparently year around, spawning movements (if any) are undescribed	continental slope, and deep shelf gulleys and fjords.	caught with bottom tending gear. presumably D	varies	U	

Habitat Description for Pacific Ocean Perch

(Sebastes alutus)

Management Plan and Area BSAI

Life History and General Distribution

Pacific ocean perch has a wide distribution in the North Pacific from southern California around the Pacific rim to northern Honshu Island, Japan, including the BS. The species appears to be most abundant in northern British Columbia, the GOA, and the AI. Adults are found primarily offshore along the continental slope in depths 180 to 420 m. Seasonal differences in depth distribution have been noted by many investigators. In the summer, adults inhabit shallower depths, especially those between 180 and 250 m. In the fall, the fish apparently migrate farther offshore to depths of ~300 to 420 m. They reside in these deeper depths until about May, when they return to their shallower summer distribution. This seasonal pattern is probably related to summer feeding and winter spawning. Although small numbers of Pacific ocean perch are dispersed throughout their preferred depth range on the continental slope, most of the population occurs in patchy, localized aggregations. At present, the best evidence indicates that Pacific ocean perch is mostly a demersal species. A number of investigators have speculated that there is also a pelagic component to their distribution, especially at night when they may move off-bottom to feed, but hard evidence for this is lacking.

There is much uncertainty about the life history of Pacific ocean perch, although generally more is known than for other rockfish species. The species appears to be viviparous, with internal fertilization and the release of live young. Insemination occurs in the fall, and sperm are retained within the female until fertilization takes place ~2 months later. The eggs develop and hatch internally, and parturition (release of larvae) occurs in April and May. Information on early life history is very sparse, especially for the first year of life. Positive identification of Pacific ocean perch larvae is not possible at present, but the larvae are thought to be pelagic and to drift with the current. Transformation to an adult form and the assumption of a demersal existence may take place within the first year. Small juveniles probably reside inshore in very rocky, high relief areas. By age 3, they begin to migrate to deeper offshore waters of the continental shelf. As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood.

Pacific ocean perch is a very slow growing species, with a low rate of natural mortality (estimated at 0.05), a relatively old age at 50 percent maturity (10.5 years for females in the GOA), and a very old maximum age of 98 years in Alaska. Despite their viviparous nature, the fish is relatively fecund with the number of eggs/female in Alaska ranging from 10,000 to 300,000, depending upon the size of the fish.

Fishery

Pacific ocean perch are caught almost exclusively with bottom trawls. Age at 50 percent recruitment has been estimated to be about 6.6 years. The fishery is concentrated in the summer months due to management regulations and opens in July, when most of the harvest is taken. Harvest data from 2000 to 2002 indicates that approximately 80 percent of the Pacific ocean perch in the BSAI are harvested during this month; there is no directed fishing for Pacific ocean perch in the EBS management area. The harvest of Pacific ocean perch is distributed across the AI subareas in proportion to relative biomass. From 2000 to

2002, approximately 44 percent of the harvest occurred in area 543, with 23 percent and 26 percent in the eastern and central Aleutians, respectively. Pacific ocean perch are patchily distributed, and are harvested in relatively few areas within the broad management subareas of the AI.

The 2000 to 2002 blend data indicate that about 15 percent of the harvested BSAI Pacific ocean perch is obtained as bycatch in the Atka mackerel fishery, with ~80 percent of the harvest of Pacific ocean perch occurring in the Pacific ocean perch fishery. Similarly, BSAI Pacific ocean perch target fishery consists largely of Pacific ocean perch, with percentages ranging from 71 percent to 91 percent from 2000 to 2002. Other species obtained as bycatch in the BSAI Pacific ocean perch fishery include Atka mackerel, arrowtooth flounder, walleye pollock, northern rockfish, and shortraker/rougheye.

Relevant Trophic Information

All food studies of Pacific ocean perch have shown them to be overwhelmingly planktivorous. Small juveniles eat mostly calanoid copepods, whereas larger juveniles and adults consume euphausiids as their major prey items. Adults, to a much lesser extent, may also eat small shrimp and squids. It has been suggested that Pacific ocean perch and walleye pollock compete for the same euphausiid prey. Consequently, the large removals of Pacific ocean perch by foreign fishermen in the GOA in the 1960s may have allowed walleye pollock stocks to increase greatly.

Documented predators of adult Pacific ocean perch include Pacific halibut and sablefish, and it is likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon, and benthic juveniles are eaten by lingcod and other large demersal fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): For GOA: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*. For AI and BS: unknown for both sexes.

Habitat and Biological Associations

Egg/Spawning: Little information is known. Insemination is thought to occur after adults move to deeper offshore waters in the fall. Parturition is reported to occur from 20 to 30 m off bottom at depths of 360 to 400 m.

Larvae: Little information is known. Earlier information suggested that after parturition, larvae rise quickly to near surface, where they become part of the plankton. More recent data from British Columbia indicates that larvae may remain at depths >175 m for some period of time (perhaps two months), after which they slowly migrate upward in the water column.

Juveniles: Again, information is very sparse, especially for younger juveniles. After metamorphosis from the larval stage, juveniles may reside in a pelagic stage for an unknown length of time. They eventually become demersal, and at age 1 to 3 probably live in very rocky inshore areas. Afterward, they move to progressively deeper waters of the continental shelf. Older juveniles are often found together with adults at shallower locations of the continental slope in the summer months.

Adults: Commercial fishery data have consistently indicated that adult Pacific ocean perch are found in aggregations over reasonably smooth, trawlable bottom of the continental slope. Generally, they are found in shallower depths (180 to 250 m) in the summer, and deeper (300 to 420 m) in the fall, winter, and early spring. In addition, investigators in the 1960s and 1970s speculated that the fish sometimes inhabited the mid-water environment off bottom and also might be found in rough, untrawlable areas. Hard evidence to support these latter two conjectures has, however, been lacking. The best information available at present suggests that adult Pacific ocean perch is mostly a demersal species that prefers a flat, pebbled substrate along the continental slope. More research is needed, however, before definitive conclusions can be drawn as to its habitat preferences.

Additional Information Sources

Eggs and Larvae: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory; NMFS, Alaska Fisheries Science Center, FOCI program; Canada Dept. of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B.C.

Juveniles: Carlson, H.R., and R.E. Haight. 1976. Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fiords of southeastern Alaska: Their environment, growth, food habits, and schooling behavior. Trans. Am, Fish. Soc. 105:191-201.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dept. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Carlson, H.R., and R.E. Haight. 1976. Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fiords of southeastern Alaska: their environment, growth, food habits, and schooling behavior. Trans. Am. Fish. Soc. 105:191-201.

Carlson, H.R., and R.R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp., in rocky coastal areas of Southeastern Alaska. Mar. Fish. Rev. 43: 13-19.

Doyle, M.J. 1992. Patterns in distribution and abundance of ichthyoplankton off Washington, Oregon, and Northern California (1980-1987). U.S. Dept. Commer. NOAA NMFS AFSC Processed Rept. 92-14, 344 p.

Gillespie, G.E., R.D. Stanley, and B.M. Leaman. 1992. Early life history of rockfishes in British Columbia; preliminary results of the first year of investigation. Proc. 1992 W. Groundfish Conf. Alderbrook Inn Resort, Union, WA, Jan 27-30, 1992.

Gunderson, D.R. 1971. Reproductive patterns of Pacific ocean perch (*Sebatodes alutus*) off Washington and British Columbia and their relation to bathymetric distribution and seasonal abundance. J. Fish. Res. Bd. Can. 28: 417-425.

Gunderson, D.R., and M.O. Nelson. 1977. Preliminary report on an experimental rockfish survey conducted off Monterey, California and in Queen Charlotte Sound, British Columbia during August-September, 1976. Prepared for Feb. 15-16, 1977, Interagency Rockfish Survey Coordinating Committee Meeting, NWAFC, Seattle, WA. Unpubl. manuscr. 82 p.

Harrison, R.C. 1993. Data report: 1991 bottom trawl survey of the AI area. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-12. 144 p.

Heifetz, J., and D. Ackley. 1997. Bycatch in rockfish fisheries in the GOA. Unpubl. Manuscr. 20 p. Available from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau, AK 99801.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 229-269. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501-2252.

Ito, D.H. 1982. A cohort analysis of Pacific ocean perch stocks from the GOA and BS regions. U.S. Dept. Commer., NWAFC Processed Rept. 82-15, 157 p.

Ito, D.H., and J.N. Ianelli. 1996. Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the BSAI regions, p. 331-359. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501-2252.

Kendall, A.W., and W.H. Lenarz. 1986. Status of early life history studies of northeast Pacific rockfishes. Proc. Int. Rockfish Symp. Oct. 1986, Anchorage Alaska; p. 99-117.

Krieger, K.J. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fish. Bull., U.S. 91:87-96.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA bottom trawl survey. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dept. Commer. NOAA Tech. Rept. NMFS 80, 652 p.

Matthews, K.R., J.R. Candy, L.J. Richards, and C.M. Hand. 1989. Experimental gill net fishing on trawlable and untrawlable areas off northwestern Vancouver Island, from the MV Caledonian, August 15-28, 1989. Can. Manuscr. Rep. Fish. Aquat. Sci. 2046, 78 p.

Mattson, C.R., and B.L. Wing. 1978. Ichthyoplankton composition and plankton volumes from inland coastal waters of southeastern Alaska, April-November 1972. U.S. Dept. Commer., NOAA Tech. Rept. NMFS SSRF-723, 11 p.

Moser, H.G., 1996. SCORPAENIDAE: scorpionfishes and rockfishes. *In*: Moser, H.G., editor. The early stages of fishes in the California Current region, p. 733-795. CalCOFI Atlas No.33. 1505 p.

NOAA (National Oceanic and Atmospheric Administration). 1990. Pacific ocean perch, *Sebastes alutus*. *In*: West coast of North America coastal and ocean zones strategic assessment: data atlas. Invertebrate and fish volume, Plate 3.2.20. U.S. Dept. Commer. NOAA. OMA/NOS, Ocean Assessments Division, Strategic Assessment Branch.

Ronholt, L.L., K. Teshima, and D.W. Kessler. 1994. The groundfish resources of the AI region and southern BS 1980, 1983, and 1986. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-31. 351 p.

Seeb, L.W. 1993. Biochemical identification of larval rockfishes of the genus *Sebastes*. Final Report Contract #43ABNF001082. U.S. Dept. Commer. NOAA/NMFS NWAFC/RACE Division, Seattle, WA. 28 p.

Seeb, L.W., and A.W. Kendall, Jr. 1991. Allozyme polymorphisms permit the identification of larval and juvenile rockfishes of the genus *Sebastes*. Environmental Biology of Fishes 30:191-201.

Stark, J.W., and D.M. Clausen. 1995. Data report: 1990 GOA bottom trawl survey. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-49. 221 p.

Westrheim, S.J. 1970. Survey of rockfishes, especially Pacific ocean perch, in the northeast Pacific Ocean, 1963-66. J. Fish. Res. Bd. Canada 27: 1781-1809.

Westrheim, S.J. 1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32: 2399-2411.

Wing, B.L. 1985. Salmon stomach contents from the Alaska troll logbook program, 1977-84. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-91. 41 p.

Wing, B.L., C. Derrah, and V. O'Connell. 1997. Ichthyoplankton in the eastern GOA, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-376, 42 p.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dept. Commer., NOAA Tech. Memo. NMFS - AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the AI in summer 1991. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

SPECIES: Pacific Ocean Perch

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	Internal incubation; ~90 d	NA	Winter	NA	NA	NA	NA	NA
Larvae	U; assumed between 60 and 180 days	U; assumed to be micro-zooplankton	Spring-summer	ICS, MCS, OCS, USP, LSP, BSN	P	NA	U	U
Juveniles	3 to 6 months to 10 years	Early juv: calanoid copepods; late juv: euphausiids	All year	ICS, MCS, OCS, USP	?P (early juv. only), D	R (<age 3)	U	U
Adults	10 to 98 years of age	Euphausiids	Insemination (fall); Fertilization, incubation (winter); Larval release (spring); Feeding in shallower depths (summer)	OCS, USP	D	CB, G,?M, ?SM,?MS	U	U

Habitat Description for Shortraker Rockfish (*Sebastes borealis*) and Rougheye Rockfish (*Sebastes aleutianus*)

Management Plan and Area BSAI

Life History and General Distribution

Shortraker and rougheye rockfishes are found along the northwest slope of the EBS, throughout the AI, and south to Point Conception, California. Both species are demersal and can be found at depths ranging from 25 to 875 m; however, commercial concentrations usually occur at depths from 300 to 500 m. Though relatively little is known about their biology and life history, both species appear to be K-selected with late maturation, slow growth, extreme longevity, and low natural mortality. Rougheye rockfish attain maturity relatively late in life, at about 20+ years of age. Both species are among the largest *Sebastes* species in Alaska waters, attaining sizes of up to 104 cm for shortraker and 96 cm for rougheye rockfish. Shortraker rockfish have been estimated to attain ages in excess of 120 years and rougheye rockfish in excess of 140 years. Natural mortality for both species is low, estimated to be on the order of 0.01 to 0.04.

Fishery

A directed fishery does not exist for shortraker rockfish or rougheye rockfish in the BSAI area. Harvest data from 2000 to 2002 indicates that over 90 percent of the harvest of BSAI shortraker and rougheye rockfish is taken in the AI, with the proportion among the three subareas ranging from 26 percent to 34 percent. Rougheye and shortraker rockfish are most commonly caught in July, with 58 percent of the harvest from 2000 to 2002, and the bulk of this harvest is obtained as bycatch in the Pacific ocean perch trawl fishery. Rougheye and shortraker are also caught in the sablefish longline fishery, particularly in the eastern and central AI, and in the Pacific cod longline fishery, particularly in the central and western Aleutians.

Relevant Trophic Information

Shortraker and rougheye rockfishes prey primarily on shrimps, squids, and myctophids. It is uncertain what are the main predators on both species.

Approximate Upper Size Limit of Juvenile Fish (in cm): For shortraker rockfish, length at 50 percent sexual maturity is about 45 cm and about 44 cm for rougheye rockfish.

Habitat and Biological Associations

Egg/Spawning: The timing of reproductive events is apparently protracted. One study indicated that vitellogenesis was present for 4 to 5 months and lasted from about July until late October and November. Parturition apparently occurs mainly from early spring through summer.

Larvae: No information is available regarding the habitats and biological associations of shortraker and rougheye rockfish larvae.

Juveniles: Very little information is available regarding the habitats and biological associations of shortraker and rougheye rockfish juveniles. It is suspected, however, that the juveniles of both species occupy shallower habitats than that of the adults.

Adults: Adults are demersal and can be found at depths ranging from 25 to 875 m. Submersible observations indicate that adults occur over a wide range of habitats. Soft substrates of sand or mud usually had the highest densities, whereas hard substrates of bedrock, cobble, or pebble usually had the lowest adult densities. Habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders.

Additional Information Source

NMFS, Alaska Fisheries Science Center.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102 p.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the 1997 GOA groundfish fishery, p. 230-270. North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.

Kramer, D.E., and V.M. O'Connell. 1986. Guide to northeast Pacific rockfishes, Genera *Sebastes* and *Sebastolobus*. Marine Advisory Bulletin No. 25: 1-78. Alaska Sea Grant College Program, University of Alaska.

Krieger, K. 1992. Shortraker rockfish, *Sebastes borealis*, observed from a manned submersible. Mar. Fish. Rev., 54(4): 34-37.

Krieger, K.J. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fish. Bull. 91:87-96.

Krieger, K.J., and D.H. Ito. Unpublished. Distribution and abundance of shortraker rockfish, *Sebastes borealis*, and rougheye rockfish, *Sebastes aleutianus*, determined from a submersible. Unpublished manuscript.

McDermott, S.F. 1994. Reproductive biology of rougheye and shortraker rockfish, *Sebastes aleutianus* and *Sebastes borealis*. Masters Thesis. Univ. Washington, Seattle. 76 p.

Sigler, M.F., and H.H. Zenger, Jr. 1994. Relative abundance of GOA sablefish and other groundfish based on the domestic longline survey, 1989. NOAA Tech. Memo. NMFS-AFSC-40.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the AI in summer 1991. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

SPECIES: Shortraker and Rougheye Rockfish

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	U	U	U	U	U	U	U	
Larvae	U	U	Spawning: Early spring through summer	U	U	U	U	
Early Juveniles	U	U Shrimp & amphipods?	U	U MCS, OCS?	U	U	U	
Late Juveniles								
Adults	15+ years of age	Shrimp Squid Myctophids	Year-round?	OCS, USP	D	M, S, R, SM, CB, MS, G	U	

Habitat Description for Northern Rockfish

(*Sebastes polyspinus)*

Management Plan and Area BSAI

Life History and General Distribution

Northern rockfish range from northern British Columbia through the GOA and AI to eastern Kamchatka, including the BS. The species is most abundant from about Portlock Bank in the central GOA to the western end of the AI. Within this range, adult fish appear to be concentrated at discrete, relatively shallow offshore banks of the outer continental shelf. Typically, these banks are separated from land by an intervening stretch of deeper water. The preferred depth range is ~75 to 125 m in the GOA, and ~100 to 150 m in the AI. The fish appear to be demersal, although small numbers are occasionally taken in pelagic tows. In common with many other rockfish species, northern rockfish tend to have a localized, patchy distribution, even within their preferred habitat, and most of the population occurs in aggregations. Most of what is known about northern rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on northern rockfish is extremely sparse. The fish are assumed to be viviparous, as are other *Sebastes*, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring and is mostly completed by summer. Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage is unknown, but the fish apparently metamorphose to a pelagic juvenile stage, which also has been described. There is no information on when the juveniles become benthic or what habitat they occupy. Older juveniles are found on the continental shelf, generally at locations inshore of the adult habitat.

Northern rockfish is a slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50 percent maturity (12.8 years for females in the GOA), and an old maximum age of 57 years in Alaska. No information on fecundity is available.

Fishery

In the BSAI area, there is no directed fishery for northern rockfish. Harvest data from 2000 to 2002 indicate that approximately 90 percent of the BSAI northern rockfish are harvested in the Atka mackerel fishery, with a large amount of the catch occurring in September in the western Aleutians (area 543). The distribution of northern rockfish harvest by AI subarea reflects both the spatial regulation of the Atka mackerel fishery and the increased biomass of northern rockfish in the western AI. The average proportion of northern rockfish biomass occurs in the western, central, and eastern AI, based on trawl surveys from 1991 to 2002, were 72, 22, and 5 percent, respectively. Northern rockfish are patchily distributed and are harvested in relatively few areas within the broad management subareas of the AI, with important fishing grounds being Petral Bank, Sturdevant Rock, south of Amchitka Island, and Seguam Pass (Dave Clausen, NMFS-AFSC, personal communication).

Relevant Trophic Information

Although no comprehensive food study of northern rockfish has been done, several smaller studies have all shown euphausiids to be the predominate food item of adults in both the GOA and BS. Copepods, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities.

Predators of northern rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

Approximate Upper Size Limit of Juvenile Fish (in cm): For GOA: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*. For AI and BS: unknown for both sexes. Because northern rockfish in the AI attain a much smaller size than in the Gulf, the upper size limit of juveniles there is probably much smaller than in the Gulf.

Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring.

Larvae: No information known.

Juveniles: No information known for small juveniles (<20 cm), except that juveniles apparently undergo a pelagic phase immediately after metamorphosis from the larval stage. Larger juveniles have been taken in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds.

Adults: Commercial fishery and research survey data have consistently indicated that adult northern rockfish are primarily found over reasonably flat, trawlable bottom of offshore banks of the outer continental shelf at depths of 75 to 150 m. The preferred substrate in this habitat has not been documented, but observations from trawl surveys suggest that large catches of northern rockfish are often associated with hard bottoms. Generally, the fish appear to be demersal, and most of the population occurs in large aggregations. There is no information on seasonal migrations. Northern rockfish often co-occur with dusky rockfish.

Additional Information Source

Older Juveniles/Adults: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, David Clausen.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Harrison, R.C. 1993. Data report: 1991 bottom trawl survey of the AI area. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-12. 144 p.

Heifetz, J., and D. Ackley. 1997. Bycatch in rockfish fisheries in the GOA. Unpubl. Manuscr. 20 p. (Available from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau, AK 99801.)

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 229-269. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501-2252.

Kendall, A.W. 1989. Additions to knowledge of *Sebastes* larvae through recent rearing. NWAFC Proc. Rept. 89-21. 46 p.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA bottom trawl survey. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of Northeast Pacific fishes. U.S. Dept. Commerce NOAA Tech. Rept. NMFS 80, 652 p.

Ronholt, L.L., K. Teshima, and D.W. Kessler. 1994. The groundfish resources of the AI region and southern BS 1980, 1983, and 1986. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-31. 351 p.

Stark, J.W., and D.M. Clausen. 1995. Data report: 1990 GOA bottom trawl survey. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-49. 221 p.

Westrheim, S.J., and H. Tsuyuki. 1971. Taxonomy, distribution, and biology of the northern rockfish, *Sebastes polyspinis*. J. Fish. Res. Bd. Can. 28: 1621-1627.

SPECIES: Northern Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	?Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	From end of larval stage to ?	U	All year	ICS, MCS, OCS,	?P (early juv. only), D	U (juv.< 20 cm); substrate (juv.>20 cm)	U	U
Late Juveniles	to 13 years	U	All year	OCS		CB, R	U	U
Adults	13 to 57 years of age	Euphausiids	U, except that larval release is probably in the spring in the GOA	OCS, USP	SD	CB, R	U	U

Habitat Description for Thornyhead Rockfish

(Sebastolobus sp.)

Management Plan and Area BSAI

Life History and General Distribution

Thornyheads of the northeastern Pacific Ocean comprise two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). The longspine thornyhead is not common in the GOA. The shortspine thornyhead is a demersal species that inhabits deep waters from 93 to 1,460 m from the BS to Baja California. This species is common throughout the GOA, EBS, and AI. The population structure of shortspine thornyheads, however, is not well defined. Thornyheads are slow-growing and long-lived with a maximum age in excess of 50 years and a maximum size greater than 75 cm and 2 kg. Thornyheads spawn buoyant masses of eggs during the late winter and early spring that resemble bilobate “balloons,” which float to the surface (Pearcy 1962). Juvenile shortspine thornyheads have a pelagic period of about 14 to 15 months and settle out on the shelf (100 m) at about 22 to 27 mm (Moser 1974). Fifty percent of female shortspine thornyheads are sexually mature at about 21 cm and 12 to 13 years of age.

Fishery

Trawl and longline gear are the primary methods of harvest. The bulk of the fishery occurs in late winter or early spring through the summer. In the past, this species was seldom the target of a directed fishery. Today thornyheads are one of the most valuable of the rockfish species, with most of the domestic harvest exported to Japan. Thornyheads are taken with some frequency in the longline fishery for sablefish and cod and are often part of the bycatch of trawlers concentrating on pollock and Pacific ocean perch.

Relevant Trophic Information

Shortspine thornyheads prey mainly on epibenthic shrimp and fish. Yang (1996, 2003) showed that shrimp were the top prey item for shortspine thornyheads in the GOA, whereas cottids were the most important prey item in the AI region. Differences in abundance of the main prey between the two areas might be the main reason for the observed diet differences. Predator size might by another reason for the difference since the average shortspine thornyhead in the AI area was larger than that in the GOA (33.4 cm versus 29.7 cm).

Approximate Upper Size Limit of Juvenile Fish (in cm): ~27 mm (pelagic stage) ~60 mm (benthic stage)? See Moser 1974. Female shortspine thornyheads appear to be mature at about 21 to 22 cm (Miller 1985).

Habitat and Biological Associations

<u>*Egg/Spawning*</u>: Eggs float in masses of various sizes and shapes. Frequently the masses are bilobed with the lobes 15 cm to 61 cm in length, consisting of hollow conical sheaths containing a single layer of eggs in a gelatinous matrix. The masses are transparent and not readily observed in the daylight. Eggs are 1.2 to

1.4 mm in diameter with a 0.2 mm oil globule. They move freely in the matrix. Complete hatching time is unknown but is probably more than 10 days.

Larvae: Three day-old larvae are about 3 mm long and apparently float to the surface. It is believed that the larvae remain in the water column for about 14 to 15 months before settling to the bottom.

Juveniles: Very little information is available regarding the habitats and biological associations of juvenile shortspine thornyheads.

Adults: Adults are demersal and can be found at depths ranging from about 90 to 1,500 m. Groundfish species commonly associated with thornyheads include arrowtooth flounder (*Atheresthes stomias*), Pacific ocean perch (*Sebastes alutus*), sablefish *(Anoplopoma fimbria*), rex sole (*Glyptocephalus zachirus*), Dover sole (*Microstomus pacificus*), shortraker rockfish (*Sebastes borealis*), rougheye rockfish (*Sebastes aleutianus*), and grenadiers (family Macrouridae). Two congeneric thornyhead species, the longspine thornyhead (*Sebastolobus altivelis*) and a species common off of Japan, *S. Macrochir*, are infrequently encountered in the GOA.

Additional Information Source

NMFS, Alaska Fisheries Science Center.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Aton, M. 1981. GOA bottomfish and shellfish resources. U.S. Dept. Commerce Tech. Memo. NMFS F/NWC-10, 51 p.

Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102 p.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 230-270. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Ianelli, J.N., D.H. Ito, and M. Martin. 1996. Thornyheads (*Sebastolobus sp.*). *In* Stock Assessment and fishery evaluation report for the groundfish resources of the GOA, p. 303-330. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Jacobson, L.D. 1993. Thornyheads. *In* Status of living marine resources off the Pacific coast of the United States for 1993. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-26, 35-37 p.

Kramer, D.E., and V.M. O'Connell. 1986. Guide to northeast Pacific rockfishes, Genera *Sebastes* and *Sebastolobus*. Marine Advisory Bulletin No. 25: 1-78. Alaska Sea Grant College Program, University of Alaska.

Low, L.L. 1994. Thornyheads. *In* Status of living marine resources off Alaska, 1993. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-27, 56-57 p.

Miller, P.P. 1985. Life history study of the shortspine thornyhead, Sebastolobus alascanus, at Cape Ommaney, sorth-eastern Alaska. M.S. Thesis, Univ. Alaska, Fairbanks, AK, 61p.

Moser, H.G. 1974. Development and distribution of larvae and juveniles of Sebastolobus (Pisces: family Scorpaenidae). Fish. Bull. 72: 865-884.

Pearcy, W.G. 1962. Egg masses and early developmental stages of the scorpaenid fish, Sebastolobus. J. Fish. Res. Board Can. 19: 1169-1173.

Sigler, M.F., and H.H. Zenger, Jr. 1994. Relative abundance of GOA sablefish and other groundfish based on the domestic longline survey, 1989. NOAA Tech. Memo. NMFS-AFSC-40.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1996. Diets of the important groundfishes in the AI in summer 1991. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

Yang, M-S. 2003. Food Habits of the Important Groundfishes in the AI in 1994 and 1997. AFSC processed report 2003-07.

SPECIES: Thornyhead Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	U	Spawning: Late winter and early spring	U	P	U	U	
Larvae	<15 Months	U	Early spring through summer	U	P	U	U	
Juveniles	> 15 months when settling to bottom occurs (?)	U Shrimp, Amphipods, Mysids, Euphausiids?	U	MCS, OCS, USP	D	M, S, R, SM, CB, MS, G	U	
Adults	U	Shrimp Fish (cottids), Small crabs	Year-round?	MCS, OCS, USP, LSP	D	M, S, R, SM, CB, MS, G	U	

Habitat Description for Light Dusky Rockfish

(*Sebastes ciliatus*)

Management Plan and Area BSAI

The taxonomy of dusky rockfish is unclear. Two varieties occur which are likely distinct species: an inshore, shallow water, dark-colored variety; and a lighter-colored variety found in deeper water offshore. A taxonomic study is in progress that will probably describe the light variety as a new species. To avoid confusion, and because the light variety appears to be more abundant and is the object of a large, directed trawl fishery, this discussion of essential habitat will deal only with light dusky rockfish.

Life History and General Distribution

Light dusky rockfish range from Dixon Entrance at the U.S./Canada boundary, around the arc of the GOA, and westward throughout the AI. They are also found in the EBS north to about Zhemchug Canyon west of the Pribilof Islands. Their distribution south of Dixon Entrance in Canadian waters is uncertain; dusky rockfish have been reported as far south as Johnstone Strait, Vancouver Island, but it is likely these were of the dark variety. The center of abundance for light dusky rockfish appears to be the GOA (Reuter 1999). The species is much less abundant in the AI and BS (Reuter and Spencer 2002). Adult light dusky rockfish have a very patchy distribution and are usually found in large aggregations at specific localities of the outer continental shelf. These localities are often relatively shallow offshore banks. Because the fish are taken with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no evidence of a pelagic tendency based on the information available at present. Most of what is known about light dusky rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on light dusky rockfish is extremely sparse. The fish are assumed to be viviparous, as are other *Sebastes*, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring and is probably completed by summer. Another, older source, however, lists parturition as occurring after May. Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage, and whether a pelagic juvenile stage occurs, are unknown. There is no information on habitat and abundance of young juveniles (<25 cm fork length), as catches of these have been virtually nil in research surveys. Even the occurrence of older juveniles has been very uncommon in surveys, except for one year. In this latter instance, older juveniles were found on the continental shelf, generally at locations inshore of the adult habitat.

Light dusky rockfish is a slow growing species, with a low rate of natural mortality estimated at 0.09. However, it appears to be faster growing than many other rockfish species. Maximum age is 49 to 59 years. No information on age of maturity or fecundity is available.

Fishery

Light dusky rockfish are caught almost exclusively with bottom trawls. Age at 50 percent recruitment is unknown. The fishery in the GOA in recent years has mostly occurred in the summer months, especially

July, due to management regulations. Catches are concentrated at a number of relatively shallow, offshore banks of the outer continental shelf, especially the "W" grounds west of Yakutat and Portlock Bank. Other fishing grounds include Albatross Bank, the Snakehead (south of Kodiak Island), and Shumagin Bank. Outside of these banks, catches are generally sparse. Catch distribution by depth has not been summarized, but most of the fish are apparently taken at depths of 75 to 200 m. There is no directed fishery in the Aleutians and BS, and catches there have been generally sparse.

For Council-managed species, the major bycatch species in the GOA light dusky rockfish trawl fishery in 1993 to 1995 included (in descending order by percent) "other" species of slope rockfish, northern rockfish, and Pacific ocean perch. There is no information available on the bycatch of non-Council-managed species in the GOA light dusky rockfish fishery.

Relevant Trophic Information

Although no comprehensive food study of light dusky rockfish has been done, one smaller study in the GOA showed euphausiids to be the predominate food item of adults. Larvaceans, cephalopods, pandalid shrimp, and hermit crabs were also consumed.

Predators of light dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

Approximate Upper Size Limit of Juvenile Fish (in cm): For GOA: 47 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring, and may extend into summer.

Larvae: No information known.

Juveniles: No information known for small juveniles <25 cm fork length. Larger juveniles have been taken infrequently in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds.

Adults: Commercial fishery and research survey data suggest that adult light dusky rockfish are primarily found over reasonably flat, trawlable bottom of offshore banks of the outer continental shelf at depths of 75 to 200 m. The type of substrate in this habitat has not been documented. During submersible dives on the outer shelf (40 to 50 m) in the eastern Gulf, light dusky rockfish were observed in association with rocky habitats and in areas with extensive sponge beds where adult duskys were observed resting in large vase sponges (V. O'Connell, personal communication). Generally, the fish appear to be demersal, and most of the population occurs in large aggregations. Light dusky rockfish are the most highly aggregated of the rockfish species caught in GOA trawl surveys. Outside of these aggregations, the fish are sparsely distributed. Because the fish are taken with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no evidence of a pelagic tendency based on the information available at present. There is no information on seasonal migrations. Light dusky rockfish often co-occur with northern rockfish.

Additional Information Source

Adults: Rebecca Reuter, c/o NMFS, Alaska Fisheries Science Center, REFM Division.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Clausen, D.M., and J. Heifetz. 1996. Pelagic shelf rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 271-288. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501-2252.

Harrison, R.C. 1993. Data report: 1991 bottom trawl survey of the AI area. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-12. 144 p.

Heifetz, J., and D. Ackley. 1997. Bycatch in rockfish fisheries in the GOA. Unpubl. Manuscr. 20 p. (Available from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau, AK 99801.

Kendall, A.W. 1989. Additions to knowledge of *Sebastes* larvae through recent rearing. NWAFC Proc. Rept. 89-21. 46 p.

Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA bottom trawl survey. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dept. Commerce NOAA Tech. Rept. NMFS 80, 652 p.

Reuter, R.F. 1999. Describing Dusky rockfish (*Sebastes ciliatus*) habitat in the GOA using Historical data. M.S. thesis. California State University, Hayward 83 p.

Reuter, R.F., and P.D. Spencer. 2002. Other rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the BS and AI, p. 579-608.

Stark, J.W., and D.M. Clausen. 1995. Data report: 1990 GOA bottom trawl survey. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-49. 221 p.

Westrheim, S.J. 1973. Preliminary information on the systematics, distribution, and abundance of the dusky rockfish, *Sebastes ciliatus*. J. Fish. Res. Bd. Can. 30: 1230-1234.

Westrheim, S.J. 1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32: 2399-2411.

SPECIES: Light Dusky Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	?Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	U	U	All year	ICS, MCS, OCS,	U (small juv.< 25 cm): ?D (Larger juv.)	U (juv.< 25 cm); ?Trawlable substrate (juv.>25 cm)	U	U
Late Juveniles	U	U	U	U	U	CB, R, G	U	U
Adults	Up to 49 to 50 years	Euphausiids	U, except that larval release may be in the spring in the GOA	OCS, USP	SD, SP	CB, R, G	U	U

Habitat Description for Atka Mackerel

(Pleurogrammus monopterygius)

Management Plan and Area BSAI

Life History and General Distribution

Atka mackerel are distributed from the GOA to the Kamchatka Peninsula, most abundant along the Aleutians. Adult Atka mackerel occur in large localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are pelagic during much of the year, but migrate annually to moderately shallow waters where they become demersal during spawning. Spawning peaks in June through September, but may occur intermittently throughout the year. Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Eggs hatch in 40 to 45 days, releasing planktonic larvae which have been found up to 800 km from shore. Little is known of the distribution of young Atka mackerel prior to their appearance in trawl surveys and the fishery at about age 2 to 3 years. Atka mackerel exhibit intermediate life history traits. R-traits include age at maturity (approximately 50 percent are mature at age 3), fast growth rates, high natural mortality (M=0.3), and average and maximum ages (about 5 and 14 years, respectively). K-selected traits include low fecundity (only about 30,000 eggs/female/year, large egg diameters [1 to 2 mm] and male nest-guarding behavior).

Fishery

The atka mackerel fishery consists of bottom trawls, some pelagic trawling, with recruitment at about age 3, conducted in the AI and western GOA at depths from about 70 to 225 m, in trawlable areas on rocky, uneven bottom, along edges, and in the lee of submerged hills during periods of high current. Currently, the fishery occurs on reefs west of Kiska Island, south and west of Amchitka Island, in Tanaga Pass and near the Delarof Islands, and south of Seguam and Umnak Islands. Historically, the fishery occurred east into the GOA as far as Kodiak Island (through the mid-1980s), but is no longer there. The fishery used to be conducted entirely during the summer, in spawning season. Now it occurs throughout the year. It is a very clean fishery; bycatch of other species is minimal.

Relevant Trophic Information

Atka mackerel is an important food source for Steller sea lions in the AI, particularly during summer, and for other marine mammals (minke whales, Dall’s porpoise, and northern fur seal). Juveniles are eaten by thick billed murres and tufted puffins. Main groundfish predators are Pacific halibut, arrowtooth flounder, and Pacific cod.

Approximate Upper Size Limit of Juvenile Fish (in cm): 35 cm

Habitat and Biological Associations

<u>*Egg/Spawning*</u>: Eggs are deposited in nests built and guarded by males on rocky substrates or on kelp in shallow water.

<u>Larvae/Juveniles</u>: Planktonic larvae have been found up to 800 km from shore, usually in upper water column (neuston), but little is known of the distribution of Atka mackerel until they are about 2 years old and appear in fishery and surveys.

<u>Adults</u>: Adults occur in localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are semi-demersal/pelagic during much of the year, but migrate annually to moderately shallow waters where the males become demersal during spawning; females move between nesting and offshore feeding areas.

Additional Information Source

NMFS, Alaska Fishery Science Center.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dept. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the AI, Alaska, after a ban on salmon driftnets. U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, AI Unit, PSC 486, Box 5251, FPO AP 96506-5251, Adak, Alaska.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western GOA during spring. Fishery Bulletin 93: 231-253.

Fritz, L.W. 1993. Trawl locations of walleye pollock and Atka mackerel fisheries in the BS, AI, and GOA from 1977-1992. AFSC Processed Report 93-08, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 pp.

Gorbunova, N.N. 1962. Razmnozhenie I razvite ryb semeistva terpugovykh (Hexagrammidae) Spawning and development of greenlings (family Hexagrammidae). Tr. Inst. Okeanol., Akad. Nauk SSSR 59:118-182. In Russian. (Trans. by Isr. Program Sci. Trans., 1970, p. 121-185 in T.S. Rass (editor), Greenlings: taxonomy, biology, interoceanic transplantation; available from the U.S. Dept. Commerce, Natl. Tech. Inf. Serv., Springfield, VA., as TT 69-55097).

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal Callorhinus ursinus, in the eastern north Pacific Ocean and EBS. NOAA Tech. Rept. NMFS SSRF-779. USDOC, NOAA, NMFS, 49 pp.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dept. Commerc., NOAA Tech. Rpt. NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Lee, J.U. 1985. Studies on the fishery biology of the Atka mackerel *Pleurogrammus monopterygius* (Pallas) in the north Pacific Ocean. Bull. Fish. Res. Dev. Agency, 34, pp. 65-125.

Levada, T.P. 1979. Comparative morphological study of Atka mackerel. Pac. Sci. Res. Inst. Fish. Oceanogr. (TINRO), Vladivostok, U.S.S.R., Unpublished manuscript.

Levada, T.P. 1979. Some data on biology and catch of Atka mackerel. Pac. Sci. Res. Inst. Fish. Oceanogr. (TINRO), Vladivostok, U.S.S.R., Unpublished manuscript.

Lowe, S.A., and L.W. Fritz. 1996. Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Lowe, S.A., and L.W. Fritz. 1996. Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the GOA as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

McDermott, S.F., and S.A. Lowe. 1997. The reproductive cycle and sexual maturity of Atka mackerel (*Pleurogrammus monopterygius*) in Alaska waters. Fishery Bulletin 95: 321-333.

Morris, B.F. 1981. An assessment of the living marine resources of the central BS and potential resource use conflicts between commercial fisheries and Petroleum development in the Navarin Basin, Proposed sale No. 83. Anchorage, AK: USDOC, NOAA, NMFS, Environmental Assessment Division.

Musienko, L.N. 1970. Razmnozheine I razvitie ryb Beringova morya (Reproduction and development of BS fishes). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Koz. Okeanogr. 70: 161-224 In P.A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, Avail. Natl. Tech. Info. Serv., Springfield, VA as TT 74-50127.

NMFS. 1995. Status review of the Unites States Steller sea lion (*Eumetopias jubatus*) population. National Marine Mammal Laboratory, Alaska Fishery Science Center, National Marine Fisheries Service, 7600 Sand Point Way, NE, Seattle, WA 98115.

Orlov, A.M. 1996. The role of mesopelagic fishes in feeding of Atka mackerel in areas of the North Kuril islands. Publ. Abstract in Role of forage fishes in marine ecosystems. Symposium held Nov 1996, AK Sea Grant, U. Alaska, Fairbanks.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the EBS, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1996. Trophic role of Atka mackerel in the AI. Publ. Abstract in Role of forage fishes in marine ecosystems. Symposium held Nov 1996, AK Sea Grant, U. Alaska, Fairbanks.

Zolotov, O.G. 1993. Notes on the reproductive biology of *Pleurogrammus monopterygius* in Kamchatkan waters. J of Ichthy. 33(4), pp. 25-37.

SPECIES: Atka Mackerel

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	40 to 45 days	NA	summer	IP, ICS	D	GR, R, K	U	develop 3-20˚C optimum 9-13˚C
Larvae	up to 6 mos	U copepods?	fall-winter	U	U N?	U	U	2-12˚C optimum 5-7˚C
Juveniles	½ to 2 years of age	U copepods & euphausiids?	all year	U	U	U	U	3-5˚C
Adults	3+ years of age	copepods euphausiids meso-pelagic fish (myctophids)	spawning (May-Oct) non-spawning (Nov-Apr) tidal/diurnal, year-round?	ICS and MCS, IP MCS and OCS, IP ICS, MCS, OCS, IP	D (males) SD females SD/D all sexes D when currents high/day SD slack tides/night	GR, R, K	F, E	3-5˚C all stages >17 ppt only

Habitat Description for Capelin

(*osmeridae*)

Management Plan and Area BSAI

Species Representative

Capelin (*Mallotus villosus*)

Life History and General Distribution

Capelin is a short-lived marine (neritic), pelagic, filter-feeding schooling fish distributed along the entire coastline of Alaska and the BS and south along British Columbia to the Strait of Juan de Fuca, circumpolar. In the North Pacific, capelin grow to a maximum of 25 cm and 5 years of age. They spawn at ages 2 to 4 in spring and summer (May to August; earlier in the south, later in the north) when about 11 to 17 cm on coarse sand and fine gravel beaches, especially in Norton Sound, northern Bristol Bay, along the Alaska Peninsula, and near Kodiak. Age at 50 percent maturity is 2 years. Fecundity is 10,000 to 15,000 eggs per female. Eggs hatch in 2 to 3 weeks. Most capelin die after spawning. Larvae and juveniles are distributed on the inner mid-shelf in summer (they are rarely found in waters deeper than about 200 m), and juveniles and adults congregate in fall in mid-shelf waters east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands, and north into the Gulf of Anadyr. They are distributed along the outer shelf and under the ice edge in winter. Larvae, juveniles, and adults have diurnal vertical migrations following scattering layers; at night they are near the surface, and they are at depth during the day. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Fishery

Capelin are not a target species in groundfish fisheries of the BSAI or GOA, but they are caught as bycatch (up to several hundred tons per year in the 1990s) principally by the yellowfin sole trawl fishery in Kuskokwim and Togiak Bays in spring in BSAI; almost all are discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Capelin are important prey for marine birds and mammals, as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a, Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987, Wespestad 1987). Smelts are also found in the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the BS (Allen 1987, Yang 1993, Livingston, in prep.).

Approximate Upper Size Limit of Juvenile Fish (in cm): 13 cm

Habitat and Biological Associations

Egg/Spawning: Spawn adhesive eggs (about 1 mm in diameter) on fine gravel or coarse sand (0.5 to 1 mm grain size) beaches intertidally to depths of up to 10 m from May to July in Alaska (later to the north in Norton Sound). Hatching occurs in 2 to 3 weeks. Most intense spawning when coastal water temperatures are 5 to 9ºC.

Larvae: After hatching, 4 to 5 mm larvae remain on the middle-inner shelf in summer; distributed pelagically; centers of distribution are unknown, but have been found in high concentrations north of Unimak Island, in the western GOA, and around Kodiak Island.

Juveniles: In fall, juveniles are distributed pelagically in mid-shelf waters (50 to 100 m depth; -2 to 3ºC) and have been found in the highest concentrations east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Adults: Found in pelagic schools in inner-mid shelf in spring-fall, feed along semi-permanent fronts separating inner, mid, and outer shelf regions (~50 and 100 m). In winter, found in concentrations under the ice edge and along the mid outer shelf.

Additional Information Sources

Paul Anderson, NMFS/RACE, Kodiak, AK.
Jim Blackburn, ADFG, Kodiak, AK.
Mark W. Nelson, NMFS/REFM, Seattle, WA.

Literature

Allen, M.J. 1987. Demersal fish predators of pelagic forage fishes in the southeastern BS. Pp. 29-32 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Crawford, T.W. 1981. Vertebrate prey of *Phocoenoides dalli* (Dall's porpoise), associated with the Japanese high seas salmon fishery in the North Pacific Ocean. M.S. Thesis, Univ. Washington, Seattle, 72 p.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western GOA during spring. Fishery Bulletin 93: 231-253.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Fritz, L.W., V.G. Wespestad, and J.S. Collie. 1993. Distribution and abundance trends of forage fishes in the BS and GOA. Pp. 30-44 *In* Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. K-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Frost, K.J., and L. Lowry. 1987. Marine mammals and forage fishes in the southeastern BS. Pp. 11-18 In Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Hunt, G.L., Jr., B. Burgeson, and G.A. Sanger. 1981a. Feeding ecology of seabirds of the EBS. Pp 629-647 *In* D.W. Hood and J.A. Calder (eds.), The EBS Shelf: Oceanography and Resources, Vol. II. U.S. Dept. Commerce, NOAA, OCSEAP, Office of Marine Pollution Assessment, Univ. WA Press, Seattle, WA.

Hunt, G.L., Jr., Z. Eppley, B. Burgeson, and R. Squibb. 1981b. Reproductive ecology, foods and foraging areas of seabirds nesting on the Pribilof Islands, 1975-79. Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, RU-83, U.S. Dept. Commerce, NOAA, OCSEAP, Boulder, CO.

Kawakami, T. 1980. A review of sperm whale food. Sci. Rep. Whales Res. Inst. Tokyo 32: 199-218.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dept. Commerce, NOAA Tech. Rept NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Livingston, P.A. Groundfish utilization of walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*) and capelin (*Mallotus villosus*) resources in the GOA. In preparation.

Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the GOA: a resource assessment for the GOA/Cook Inlet Proposed Oil and Gas Lease Sale 88. U.S. Dept. Commerce, NOAA, NMFS.

Murphy, E.C., R.H. Day, K.L. Oakley, A.A. Hoover. 1984. Dietary changes and poor reproductive performances in glaucous-winged gulls. Auk 101: 532-541.

Naumenko, E.A. 1996. Distribution, biological condition, and abundance of capelin (*Mallotus villosus socialsis)* in the BS. Pp. 237-256 *In* O.A. Mathisen and K.O. Coyle (eds.), Ecology of the BS: a review of Russian literature. Alaska Sea Grant Report No. 96-01, Alaska Sea Grant College Program, U. Alaska, Fairbanks, AK 99775-5040. 306 p.

Pahlke, K.A. 1985. Preliminary studies of capelin Mallotus villosus in Alaska waters. Alaska Dept. Fish Game, Info. Leaf. 250, 64 p.

Perez, M.A., and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fish. Bull., U.S. 84: 957-971.

Pitcher, K.W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the GOA. Fish. Bull., U.S. 78:544-549.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the EBS, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

Wespestad, V.G. 1987. Population dynamics of Pacific herring (*Clupea palasii*), capelin (*Mallotus villosus*), and other coastal pelagic fishes in the EBS. Pp. 55-60 *In* Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.

SPECIES: Capelin

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	2 to 3 weeks to hatch	na	May-August	BCH (to 10 m)	D	S, CB		5-9˚C peak spawning
Larvae	4 to 8 months?	Copepods phytoplankton	summer/fall/ winter	ICS, MCS	N, P	U NA?	U	
Juveniles	1.5+ years up to age 2	Copepods Euphausiids	all year	ICS, MCS	P	U NA?	U F? Ice edge in winter	
Adults	2 years ages 2 to 4+		spawning (May-August)	BCH (to 10 m)	D, SD	S, CB, G		
		Copepods Euphausiids polychaetes small fish	non-spawning (Sep-Apr)	ICS, MCS, OCS	P	NA?	F Ice edge in winter	-2 - 3˚C Peak distributions in EBS?

Habitat Description for Eulachon

(*osmeridae*)

Management Plan and Area BSAI

Species Representative

Eulachon, candlefish *(Thaleichthys pacificus*)

Life History and General Distribution

Eulachon is a short-lived anadromous, pelagic schooling fish distributed from the Pribilof Islands in the EBS, throughout the GOA, and south to California. They are consistently found pelagically in Shelikof Strait (hydroacoustic surveys in late winter and spring) and between Unimak Island and the Pribilof Islands (bycatch in groundfish trawl fisheries) from the middle shelf to over the slope. In the North Pacific, eulachon grow to a maximum of 23 cm and 5 years of age. They spawn at ages 3 to 5 in spring and early summer (April to June) when about 14 to 20 cm in rivers on coarse sandy bottom. Age at 50 percent maturity is 3 years. Fecundity is ~25,000 eggs per female. Eggs adhere to sand grains and other substrates on river bottom. Eggs hatch in 30 to 40 days in BC at 4 to 7ºC. Most eulachon die after first spawning. Larvae drift out of rivers and develop at sea. Smelts are captured during trawl surveys, but their patchy distribution, both in space and time, reduces the validity of biomass estimates.

Fishery

Eulachon are not a target species in groundfish fisheries of the BSAI or GOA, but they are caught as bycatch (up to several hundred tons per year in the 1990s) principally in midwater pollock fisheries in Shelikof Strait (GOA), on the east side of Kodiak (GOA), and between the Pribilof Islands and Unimak Island on the outer continental shelf and slope (EBS); almost all are discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Eulachon may be important prey for marine birds and mammals, as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep-diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance, and juvenile pollock (Hunt et al. 1981a, Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, and beluga whales) feed on smelts, which may provide an important seasonal food source near the ice edge in winter and as they assemble nearshore in spring to spawn (Frost and Lowry 1987, Wespestad 1987). Smelts also comprise significant portions of the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon throughout the North Pacific Ocean and the BS (Allen 1987, Yang 1993, Livingston, in prep.).

Approximate Upper Size Limit of Juvenile Fish (in cm): 14 cm

Habitat and Biological Associations

Egg/Spawning: Anadromous; return to spawn in spring (May and June) in rivers; demersal eggs adhere to bottom substrate (sand, cobble, etc.). Hatching occurs in 30 to 40 days.

Larvae: After hatching, 5 to 7 mm larvae drift out of river and develop pelagically in coastal marine waters; centers of distribution are unknown.

Juveniles and Adults: Distributed pelagically in mid-shelf to upper slope waters (50 to 1,000 m water depth) and have been found in highest concentrations between the Pribilof Islands and Unimak Island on the outer shelf, and in Shelikof east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands, and north into the Gulf of Anadyr.

Literature

Allen, M.J. 1987. Demersal fish predators of pelagic forage fishes in the southeastern BS. Pp. 29-32 *In* Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Crawford, T.W. 1981. Vertebrate prey of *Phocoenoides dalli* (Dall's porpoise), associated with the Japanese hign seas salmon fishery in the North Pacific Ocean. M.S. Thesis, Univ. Washington, Seattle, 72 p.

Fritz, L.W., V.G. Wespestad, and J.S. Collie. 1993. Distribution and abundance trends of forage fishes in the BS and GOA. Pp. 30-44 *In* Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. AK-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Frost, K.J., and L. Lowry. 1987. Marine mammals and forage fishes in the southeastern BS. Pp. 11-18 *In* Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Hunt, G.L., Jr., B. Burgeson, and G.A. Sanger. 1981a. Feeding ecology of seabirds of the EBS. Pp 629-647 *In* D.W. Hood and J.A. Calder (eds.), The EBS Shelf: Oceanography and Resources, Vol. II. U.S. Dept. Commerce, NOAA, OCSEAP, Office of Marine Pollution Assessment, Univ. WA Press, Seattle, WA.

Hunt, G.L., Jr., Z. Eppley, B. Burgeson, and R. Squibb. 1981b. Reproductive ecology, foods and foraging areas of seabirds nesting on the Pribilof Islands, 1975-79. Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, RU-83, U.S. Dept. Commerce, NOAA, OCSEAP, Boulder, CO.

Kawakami, T. 1980. A review of sperm whale food. Sci. Rep. Whales Res. Inst. Tokyo 32: 199-218.

Livingston, P.A. Groundfish utilization of walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*) and capelin (*Mallotus villosus*) resources in the GOA. In preparation.

Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the GOA: a resource assessment for the GOA/Cook Inlet Proposed Oil and Gas Lease Sale 88. U.S. Dept. Commerce, NOAA, NMFS.

Perez, M.A., and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fish. Bull., U.S. 84: 957-971.

Pitcher, K.W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the GOA. Fish. Bull., U.S. 78: 544-549.

Sanger, G.A. 1983. Diets and food web relationships of seabirds in the GOA and adjacent marine regions. Outer Continental Shelf Environmental Assessment Program, Final Reports of Principal Investigators 45: 631-771.

Wespestad, V.G. 1987. Population dynamics of Pacific herring (*Clupea palasii*), capelin (*Mallotus villosus*), and other coastal pelagic fishes in the EBS. Pp. 55-60 *In* Forage fishes of the southeastern BS. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.

SPECIES: Eulachon (Candlefish)

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	30 to 40 days	na	April-June	Rivers, FW	D	S (CB?)		4 - 8˚C for egg development
Larvae	1 to 2 months ?	Copepods phytoplankton mysids, larvae	summer/fall	ICS ?	P?	U NA?	U	
Juveniles	2.5+ years up to age 3	Copepods Euphausiids	all year	MCS, OCS, USP	P	U NA?	U F?	
Adults	3 years ages 3 to 5+		spawning (May-June)	Rivers-FW	D	S (CB?)		
		Copepods Euphausiids	non-spawning (July-Apr)	MCS, OCS, USP	P	NA?	F?	

Habitat Description for Sculpins

(*cottidae*)

Management Plan and Area BSAI

Species Representatives:

Yellow Irish lord (*Hemilepidotus jordani)*
Red Irish lord (*Hemilepidotus hemilepidotus*)
Butterfly sculpin (*Hemilepidotus papilio*)
Bigmouth sculpin (*Hemitripterus bolini*)
Great sculpin (*Myoxocephalus polyacanthocephalus*)
Plain sculpin (*Myoxocephalus jaok*)

Life History and General Distribution

Cottidae (sculpins) is a large circumboreal family of demersal fishes inhabiting a wide range of habitats in the north Pacific Ocean and BS. Most species live in shallow water or in tidepools, but some inhabit the deeper waters (to 1,000 m) of the continental shelf and slope. Most species do not attain a large size (generally 10 to 15 cm), but those that live on the continental shelf and are caught by fisheries can be 30 to 50 cm; the cabezon is the largest sculpin and can be as long as 100 cm. Most sculpins spawn in the winter. All species lay eggs, but in some genera, fertilization is internal. The female commonly lays demersal eggs amongst rocks where they are guarded by males. Egg incubation duration is unknown; larvae were found across broad areas of the shelf and slope year-round in ichthyoplankton collections from the southeast BS and GOA. Larvae exhibit diel vertical migration (near surface at night and at depth during the day). Sculpins generally eat small invertebrates (e.g., crabs, barnacles, mussels), but fish are included in the diet of larger species; larvae eat copepods.

Yellow Irish lords: They are distributed from subtidal areas near shore to the edge of the continental shelf (down to 200 m) throughout the BS, AI, and eastward into the GOA as far as Sitka, AK; up to 40 cm in length. Twelve to 26 mm larvae collected in spring on the western GOA shelf.

Red Irish lords: They are distributed from rocky, intertidal areas to about 100 m depth on the middle continental shelf (most shallower than 50 m), from California (Monterey Bay) to Kamchatka; throughout the BS and GOA; rarely over 30 cm in length. Spawns masses of pink eggs in shallow water or intertidally. Larvae were 7 to 20 mm long in spring in the western GOA.

Butterfly sculpins: They are distributed primarily in the western north Pacific and northern BS, from Hokkaido, Japan, Sea of Okhotsk, Chukchi Sea, to southeast BS and in the AI; they are found at depths of 20 to 250 m, most frequently from 50 to 100 m.

Bigmouth sculpin: They are distributed in deeper waters offshore, between about 100 to 300 m in the BS, AI, and throughout the GOA; they are up to 70 cm in length.

Great sculpin: They are distributed from the intertidal to 200 m, but may be most common on sand and muddy/sand bottoms in moderate depths (50 to 100 m); up to 80 cm in length. They are found throughout the BS, AI, and GOA, but may be less common east of Prince William Sound. *Myoxocephalus* spp. larvae ranged in length from 9 to 16 mm in spring ichthyoplankton collections in the western GOA.

Plain sculpin: They are distributed throughout the BS and GOA (not common in the AI) from intertidal areas to depths of about 100 m, but most common in shallow waters (<50 m); up to 50 cm in length. *Myoxocephalus* spp. larvae ranged in length from 9 to 16 mm in spring ichthyoplankton collections in the western GOA.

Fishery

Sculpin are not a target of groundfish fisheries of BSAI or GOA, but sculpin bycatch (second to skates in weight amongst the other species) has ranged from 6,000 to 11,000 mt per year in the BSAI from 1992 to 1995, and 500 to 1,400 mt per year in the GOA. Bycatch occurs principally in bottom trawl fisheries for flatfish, Pacific cod, and pollock, but also while longlining for Pacific cod; almost all is discarded. Annual sculpin bycatch in the BSAI ranges between 1 and 4 percent of annual survey biomass estimates; however, little is known of the species distribution of the bycatch.

Relevant Trophic Information

Sculpin feed on bottom invertebrates (e.g., crabs, barnacles, mussels, and other molluscs); larger species eat fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown

Habitat and Biological Associations

Egg/Spawning: Lay demersal eggs in nests guarded by males; many species in rocky shallow waters near shore.

Larvae: Distributed pelagically and in neuston across broad areas of shelf and slope, but predominantly on inner and middle shelf; have been found year-round.

Juveniles and Adults: Sculpins are demersal fish and live in a broad range of habitats from rocky intertidal pools to muddy bottoms of the continental shelf and in rocky, upper slope areas. Most commercial bycatch occurs on middle and outer shelf areas used by bottom trawlers for Pacific cod and flatfish.

Additional Information Sources

Sarah Gaichas, NMFS, Alaska Fisheries Science Center.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western GOA during spring. Fishery Bulletin 93: 231-253.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dept. Commerce, NOAA Tech. Rpt. NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the EBS, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

SPECIES: Sculpins

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	na	winter?	BCH, ICS (MSC, OSC?)	D	R (others?)	U	
Larvae	U	copepods	all year?	ICS, MSC, OCS, US	N, P	na?	U	
Juveniles and Adults	U	bottom invertebrates (crabs, molluscs, barnacles) and small fish	all year	BCH, ICS, MSC, OSC, US	D	R, S, M, SM	U	

Habitat Description for Sharks

Management Plan and Area BSAI

Species Representatives:

Lamnidae: Salmon shark (*Lamna ditropis*)
Squalidae: Sleeper shark (*Somniosus pacificus*)
Spiny dogfish (*Squalus acanthias*)

Life History and General Distribution

Sharks of the order Squaliformes (which includes the two families Lamnidae and Squalidae) are the higher sharks with five gill slits and two dorsal fins. The Lamnidae are large, ovoviviparous (with small litters, 1 to 4; embryos nourished by intrauterine cannibalism), widely migrating sharks which are highly aggressive predators (salmon and white sharks). The Lamnidae are partly warm-blooded; the heavy trunk muscles are warmer than water for greater power and efficiency. Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the GOA (where they occur all year and are probably most abundant in Alaska waters), the BS, and off Japan. In groundfish fishery and survey data, they occur chiefly on outer shelf/upper slope areas in the BS, but near the coast to the outer shelf in the GOA, particularly near Kodiak Island. They are not commonly seen in AI. They are believed to eat primarily fish, including salmon, sculpins, and gadids and can be up to 3 m in length.

The Pacific sleeper shark is distributed from California around the Pacific rim to Japan and in the BS principally on the outer shelf and upper slope (but has been observed nearshore), generally demersal (but also seen near surface). Other members of the Squalidae are ovoviviparous, but fertilization and development of sleeper sharks are not known; adults are up to 8 m in length. They are voracious, omnivorous predators of flatfish, cephalopods, rockfish, crabs, seals, and salmon; they may also prey on pinnipeds. In groundfish fishery and survey data, they occur chiefly on outer shelf/upper slope areas in the BS, but near coast to the outer shelf in the GOA, particularly near Kodiak Island.

Spiny dogfish (or closely related species?) are widely distributed through the Atlantic, Pacific, and Indian Oceans. In the north Pacific, they may be most abundant in the GOA, but are also common in the BS. They are pelagic species and are found at surface and to depths of 700 m; they are found at mostly 200 m or less on shelf and neritic; they are often found in aggregations. They are ovoviviparous, with litter size proportional to size of female, from 2 to 9; gestation may be 22 to 24 months. Young are 24 to 30 cm at birth, with growth initially rapid, then it slows dramatically. Maximum adult size is about 1.6 m and 10 kg; maximum age is about 40 years. Fifty percent of females are mature at 94 cm and 29 years old; males are mature at 72 cm and 19 years old. Females give birth in shallow coastal waters, usually from September to January. Dogfish eat a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus). Tagging experiments indicate local indigenous populations in some areas and widely migrating groups in others. They may move inshore in summer and offshore in winter.

Fishery

Sharks are not a target of groundfish fisheries of BSAI or GOA, but shark bycatch has ranged from 300 to 700 mt per year in the BSAI from 1992 to 1995; 500 to 1,400 mt per year in the GOA principally by pelagic trawl fishery for pollock, longline fisheries for Pacific cod and sablefish, and bottom trawl fisheries for pollock, flatfish, and cod; almost all are discarded. Little is known of shark biomass in BSAI or GOA.

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown for salmon sharks and sleeper sharks; for spiny dogfish: 94 cm for females, 72 cm for males.

Habitat and Biological Associations

Egg/Spawning: Salmon sharks and spiny dogfish are ovoviviparous; reproductive strategy of sleeper sharks is not known. Spiny dogfish give birth in shallow coastal waters, while salmon sharks probably give birth offshore and pelagic.

Juveniles and Adults: Spiny dogfish are widely dispersed throughout the water column on shelf in the GOA, and along outer shelf in the EBS; they are apparently not as commonly found in the AI and are not commonly found at depths >200 m.

Salmon sharks are found throughout the GOA, but are less common in the EBS and AI; they are epipelagic and are found primarily over shelf/slope waters in the GOA and outer shelf in the EBS.

Sleeper sharks are widely dispersed on shelf/upper slope in the GOA and along the outer shelf/upper slope only in the EBS; they are generally demersal and may be less commonly found in the AI.

Additional Information Sources

Sarah Gaichas, NMFS, Alaska Fisheries Science Center.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

SPECIES: Sharks

Life Stage	**Duration or Age**	**Diet/Prey**	**Season-Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs								
Larvae								
Juveniles and Adults								
Salmon shark	U	fish (salmon, sculpins and gadids)	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	P	NA	U	
Sleeper shark	U	omnivorous; flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	D	U	U	
Spiny dogfish	40 years	fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus)	all year	ICS, MSC, OCS in GOA; OCS in BSAI give birth ICS in fall/winter?	P	U	U	Euhaline 4-16˚C

Habitat Description for Skates

(*Rajidae*)

Management Plan and Area BSAI

Species Representatives:

Alaska skate (*Bathyraja parmifera*)
Aleutian skate (*Bathyraja aleutica*)
Bering skate (*Bathyraja interrupta*)

Life History and General Distribution:

Skates (*Rajidae*) that occur in the BSAI and GOA are grouped into two genera: *Bathyraja* sp., or soft-nosed species (rostral cartilage slender and snout soft and flexible), and *Raja* sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). Skates are oviparous; fertilization is internal, and eggs (one to five or more in each case) are deposited in horny cases for incubation. Adults and juveniles are demersal, and feed on bottom invertebrates and fish. Adult distributions from survey are Alaska skate: mostly 50 to 200 m on shelf in EBS and AI, less common in the GOA; Aleutian skate: throughout EBS and AI, but less common in GOA, mostly 100 to 350 m; Bering skate: throughout EBS and GOA, less common in AI, mostly 100 to 350 m. Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. BSAI skate biomass estimate more than doubled between 1982 to 1996 from bottom trawl survey; it may have decreased in the GOA and remained stable in the AI in the 1980s.

Fishery

Skates are not a target of groundfish fisheries of BSAI or GOA, but they are caught as bycatch (13,000 to 17,000 mt per year in the BSAI from 1992 to 1995; 1,000 to 2,000 mt per year in the GOA) principally by the longline Pacific cod and bottom trawl pollock and flatfish fisheries; almost all are discarded. Skate bycatches in the EBS groundfisheries ranged between 1 and 4 percent of the annual EBS trawl survey biomass estimates in 1992 to 1995.

Relevant Trophic Information

Skates feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown

Habitat and Biological Associations

<u>*Egg/Spawning*</u>: Deposit eggs in horny cases on shelf and slope.

<u>*Juveniles and Adults*</u>: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown. Adults are found across wide areas of shelf and slope; surveys found most skates at depths <500 m in the GOA and EBS, but >500 m in the AI. In the GOA, most skates found between 4 to 7ºC, but data are limited.

Additional Information Sources

NMFS, Alaska Fisheries Science Center, Sarah Gaichas.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS 66, 151 p.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Teshima, K., and T.K. Wilderbuer. 1990. Distribution and abundance of skates in the EBS, AI region, and the GOA. Pp. 257-267 *in* H.L. Pratt, Jr., S.H. Gruber, and T. Taniuchi (eds.), Elasmobranchs as living resources: advances in the biology, ecology, systematics and the status of the fisheries. U.S. Dept. Commerce, NOAA Technical Report 90.

SPECIES: Skates

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	U	na	U	MCS, OCS, USP	D	U	U	
Larvae	na	na	na	na	na	na	na	
Juveniles	U	Invertebrates small fish	all year	MCS, OCS, USP	D	U	U	
Adults	U	Invertebrates small fish	all year	MCS, OCS, USP	D	U	U	

Habitat Description for Squid

(*Cephalopoda*, *Teuthida*)

Management Plan and Area BSAI

Species Representatives:

Gonaditae: Red or magistrate armhook squid (*Berryteuthis magister*)
Onychoteuthidae:
  Boreal clubhook squid (*Onychoteuthis banksii borealjaponicus)*
  Giant or robust clubhook squid (*Moroteuthis robusta*)
Sepiolidae: eastern Pacific bobtail squid (*Rossia pacifica*)

Life History and General Distribution

Squid are members of the molluscan class *Cephalopoda*, along with octopus, cuttlefish, and nautiloids. In the BSAI and GOA, gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities >30 ppt. Fertilization is internal, and development is direct ("larval" stages are only small versions of adults). The eggs of inshore neritic species are often enveloped in a gelatinous matrix attached to rocks, shells, or other hard substrates, while the eggs of some offshore oceanic species are extruded as large, sausage-shaped drifting masses. Little is known of the seasonality of reproduction, but most species probably breed in spring-early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2 to 3 years, but the giant *Moroteuthis robusta* clearly lives longer.

B magister is widely distributed in the boreal north Pacific from California, throughout the BS, to Japan in waters 30 to 1,500 m deep; adults are most often found at mesopelagic depths or near bottom on shelf, rising to the surface at night; juveniles are widely distributed across shelf, slope, and abyssal waters in meso- and epipelagic zones, and they rise to the surface at night. They migrate seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. Maximum size for females is 50 cm mantle length (ML); for males, maximum size is 40 cm ML. Spermatophores are transferred into the mantle cavity of the female, and eggs are laid on the bottom on the upper slope (200 to 800 m). Fecundity is estimated at 10,000 eggs/female. Spawning of eggs occurs from February to March in Japan, but apparently year-round in the BS. Eggs hatch after 1 to 2 months of incubation; development is direct. Adults are gregarious prior to and most die after mating.

O. banksii borealjaponicus, an active, epipelagic species, is distributed in the north Pacific from the Sea of Japan, throughout the AI and south to California, but is absent from the Sea of Okhotsk and is not common in the BS. Juveniles can be found over shelf waters at all depths and near shore. Adults apparently prefer the upper layers over slope and abyssal waters; they are diel migrators and gregarious. Development includes a larval stage; maximum size is about 55 cm.

M. robusta, a giant squid, lives near the bottom on the slope and mesopelagically over abyssal waters; it is rare on the shelf. It is distributed in all oceans and is found in the BS, AI, and GOA. Mantle length can be up to 2.5 m long, with tentacles, at least 7 m, but most are about 2 m long.

R. pacifica is a small (maximum length with tentacles of less than 20 cm) demersal, neritic and shelf, boreal species, distributed from Japan to California in the North Pacific and in the BS in waters of about 20 to 300 m depth. Other *Rossia* spp. deposit demersal egg masses.

Fishery

Squid are not currently a target of groundfish fisheries of BSAI or GOA. A Japanese fishery catching up to 9,000 mt of squid annually existed until the early 1980s for *B. magister* in the BS and *O. banksii borealjaponicus* in the AI. Since 1990, annual squid bycatch has been about 1,000 mt or less in the BSAI and between 30 to 150 mt in the GOA; in the BSAI, almost all squid bycatch is in the midwater pollock fishery near the continental shelf break and slope, while in the GOA, trawl fisheries for rockfish and pollock (again mostly near the edge of the shelf and on the upper slope) catch most of the squid bycatch.

Relevant Trophic Information

The principal prey items of squid are small forage fish pelagic crustaceans (e.g., euphausiids and shrimp) and other cephalopods; cannibalism is not uncommon. After hatching, small planktonic zooplankton (copepods) are eaten. Squid are preyed upon by marine mammals, seabirds, and, to a lesser extent by fish, and they occupy an important role in marine food webs worldwide. Perez (1990) estimated that squids comprise over 80 percent of the diets of sperm whales, bottlenose whales, and beaked whales and about half of the diet of Dall's porpoise in the EBS and AI. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break (e.g., Buldir Island, Pribilof Islands) are also known to feed heavily on squid (Hatch et al. 1990, Byrd et al. 1992, Springer 1993). In the GOA, only about 5 percent or less of the diets of most groundfish consisted of squid (Yang 1993). However, squid play a larger role in the diet of salmon (Livingston and Goiney 1983).

Approximate Upper Size Limit of Juvenile Fish (in cm): For *B. magister*, approximately 20 cm ML for males, 25 cm ML for females; both at approximately 1 year of age.

Habitat Narrative for *B. magister*

Egg/Spawning: Eggs are laid on the bottom on the upper slope (200 to 800 m); incubate for 1 to 2 months.

Young Juveniles: Distributed epipelagically (top 100 m) from the coast to open ocean.

Old Juveniles and Adults: Distributed mesopelagically (most from 150 to 500 m) on the shelf (summer only?), but mostly in outer shelf/slope waters (to lesser extent over the open ocean). They migrate to slope waters to mate and spawn demersally.

Additional Information Sources

NMFS, Alaska Fisheries Science Center, Sarah Gaichas
NMFS, Alaska Fisheries Science Center, Beth Sinclair

Literature

Arkhipkin, A.I., V.A. Bizikov, V.V. Krylov, and K.N. Nesis. 1996. Distribution, stock structure, and growth of the squid *Berryteuthis magister* (Berry, 1913) (Cephalopoda, Gonatidae) during summer and fall in the western BS. Fish. Bull. 94: 1-30.

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the AI, Alaska, after a ban on salmon driftnets. U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, AI Unit, PSC 486, Box 5251, FPO AP 96506-5251, Adak, Alaska.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK.

Hatch, S.A., G.V. Byrd, D.B. Irons, and G.L. Hunt, Jr. 1990. Status and ecology of kittiwakes in the North Pacific. Proc. Pacific Seabird Group Symposium, Victoria, B.C., 21-25 February 1990.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS F/NWC-54, 81 p.

Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, USA. 351 pp.

Perez, M. 1990. Review of marine mammal population and prey information for BS ecosystem studies. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS F/NWC-186, 81 p.

Sobolevsky, Ye.I. 1996. Species composition and distribution of squids in the western BS. Pp. 135-141 *In* O.A. Mathisen and K.O.Coyle (eds.), Ecology of the BS: a review of Russian literature. Alaska Sea Grant Rept 96-01, U. Alaska, Fairbanks, AK 99775.

Springer, A. 1993. Report of the seabird working group. pp. 14-29 *In* Is it food? Addressing marine mammal and seabird declines: a workshop summary. Alaska Sea Grant Report 93-01, Univ. Alaska, Fairbanks, AK, 99775.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

SPECIES: *Berryteuthis magister* (Red Squid)

Life Stage	**Duration or Age**	**Diet/Prey**	**Season-Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	1 to 2 months	NA	varies	USP, LSP	D	M, SM, MS	U	
Young juveniles	4 to 6 months	zooplankton		All shelf, slope, BSN	P, N	NA	UP, F?	
Older Juveniles and Adults	1 to 2 years (may be up to 4 years)	euphausiids, shrimp, small forage fish, and other cephalopods	summer	All shelf, USP, LSP, BSN	SP	U	UP, F?	Euhaline waters, 2-4˚C
			winter		SP	U	UP, F?	

Habitat Description for Octopus

Management Plan and Area GOA

Species Representatives:

Octopoda: Octopus *(Octopus gilbertianus; O. dofleini*)
Vampyromorpha: Pelagic octopus (*Vampyroteuthis infernalis*)

Life History and General Distribution:

Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish, and nautiloids. In the BSAI and GOA, the most commonly encountered octopods are the shelf demersal species *O. gilbertianus* and *O. dofleini*, and the bathypelagic finned species, *V. infernalis*. Octopods, like other cephalopods are dioecious, with fertilization of eggs (usually within the mantle cavity of the female) requiring transfer of spermatophores during copulation. Octopods probably do not live longer than about 2 to 4 years, and females of some species (e.g., *O. vulgaris*) die after brooding their eggs on the bottom.

O. gilbertianus is a medium-size octopus (up to 2 m in total length) distributed across the shelf (to 500 m depth) in the eastern and western BS (where it is the most common octopus), AI, and GOA (endemic to the North Pacific). Little is known of its reproductive or trophic ecology, but eggs are laid on the bottom and tended by females. It lives mainly among rocks and stones.

O. dofleini is a giant octopus (up to 10 m in total length, though mostly about 3 to 5 m) distributed in the southern boreal region from Japan and Korea, through the AI, Gulf Alaska, and south along the Pacific coast of North America to California. Inhabits the sublittoral to upper slope. Egg length is 6 to 8 mm, and they are laid on bottom. Copulation may occur in late fall-winter, but oviposition is the following spring; each female lays several hundred eggs.

V. infernalis is a relatively small (up to about 40 cm total length) bathypelagic species, living at depths well below the thermocline; they may be most commonly found at 700 to 1,500 m. They are found throughout the world's oceans. Eggs are large (3 to 4 mm in diameter) and are shed singly into the water. Hatched juveniles resemble adults, but with different fin arrangements, which change to the adult form with development. Little is known of their food habits, longevity, or abundance.

Fishery

Octopus are not currently a target of groundfish fisheries of BSAI or GOA. Bycatch has ranged between 200 to 1,000 mt in the BSAI and 40 to 100 mt in the GOA, chiefly in the pot fishery for Pacific cod and bottom trawl fisheries for cod and flatfish, but sometimes in the pelagic trawl pollock fishery. Directed octopus landings have been less than 8 mt/year from 1988 to 1995. Age/size at 50 percent recruitment is unknown. Most of the bycatch occurs on the outer continental shelf (100 to 200 m depth), chiefly north of the Alaska Peninsula from Unimak Island. To Port Moller and northwest to the Pribilof Islands; also around Kodiak Island and many of the AI.

Relevant Trophic Information

Octopus are eaten by pinnipeds (principally Steller sea lions, and spotted, bearded, and harbor seals) and a variety of fishes, including Pacific halibut and Pacific cod (Yang 1993). When small, octopods eat planktonic and small benthic crustaceans (mysids, amphipods, copepods). As adults, octopus eat benthic crustaceans (crabs) and molluscs (clams).

Approximate Upper Size Limit of Juvenile Fish (in cm): Unknown

Habitat Narrative for *Octopus* spp.:

Egg/Spawning: Occurs on shelf; eggs are laid on bottom, maybe preferentially among rocks and cobble.

Young Juveniles: Are semi-demersal; are widely dispersed on shelf, upper slope.

Old Juveniles and Adults: Are demersal; are widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud.

Additional Information Source

NMFS, Alaska Fisheries Science Center, Sarah Gaichas.

Literature

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, USA. 351 pp.

Perez, M. 1990. Review of marine mammal population and prey information for BS ecosystem studies. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS F/NWC-186, 81 p.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

SPECIES: ***Octopus dofleini*****,** ***O.gilbertianus***

Life Stage	**Duration or Age**	**Diet/Prey**	**Season-Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	U (1-2 months?)	NA	spring-summer?	U, ICS, MCS	D	R, G?	U	Euhaline waters
Young juveniles	U	zooplankton	summer-fall?	U, ICS, MCS, OCS, USP	D, SD	U	U	Euhaline waters
Older Juveniles and Adults	U (2 to 3 years? for *O. gilbertianus*; older for *O.dofleini*)	crustaceans, molluscs	all year	ICS, MCS, OCS, USP	D	R, G, S, MS?	U	Euhaline waters

APPENDIX F.3
ESSENTIAL FISH HABITAT ASSESSMENT REPORT for the Bering Sea and Aleutian Islands King and Tanner Crabs

April 2005

NOAA Fisheries
NMFS Alaska Region
709 West 9th Street
Juneau, AK 99802

NOAA Fisheries
National Marine Fisheries Service

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Introduction

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to require the description and identification of Essential Fish Habitat (EFH) in Fishery Management Plans (FMPs), adverse impacts on EFH, and actions to conserve and enhance EFH. National Marine Fisheries Service (NMFS) developed guidelines to assist Fishery Management Councils in fulfilling the requirements set forth by the Act.

Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

With respect to type, the information available for almost all species is primarily broad geographic distributions based on specific samples from surveys and fisheries, which have not been linked with habitat characteristics. Furthermore, NMFS' ability to precisely define the habitat (and its location) of each life stage of each managed groundfish species in terms of its oceanographic (temperature, salinity, nutrient, current), trophic (presence of food, absence of predators), and physical (depth, substrate, latitude, and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions for each species and life stage is restricted primarily to their position in the water column (e.g., demersal, pelagic), broad biogeographic and bathymetric areas (e.g., 100 to 200 meter [m] zone, south of the Pribilof Islands and throughout the Aleutian Islands [AI]) and occasional references to known bottom types associations.

Identification of EFH for some species included historical range information. Traditional knowledge and sampling data have indicated that fish distributions may contract and expand due to a variety of factors including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution.

Background

In preparation of the 1999 EFH Environmental Assessment, EFH Technical Teams, consisting of scientific stock assessment authors, compiled scientific information and prepared the 1999 Habitat Assessment Reports. These reports provided the scientific information baseline to describe EFH. Recent scientific evidence has not proved to change existing life history profiles of the federally managed species. However, where new information does exist, new data help fill information gaps in the region's limited habitat data environment.

Stock assessment authors used information contained in these summaries and personal knowledge, along with data contained in reference atlases (NOAA 1987, 1990; Council 1997a,b), fishery and survey data (Allen and Smith 1988, Wolotira et al. 1993, NOAA 1998), and fish identification books (Hart 1973, Eschmeyer and Herald 1983, Mecklenburg and Thorsteinson 2002), to describe EFH for each life stage using best scientific judgment and interpretation; see Table 1.

Species Profiles and Habitat Descriptions

FMPs must describe EFH in text, map EFH distributions, and include tables, which provide information on habitat and biological requirements for each life history stage of the species; see Tables 2 to 4. Information contained in this report details life history information for federally managed fish species. This collection of scientific information is interpreted, then referenced to describe and delineate EFH for each species by life history stage using the geographic information system (GIS). EFH text and map descriptions are not compiled in this report due to differences in the characteristics of a species life history and the overall distribution of the species. Specific EFH text descriptions and maps are in Appendix D.

References

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Council (North Pacific Fishery Management Council). 1997a. Essential fish habitat assessment report for the groundfish resources of the BS and AI regions. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Council. 1997b. Essential fish habitat assessment report for the groundfish resources of the GOA region. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Eschmeyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes. Houghton Mifflin Co., Boston. 336 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180. Ottawa. 740 p.

Mecklenburg, Commerce., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fish Society. Bethsda, Maryland. 1037 p.

NOAA (National Oceanic and Atmospheric Administration). 1987. Bering, Chukchi, and Beaufort Seas. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1990. West coast of North America. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1998. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the BS, AI, and GOA regions based on groundfish fishery observer data. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-88.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

General Life History Information for Crab

Shallow inshore areas (less than 50 m deep) are very important to king crab reproduction as they move onshore to molt and mate. Tanner crabs also occupy shallower depths during molting and mating. All BSAI crab are highly vulnerable to predation and damage during molting when they shed their exoskeleton. Female king crab molt annually to mate, while Tanner and snow crab exhibit terminal molt and carry sperm for future clutch fertilization. The habitat occupied by molting and mating crab differs from that occupied by mature crabs during the remainder of the year. The crab technical team noted that protection of crab in molting mating habitat during this sensitive life history stage is important.

Larval stages are distributed according to vertical swimming abilities and the currents, mixing, or stratification of the water column. Generally, the larval stages occupy the upper 30 m, often in the mixed layer near the sea surface. As the larvae molt and grow into more active swimming stages, they can seek a preferred depth. After molting through multiple larval stages, crabs settle on the bottom. Settlement on habitat with adequate shelter, food, and temperature is imperative to survival of first settling crabs. Young of the year red and blue king crabs require nearshore shallow habitat with significant cover that offers protection (e.g., sea stars, anemones, macroalgae, shell hash, cobble, shale) to this frequently molting life stage. Early juvenile stage Tanner and snow crab also occupy shallow waters and are found on mud habitat. Late Juvenile stage crabs are most active at night when they feed and molt. The crab technical team emphasized the importance of shallow areas to all early juvenile stage crabs and, in particular, the importance to red and blue king crabs of high relief habitat nearshore with extensive biogenic assemblages. The area north and adjacent to the Alaska Peninsula (Unimak Island to Port Moller), the eastern portion of Bristol Bay, and nearshore areas of the Pribilof and Saint Matthew Islands are locations known to be particularly important for king crab spawning and juvenile rearing.

Egg Stage: Female king and Tanner crab extrude eggs, carry, and nurture them outside the maternal body. The number of eggs developed by the female increases with body size and is linked to nutrition at favorable temperatures. Information on egg bearing females is used to define habitat for the egg stage of crabs.

Larval Stage: Successful hatching of king and Tanner crab larvae is a function of both temperature and concentration of diatoms, so the presence of larvae in the water column can vary. Larvae are planktonic. Their sustained horizontal swimming is inconsequential compared to horizontal advection by oceanographic conditions. Larvae vertically migrate within the water column to feed. Diel vertical migration may be a retention mechanism to transport larvae inshore.

Early Juvenile Stage: The early juvenile stage includes crabs first settling on the bottom (glacothoe and megalops), young of the year crabs, and crabs up to a size approximating age 2. Habitat relief is obligatory for red and blue king crabs of this life stage. Individuals less than 20 mm carapace length (CL) typically are distributed in nearshore waters among niches provided by sea star arms, anemones, shell hash, rocks, and other bottom relief. Early juvenile Tanner crab settle on mud and are known to occur there during summer, but are not easily found in this habitat in winter.

Late Juvenile Stage: The late juvenile stage for crab is defined as the size at about age 2 to the first size of functional maturity. Late juvenile crabs typically are found further offshore in cooler water than early juvenile crabs. Smaller red king crabs of this life stage form pods during the day that break apart during the night when the crabs forage and molt. As these crabs increase in size, podding behavior declines, and the animals are found to forage throughout the day.

Mature Stage: Mature crabs are defined as those crabs of a size that is functionally mature. Functional maturity is based on size observed in mating pairs of crabs. This maturity definition differs from morphometric maturity based on chela height and physiological maturity when sperm or eggs can be produced. The mature stage includes crabs from the first size of functional maturity to senescence.

Table 1. Summary Table of Major References and Atlases

	References					
Species	NOAA 1988	Epifanio 1988	NOAA 1990	Wolotira et al. 1993	Council Witherell 1996	Tyler and Kruse 1996;1997
Red king crab	X	X	X	X	X	X
Blue king crab	X	X	X	X	X	X
Golden king crab	X	X	X	X	X	X
Tanner crab	X	X	X	X	X	X
Snow crab	X	X	X		X	X

Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.

Location

ICS = inner continental shelf (1-50 m)
MCS = middle continental shelf (50-100 m)
OCS = outer continental shelf (100-200 m)
USP = upper slope (200-1000 m)
LSP = lower slope (1000-3000 m)
BSN= basin (>3000 m)

BCH = beach (intertidal)
BAY = nearshore bays, give depth if appropriate (e.g., fjords)
IP = island passes (areas of high current), give depth if appropriate

Water column

D = demersal (found on bottom)
SD/SP =semi-demersal or semi-pelagic if slightly greater or less than 50 percent on or off bottom
P = pelagic (found off bottom, not necessarily associated with a particular bottom type)
N = neustonic (found near surface)

Bottom Type

M = mud
SM = sandy mud
MS = muddy sand
S = sand
CB = cobble
G = gravel
R = rock
C = coral
K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features

UP = upwelling
G = gyres
F = fronts
E = edges
CL = thermocline or pycnocline

General

U = Unknown
N/A = not applicable

Table 2. Summary of Habitat Associations for BSAI Crab

BSAI Crab		Nearshore				Shelf			Slope						Stratum Reference							Location							Physical Oceanography					Substrate													Structure										Community Associations												hic Properties			
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic																																														
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Blue King Crab	M					x	x	x																	x											x	x								x	x			x	x	x	x		x	x			x	x	x		x			x							M
	LJ					x	x	x																	x											x	x								x	x			x	x	x	x		x	x			x	x	x		x			x							LJ
	EJ					x	x																		x																																																EJ
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	E					x	x	x																	x											x	x								x	x			x	x	x	x		x	x			x	x	x		x			x							E
Golden King Crab	M							x	x	x	x	x				x		x							x											x	x								x	x			x	x	x	x	x	x	x			x	x	x		x			x				<5	>30		M
	LJ												x	x				x							x											x	x								x	x			x	x	x	x		x	x			x	x	x		x			x				<5	>30		LJ
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	E							x	x	x	x							x							x											x	x								x	x			x	x	x	x		x	x			x	x	x		x			x				<5	>30		E
Red King Crab	M					x	x	x																	x									x	x	x	x	x	x	x	x	x	x	x														x	x	x		x			x							M
	LJ					x	x	x																	x									x	x	x	x	x	x	x	x	x	x	x														x	x	x		x			x							LJ
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	E					x	x	x																	x									x	x	x	x	x	x	x	x	x	x	x														x	x	x		x			x							E
Snow Crab	M					x	x	x																	x									x	x	x	x	x	x	x	x	x	x	x																												M
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	E					x	x	x																	x									x	x	x	x	x	x	x	x	x	x	x																												E
Tanner	M					x	x	x	x	x	x						x	x							x							x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x			x		x	x	x	x	x	x	x	x		x	x	>4	>30		M
	LJ			x	x	x	x	x	x	x								x							x						x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		LJ
	EJ				x	x	x	x	x	x								x							x									x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		EJ
	L		x	x	x	x	x																			x						x																																					>4	>30		L
	E				x	x	x	x	x	x	x	x													x							x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		E

Table 3. Summary of Reproductive Traits of BSAI Crab

		Reproductive Traits																										
BSAI Crab		Age at Maturity				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	**50%**	**100%**	**50%**	**100%**	**External**	**Internal**	**Oviparous**	**Ovoviviparous**	**Viviparous**	**Batch Spawner**	**Broadcast Spawner**	**Egg Case Deposition**	**Nest Builder**	**Egg/Young Guarder**	**Egg/Young Bearer**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Blue King Crab	M	6+			6+	X		X								X	X	X	X	X	X	X	X					
	LJ																											
	EJ																											
	L																											
	E																											
Golden King Crab	M	6+			6+	X		X								X	X	X	X	X	X	X	X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Red King Crab	M	7 to 8		7 to 10		X		X								X	X	X	X	X	X	X	X					
	LJ																											
	EJ																											
	L																											
	E																											
Snow Crab	M	5 to 6		6 to 8		X	X	X								X	X	X	X	X	X	X						
	LJ																											
	EJ																											
	L																											
	E																											
Tanner Crab	M	5 to 6		6 to 8		X	X	X								X	X	X	X	X	X	X						
	LJ																											
	EJ																											
	L																											
	E																											

Snow and tanner crab fertilization is internal. Eggs are extruded and carried externally until hatching.
King crab fertilization and egg carrying are external.

Table 4. Summary of Predator and Prey Relationships for BSAI Crab

BSAI Crab		Predator to																														Prey of																												
Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Salmon	Cod	Pollock	Halibut		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pac fic Cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Skate	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Tererstrial Mammals
Blue King Crab	M	X				X			X			X	X			X	X	X																					X							X														
	LJ	X				X			X			X	X			X	X	X																					X							X														
	EJ																																						X							X														
	L																																																											
	E																																																											
Golden King Crab	M	X				X			X			X	X			X	X	X	X																				X							X														
	LJ	X				X			X			X	X			X	X	X																					X							X														
	EJ																																						X							X														
	L																																																											
	E																																																											
Red King Crab	M	X				X			X			X	X			X	X	X																					X							X														
	LJ	X				X			X			X	X			X	X	X																					X							X														
	EJ																																						X							X														
	L																																																											
	E																																																											
Snow Crab	M	X				X			X			X	X			X	X	X																					X																					
	J	X				X			X			X	X			X	X	X																					X			X	X		X	X														
	L																																																											
Tanner Crab	M	X				X			X			X	X			X	X	X																					X																					
	LJ	X				X			X			X	X			X	X	X																					X		X	X	X		X	X														
	EJ																																						X		X	X	X		X	X														
	L	X			X	X																										X		X		X	X	X																						
	E																																																											

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Table 4 - Diet Prey

Habitat Description for Red King Crab

(*Paralithodes camtschaticus*)

Management Plan Area BSAI

Life History and General Distribution

Red king crab (*Paralithodes camtshaticus*) is widely distributed throughout the BS and AI, GOA, Sea of Okhotsk, and along the Kamchatka shelf. Red king crab are typically at depths <100 fathoms (fm). King crab molt multiple times per year through age 3 after which molting is annual. At larger sizes, king crab may skip molt as growth slows. Females grow slower and do not get as large as males. In Bristol Bay, 50 percent maturity is attained by males at 12 cm CL and 9 cm CL by females (about 7 years). Female red king crab in the Norton Sound area reach 50 percent maturity at 6.8 cm and do not attain maximum sizes found in other areas. Size at 50 percent maturity for females in the western Aleutians is 8.9 cm CL. Natural mortality of adult red king crab is assumed to be about 18 percent per year (M=0.2), due to old age, disease, and predation.

Fishery

The red king crab fisheries are prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Mean age at recruitment is about 8 to 9 years. Two discrete populations of red king crab are actively fished in the BSAI region: Bristol Bay and Norton Sound. A third population surrounding the AI was managed separately as Adak and Dutch Harbor stocks until 1996 when the management areas were combined. The fishery on the Adak stock was closed in 1996, and the fishery on the Dutch Harbor stock has closed since the 1983 to 1984 season. These fisheries historically occurred in the winter and spring. Red king crab are allowed as bycatch during golden king crab fisheries in those areas. Other populations of red king crab are fished in the Pribilof Islands area, St. Matthew, and St. Lawrence Island area, but are managed in conjunction with the predominant blue king crab fisheries. Red king crab stocks are managed separately to accommodate different life histories and fishery characteristics. Male only red king crab >16.5 cm CL are allowed to be taken from Bristol Bay and the Pribilof and AI. The minimum size limit for harvest of male only crab from the Norton Sound and the St. Matthew and St. Lawrence Island population is 12 cm. The season in Bristol Bay begins on November 1 and generally has lasted less than 10 days in recent years. Bycatch in red king crab fisheries consists primarily of Tanner crab and nonlegal red king crab. The commercial fishery for red king crab in Norton Sound occurs in the summer, opening July 1, and a winter through-the-ice fishery opens November 15 and closes May 15.

Bottom trawls and dredges could disrupt nursery and adult feeding areas.

Relevant Trophic Information

Pacific cod is the main predator on red king crabs. Walleye pollock, yellowfin sole, and Pacific halibut are minor consumers of pelagic larvae, settling larvae, and larger crabs, respectively. Juvenile crab may be cannibalistic during molting.

Aapproximate Upper Size Limit of Juvenile Fish (in cm): The size at 50 percent maturity is 7 and 9 cm CL for female and male red king crabs, respectively, from Norton Sound and St. Matthew and

St. Lawrence Islands; it is 9 and 12 cm, respectively, for Bristol Bay and the Pribilof and Aleutian Islands.

Habitat and Biological Associations

Egg: Egg hatch of larvae is synchronized with the spring phytoplankton bloom in southeast Alaska suggesting temporal sensitivity in the transition from benthic to planktonic habitat. Also see mature phase description; eggs are carried by adult female crab.

Larvae: Red king crab larvae spend 2 to 3 months in pelagic larval stages before settling to the benthic life stage. Reverse diel migration and feeding patterns of larvae coincide with the distribution of food sources.

Early Juvenile: Early juvenile stage red king crabs are solitary and need high relief habitat or coarse substrate such as boulders, cobble, shell hash, and living substrates such as bryozoans and stalked ascidians. Young-of-the-year crabs occur at depths of 50 m or less.

Late Juvenile: Late juvenile stage red king crabs ages of 2 and 4 years exhibit decreasing reliance on habitat and a tendency for the crab to form pods consisting of thousands of crabs. Late juvenile crab associate with deeper waters and migrate to shallower water for molting and mating in the spring. Aggregation behavior continues into adulthood.

Mature: Mature red king crabs exhibit seasonal migration to shallow waters for reproduction. The remainder of the year, red king crabs are found in deeper waters. In Bristol Bay, red king crabs mate when they enter shallower waters (<50 m), generally beginning in January and continuing through June. Males grasp females just prior to female molting, after which the eggs (43,000 to 500,000 eggs) are fertilized and extruded on the female's abdomen. The female red king crab carries the eggs for 11 months before they hatch, generally in April.

Additional Information Sources

ADF&G, Dutch Harbor, AK, Larry Boyle.
ADF&G, Dutch Harbor, AK, Rance Morrison, Robert Gish.

SPECIES: Red King Crab, *Paralithodes camtschaticus*

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceanographic Features**	**Other**
Eggs	11 mo	NA	May-April	NA	NA	NA	F	
Larvae	3-5 mo	Diatoms, Phytoplankton Copepod nauplii	April-August	MCS, JCS	P	NA	F	
Juveniles	1 to 5-6 yrs	Diatoms Hydroids	All year	ICS, MCS, BCH, BAY	D	SAV (epifauna), R, CB, G	F	Found among biogenic assemblages (sea onions, tube worms, bryozoans, ascidians, sea stars)
Adults	5-6+ yrs	Mollusks, echinoderms, polychaetes, decapod, crustaceans, Algae, urchins, hydroids, sea stars	Spawning Jan-June	MCS, ICS, BAY, BCH	D	S, M, CB, G	F	

Habitat Description for Blue King Crab

(*Paralithodes platypus*)

Management Plan Area BSAI

Life History and General Distribution

Blue king crab (*Paralithodes platypus*) has a discontinuous distribution throughout its range (Hokkaido, Japan to Southeast Alaska). In the BS, discrete populations exist in the cooler waters around the Pribilof Islands, St. Matthew Island, and St. Lawrence Island. Smaller populations have been found in Herendeen Bay and around Nunivak and King Island, as well as isolated populations in the GOA. Blue king crab molt multiple times as juveniles. In the Pribilof area, 50 percent maturity of females is attained at 9.6 cm CL, which occurs at about 5 years of age. Blue king crab in the St. Matthew area mature at smaller sizes (50 percent maturity at 8.1 cm CL for females) and do not get as large overall. Skip molting occurs with increasing probability for those males larger than 10 cm CL and is more prevalent for St. Matthew Island crab. Larger female blue king crab have a biennial ovarian cycle and a 14-month embryonic period. Unlike red king crab, juvenile blue king crab do not form pods, instead relying on cryptic coloration for protection from predators. Adult male blue king crab occur at an average depth of 70 m and an average temperature of 0.6ºC.

Fishery

The blue king crab fisheries are prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Two discrete stocks of blue king crab are fished: the Pribilof Islands and the St. Matthew Island stocks. These blue king crab fisheries have occurred in September in recent years. Bycatch in the blue king crab fisheries consist almost entirely of non-legal blue king crabs. Male only crabs >16.5 cm carapace width (CW) are harvested in the Pribilof Islands, while the St. Matthew Islands fishery is managed with a minimum size limit of 140 mm.

Bottom trawls and dredges could disrupt nursery and adult feeding areas.

Relevant Trophic Information

Pacific cod is a predator on blue king crabs.

Approximate Upper Size Limit of Juvenile Fish (in cm): The size at 50 percent maturity is 9- and 12-cm CL for female and male crabs from the Pribilof Islands, and 8- and 10.5-cm CL for St. Matthew Island.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Blue king crab larvae spend 3.5 to 4 months in pelagic larval stages before settling to the benthic life stage. Larvae are found in waters between 40 to 60 m deep.

Early Juvenile: Early juvenile blue king crabs require area found in substrate characterized by gravel and cobble overlaid with shell hash and sponge, hydroid, and barnacle assemblages. These habitat areas have been found at 40 to 60 m around the Pribilof Islands.

Late Juvenile: Late juvenile blue king crab are found in nearshore rocky habitat with shell hash.

Mature: Mature blue king crabs occur most often between 45 and 75 m deep on mud-sand substrate adjacent to gravel rocky bottom. Female crabs are found in a habitat with a high percentage of shell hash. Mating occurs in mid-spring. Larger older females reproduce biennially, while small females tend to reproduce annually. Fecundity of females range from 50,000 to 200,000 eggs per female. It has been suggested that spawning may depend on the availability of nearshore rocky-cobble substrate for protection of females. Larger older crabs disperse farther offshore and are thought to migrate inshore for molting and mating.

Additional Information Sources

ADF&G, Dutch Harbor, AK, Larry Boyle.
ADF&G, Dutch Harbor, AK, Rance Morrison.

SPECIES: Blue King Crab, *Paralithodes platypus*

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	14 mo.	NA	Starting April-May	NA	NA	NA	F	
Larvae	3.5 to 4 mo.		April-July	MCS, ICS	P	NA	F	
Juveniles	to about 5 years		All year	MCS, ICS	D	CB, G, R	F	
Adults	5+ years		Spawning Feb-Jun	MCS, ICS	D	S, M, CB, G, R	F	

Habitat Description for Golden King Crab

(Lithodes aequispina)

Management Plan Area BSAI

Life History and General Distribution

Golden king crab (*Lithodes aequispina*), also called brown king crab, range from Japan to British Columbia. In the BS and AI, golden king crab are found at depths from 100 to 1,000 m, generally in high relief habitat such as inter-island passes, and they are usually slope-dwelling. Size at sexual maturity depends on latitude and ranges from 9.8 to 11 cm CL, with crabs in the northern areas maturing at smaller sizes. Females carry up to 20,000 eggs, depending on their size. The season of reproduction appears to be protracted and may be year-round.

Fishery

The golden king crab fisheries are prosecuted using mesh covered pots set on longlines to minimize gear loss. The primary fishery is in the AI, with minor catches coming from localized areas in the BS and GOA. Until 1996, the golden king crabs in the AI were managed as two separate stocks: Adak and Dutch Harbor. The fishing season opens September 1 and male crab >15.2 cm are harvested. Golden king crab are harvested in the BS under conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game. Bycatch consists almost exclusively of non-legal golden king crab. Escape rings were adopted by the Alaska Board of Fisheries in 1996 to reduce capture and handling mortality of non-target crab; a minimum of four 5.5-inch rings are required on pots used in golden king crab fisheries.

Relevant Trophic Information None

Approximate Upper Size Limit of Juvenile Fish (in cm): The size (CL) at 50 percent maturity for females and males: Aleutians 11 and 12.5 cm, Pribilofs 10 and 10.7 cm, Northern BS 9.8 and 9.2 cm.

Habitat and Biological Associations

Golden king crabs occur on hard bottom, over steep rocky slopes, and on narrow ledges. Strong currents are prevalent. Golden king crabs coexist with abundant quantities of epifauna: sponges, hydroids, coral, sea stars, bryozoans, and brittle stars.

Egg: Information is limited. See mature phase description; eggs are carried by adult female crab.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Late juvenile golden king crabs are found throughout the depth range of the species. Abundance of late juvenile crab increases with depth, and these crab are most abundant at depths >548 m.

Mature: Mature golden king crabs occur at all depths within their distribution. Males tend to congregate in somewhat shallower waters than females, and this segregation appears to be maintained throughout the year. Legal male crabs are most abundant between 274 and 639 m. Abundance of sub-legal males increases at depth >364 m. Female abundance is greatest at intermediate depths between 274 and 364 m.

Additional Information Sources

ADF&G, Dutch Harbor, AK, Larry Boyle.
ADF&G, Dutch Harbor, AK, Robert Gish.

SPECIES: Golden King Crab, *Lithodes aequispina*

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs		n/a	all year	LSP	D			
Larvae	U		all year	U	P			
Juveniles			all year		D			
Adults		Ophiuroids, sponges, plants	Spawning Feb.-Aug.	LSP BSN	D			

Habitat Description for Scarlet King Crab

(Lithodes couesi)

Management Plan Area BSAI

Life History and General Distribution

Little information is available on the biology of the scarlet king crab (*Lithodes couesi*), found in the BS and AI area. Based on data from the GOA, this species occurs in deep water, primarily on the continental slope. Spawning may be asynchronous. Females can produce up to 5,000 eggs, depending on female size.

Fishery

Scarlet king crab are harvested by longlining mesh covered pots. Directed fishing may occur only under conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game. Scarlet king crab are also taken incidentally in the golden king crab fishery.

Relevant Trophic Information None

Approximate Upper Size Limit of Juvenile Fish (in cm): The size (CL) of 50 percent maturity for female and males is 8 cm and 9.1 cm.

Habitat and Biological Associations

Scarlet king crab are associated with steep rocky outcrops and narrow ledges. Strong currents are prevalent.

Egg: Information is limited. See mature phase description; eggs are carried by adult female crab.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Information is not available.

Mature: Information is limited. Mature scarlet king crabs are caught incidentally in the golden king crab and *C. tanneri* fisheries.

Additional Information Sources

ADF&G, Dutch Harbor, AK, Larry Boyle.
ADF&G, Dutch Harbor, AK, Robert Gish.

SPECIES: Scarlet King Crab, *Lithodes couesi*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs								
Larvae								
Juveniles								
Adults								

Habitat Description for Tanner Crab

(Chionoecetes bairdi)

Management Plan and Area BSAI

Life History and General Distribution

Tanner crab (*Chionoecetes bairdi*) are distributed on the continental shelf of the North Pacific Ocean and BS from Kamchatka to Oregon. Off Alaska, Tanner crab are concentrated around the Pribilof Islands and immediately north of the Alaska Peninsula. They are found in lower abundance in the GOA. Size at 50 percent maturity, as measured by CW is 11 cm for males and 9 cm for females in the BS. The corresponding age of maturity for male Tanner crab is approximately 6 to 8 years. Mature male Tanner crabs may skip a year of molting as they attain maturity. Natural mortality of adult Tanner crab is assumed to be about 25 percent per year (M=0.3).

Fishery

The Tanner crab fisheries are prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Mean age at recruitment is 8 to 9 years. Male crab >14 cm CW may be harvested. Fisheries operate on three separate stocks: EBS, eastern AI, and western AI. The directed fishery was closed in 1996 due to low CPUE relative to pre-season expectations. The Tanner crab stocks of the AI are very small, and populations are found in only a few large bays and inlets. As such, the fisheries are limited, occurring during the winter. No commercial fishery was allowed for Tanner crabs in either the east or west AI in 1995 and 1996. The directed fishery for BS Tanner crab opens 7 days after closure of the Bristol Bay red king crab fishery. However, retention of Tanner crab is allowed during the Bristol Bay red king crab fishery that opens November 1. Bycatch in the directed fishery consists of primarily of non-legal Tanner crab and red king crab. A 3-inch maximum tunnel height opening for Tanner crab pots is required to inhibit the bycatch of red king crab. Also, escape rings are required to reduce capture and handling mortality of all non-target crab; a minimum of four 5-inch rings are required on pots used in Tanner crab fisheries.

Bottom trawls and dredges could disrupt nursery and adult feeding areas.

Relevant Trophic Information

Pacific cod is the main predator on Tanner crabs in terms of biomass. Predators consume primarily age 0 and 1 juvenile Tanner crab with a less than 7-cm CW. However, flathead sole, rock sole, halibut, skates, and yellowfin sole are important in terms of numbers of small crab. Larval predators include salmon, herring, jellyfish, and chaetognaths. Cannibalism has been observed in laboratory environments among juvenile crabs during molting.

Approximate Upper Size Limit of Juvenile Fish (in cm): The size at 50 percent maturity is 9- and 11-cm CW for female and male crabs.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Larvae of *C. bairdi* Tanner crabs are typically found in the BSAI water column from 0 to 100 m in early summer. They are strong swimmers and perform diel migrations in the water column (down at night). They usually stay near the depth of the chlorophyll maximum during the day. The last larval stage settles onto the bottom mud.

Early Juvenile: Early juvenile *C. bairdi* Tanner crabs occur at depths of 10 to 20 m in mud habitat in summer and are known to burrow or associate with many types of cover. Early juvenile *C. bairdi* Tanner crabs are not easily found in winter.

Late Juvenile: The preferred habitat for late juvenile *C. bairdi* Tanner crabs is mud. Late juvenile Tanner crab migrate offshore of their early juvenile nursery habitat.

Mature: Mature *C. bairdi* Tanner crabs migrate inshore, and mating is known to occur from February through June. Mature female *C. bairdi* Tanner crabs have been observed in high density mating aggregations, or pods, consisting of hundreds of crabs per mound. These mounds may provide protection from predators and also attract males for mating. Mating need not occur every year, as female *C. bairdi* Tanner crabs can retain viable sperm in spermathecae up to 2 years or more. Females carry clutches of 50,000 to 400,000 eggs and nurture the embryos for 1 year after fertilization. Primiparous females may carry the fertilized eggs for as long as 1.5 years. Brooding occurs in 100 to 150 m depths.

Additional Information Sources

ADF&G, Dutch Harbor, AK, Larry Boyle.
ADF&G, Kodiak, AK, Al Spalinger.

SPECIES: Tanner Crab, *Chionoecetes bairdi*

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	1 year	NA	April-March	NA	NA	NA	F	
Larvae	2 to 7 mo.	Diatoms Algae Zooplankton	Summer	MCS, ICS	P	NA	F	
Juveniles	1 to 6 years	Crustaceans polychaetes mollusks diatoms algae hydroids	All year	MCS, ICS, BAY, BCH	D	M	F	
Adults	6+ years	Polychaetes crustaceans mollusks hydroids alsae diatoms	Spawning Jan. To June (peak April-May)	MCS, ICS	D	M	F	

Habitat Description for Snow Crab

(Chionoecetes opilio)

Management Plan and Area BSAI

Life History and General Distribution

Snow crabs (*Chionoecetes opilio*) are distributed on the continental shelf of the BS, Chukchi Sea, and in the western Atlantic Ocean as far south as Maine. Snow crab are not present in the GOA. In the BS, snow crabs are common at depths less than 200 m. The EBS population within U.S. waters is managed as a single stock; however, the distribution of the population extends into Russian waters to an unknown degree. While 50 percent of the females are mature at 5-cm CW, the mean size of mature females varies from year to year over a range of 6.3- to 7.2-cm CW. Females cease growing with a terminal molt upon reaching maturity and rarely exceed 8 cm CW. The median size of maturity for males is about 8.5-cm CW (approximately 6 to 8 years old). Males larger than 6 cm grow at about 2 cm per molt, up to an estimated maximum size of 14.5-cm CW, but individual growth rates vary widely. Natural mortality of adult snow crab is assumed to be about 25 percent per year (M=0.3).

Fishery

The snow crab fishery is prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Male only crab greater than 7.8-cm CW may be harvested; however, a market minimum size of about 10.2 cm CW is generally observed. Most male snow crab probably enter the fishery at around age 6 to 8 years. Snow crab are probably one stock in the BS. The season opening date is January 15. A 3-inch maximum tunnel height opening for snow crab pots is required to inhibit the bycatch of red king crab. A minimum of four 3.75-inch escape rings are required on snow crab pots to reduce capture and handling mortality of non-target crab. Bycatch in the snow crab fishery consists primarily of *C. bairdi* and non-legal *C. opilio*.

Bottom trawls and dredges could disrupt nursery and adult feeding areas.

Relevant Trophic Information

Pacific cod, sculpins, skates, and halibut are the main predators on snow crabs in terms of biomass. Snow crabs less than 7-cm CW are most commonly consumed. Other predators include yellowfin sole, flathead sole, Alaska plaice, walleye pollock, rock sole, bearded seals, and walrus. Juvenile snow crabs have been observed to be cannibalistic during molting in laboratory environments.

Approximate Upper Size Limit of Juvenile Fish (in cm): The size at 50 percent maturity is 5- and 8.5-cm CW for female and male crabs, respectively.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Larvae of *C. opilio* snow crab are found in early summer and exhibit diel migration. The last of three larval stages settles onto bottom in nursery areas.

Early Juvenile: Shallow water areas of the EBS are considered nursery areas for *C. opilio* snow crabs and are confined to the mid-shelf area due to the thermal limits of early and late juvenile life stages.

Late Juvenile: A geographic cline in size of *C. opilio* snow crabs indicates that a large number of morphometrically immature crabs occur in shallow waters less than 80 m.

Mature: Female *C. opilio* snow crabs are acknowledged to attain terminal molt status at maturity. Primiparous female snow crabs mate January through June and may exhibit longer egg development period and lower fecundity than multiparous female crabs. Multiparous female snow crabs can store spermatophores in seminal vesicles and fertilize subsequent egg clutches without mating. At least two clutches can be fertilized from stored spermatophores, but the frequency of this occurring in nature is not known. Females carry clutches of approximately 36,000 eggs and nurture the embryos for approximately 1 year after fertilization. However, fecundity may decrease up to 50 percent between the time of egg extrusion and hatching, presumably due to predation, parasitism, abrasion, or decay of unfertilized eggs. Brooding probably occurs in depths greater than 50 m.

Additional Information Sources

ADF&G, Dutch Harbor, AK, Rance Morrison.
ADF&G, Dutch Harbor, AK, Larry Boyle.

SPECIES: Snow Crab, *Chionoecetes opilio*

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	1 year	NA		NA	NA	NA	F	
Larvae	2 to 7 mo.	Diatoms algae zooplankton	Spring, summer	ICS, MCS	P	NA	F	
Juveniles	1 to 4 years	Crustaceans polychaetes mollusks diatoms algae hydroids	All year	ICS, MCS, OCS	D	M	F	
Adults	4+ years	Ploychaetes brittle stars mollusks crustaceans hydroids algae diatoms	Spawning Jan. To June (peak April-May)	ICS, MCS, OCS	D	M	F	

Habitat Description for Grooved Tanner Crab

(Chionoecetes tanneri)

Management Plan Area BSAI

Life History and General Distribution

In the eastern North Pacific Ocean, the grooved Tanner crab (*Chionoecetes tanneri*) ranges from northern Mexico to Kamchatka. Little information is available on the biology of the grooved Tanner crab. This species occurs in deep water and is not common at depths exceeding 300 m. Male and female crabs are found at similar depths. Male and female grooved Tanner crab generally reach maturity at 11.9- and 7.9-cm CW, respectively.

Fishery

Directed harvest of grooved Tanner crab has been sporadic since the first reported landings in 1988. Crabs are taken in mesh covered pots deployed on a longline. Harvest can occur only under conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game.

Relevant Trophic Information None.

Approximate Upper Size Limit of Juvenile Fish (in cm): Size at 50 percent maturity is 11.9-cm CW for males and 7.9-cm CW for females.

Habitat and Biological Associations

Egg: Information is not available.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Information is not available.

Mature: In the EBS, mature male grooved Tanner crabs may be found somewhat more shallow than mature females, but male and female crabs do not show clear segregation by depth.

Additional Information Source

ADF&G, Dutch Harbor, AK., Larry Boyle, Rance Morrison.

SPECIES: Grooved Tanner Crab, *Chionoecetes tanneri*

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs								
Larvae								
Juveniles								
Adults		Polychaetes, crustaceans, ophiuroids						

Habitat Description for Triangle Tanner Crab

Chionoecetes angulatus

Management Plan Area BSAI

Life History and General Distribution

In the eastern North Pacific Ocean, the distribution of triangle Tanner crab (*Chionoecetes angulatus*) ranges from Oregon to the Sea of Okhotsk. This species occurs on the continental slope in waters deeper than 300 m and has been reported as deep as 2,974 m in the EBS. A survey limited to a particular depth range found that mature male crabs inhabit depths around 647 m shallower than the mean depth of 748 m for female crabs. Size at 50 percent maturity for male triangle Tanner crabs is 9.1-cm CW and 5.8-cm CW for females.

Fishery

A directed fishery for triangle Tanner crab was documented for the first time in 1995. Prior to 1995, these crab had been harvested as bycatch in the *C. tanneri* fishery. Directed harvest is allowed only under the conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game. Crab are taken in mesh covered pots deployed on a longline.

Relevant Trophic Information None.

Approximate Upper Size Limit of Juvenile Fish (in cm): In the EBS, male triangle Tanner crabs reach size at 50 percent maturity at 9.1-cm CW and females at 5.8-cm CW.

Habitat and Biological Associations

Egg: Information is not available.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Information is not available.

Mature: The mean depth of mature male triangle Tanner crabs (647 m) is significantly less than for mature females (748 m), indicating some pattern of sexual segregation by depth.

Additional Information Source

ADF&G, Dutch Harbor, AK., Larry Boyle and Rance Morrison.

SPECIES: Triangle Tanner Crab, *Chionoecetes angulatus*

Life Stage	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs								
Larvae								
Juveniles								
Adults				USP LSP BSN				

References

Adams, A.E. 1979. The life history of the snow crab, *Chionoecetes opilio*: a literature review. UA Sea Grant Report 78-13, 141 p.

Alaska Department of Fish and Game. 1996. Shellfish fishing regulations of the Alaska Board of Fisheries for commercial fishing in Alaska, 1996-97 edition. Alaska Department of Fish and Game. Commercial Fisheries Management and Development Division. 146 pp.

Armstrong, D.A., J.L. Armstrong, R. Palacios, G. Williams, G.C. Jensen, and W. Pearson. 1985. Early life history of juvenile blue king crab, *Paralithodes platypus*, around the Pribilof Islands. *In:* Proceedings of the International King Crab Symposium UA Sea Grant report No. 85-12:211-230.

Balsiger, J., R. Narita, and C. Lynde. 1984. Background information for southeastern BS incidental catch studies. NWAFC Processed Report 84-07.

Blau, S.F., D. Pengilly, and D.A. Tracy. 1995. Distribution of Golden King crabs by sex, size and depth zones in the Eastern AI. *In*: International Symposium on Biology, Management, and Economics of Crabs from High Latitude Habitats. Lowell Wakefield Symposium, Univ. of Alaska Sea Grant College Program. AK-SG-96-02:167-186.

Blau. S.F. 1996. The 1995 St. Matthew Island blue king crab survey. Alaska Department of Fish and Game. Commercial Fisheries Management and Development Division. Regional Information Report No. 4K96-27. Kodiak. 36 p.

Blau. S.F., L.J. Watson, and J. Blackburn. 1996. The 1996 Norton Sound red king crab trawl survey. Alaska Department of Fish and Game. Commercial Fisheries Management and Development Division. Regional Information Report No. 4K96-54. Kodiak. 40 p.

Boyle, L., L.C. Byrne, and H. Moore. 1997. Alaska Department of Fish and Game Summary of the 1996 mandatory shellfish observer program database. Confidential. Alaska Department of Fish and Game. Commercial Fisheries Management and Development Division. Regional Information Report No. 4K97-51. Kodiak. 165 p.

Dew, C.B. 1990. Behavioral ecology of podding red king crab, *Paralithodes camtschatica*. Can. J. Fish. Aquat. Sci. 47: 1944-1958.

Elner, R.W., and P.G. Beninger. 1992. The reproductive biology of snow crab, *Chionoecetes opili*o: A synthesis of recent contributions. Amer. Zool., 32:524-533.

Feder, H.M., and S.C. Jewett. 1981. Feeding interactions in the EBS with emphasis on the benthos. Pages 1229-1262 *In:* Hood, D.W. and J.A. Calder. The EBS shelf: oceanography and resources, Vol. II. University of Washington Press, Seattle, WA.

Fritz, L.W., A. Greig, and R. Reuter. In press. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the BS, AI and GOA regions based on research trawl survey data. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-AFSC.

Fukuhara, F.M. 1985. Biology and fishery of southeastern BS red king crab (*Paralithodes* camtschatica, Tilesius). NWAFC Proc. Rpt. 85-11, 170 p.

Haflinger, K.E., and C.P. McRoy. 1983. Yellowfin sole (*Limanda aspera*) predation on three commercial crab species (*Chionoecetes opilio, C. bairdi,* and *Paralithodes camtschatica*) in the southeastern BS. Final Report to the U.S. NMFS, Contract #82-ABC-00202, Inst. Marine Science, U. Alaska, Fairbanks.

Incze, L.S., D.A. Armstrong, and S.L. Smith. 1987. Abundance of larval Tanner crabs (*Chionoecetes* spp.) in relation to adult females and regional oceanography of the southeastern BS. Can. J. Fish. Aquat. Sci. 44: 1143-1156.

INPFC. 1955. King crab research by the United States in 1955. *In* Annual Report of the International North Pacific Fisheries Commission. Vancouver, British Columbia.

Jewett, S.C., and H. M. Feder. 1981. Epifaunal invertebrates of the continental shelf of the eastern Bering and Chukchi Seas. Pages 1131-1153 *In* Hood, D.W. and J.A. Calder. The EBS shelf: oceanography and resources, Vol. II. University of Washington Press, Seattle, WA.

Kruse, G.H. 1993. Biological perspectives on crab management in Alaska. Pages 355-407 *In* Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations, Alaska Sea Grant College Program, AK-SG-93-02.

Lang, G.M., P.A. Livingston, R. Pacunski, J. Parkhurst, and M. Yang. 1991. Groundfish food habits and predation on commercially important prey species in the EBS from 1984 to 1986. NOAA Tech. Memo NMFS F/NWC-207.

Livingston, P.A., A. Ward, G.M. Lang, and M. Yang. 1993. Groundfish food habits and predation on commercially important prey species in the EBS from 1987 to 1989. NOAA Tech. Memo NMFS-AFSC-11.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC Processed Report 96-04, NMFS, U.S. Dept. Commerce, 214 p.

Lovrich, G.A., and B. Stainte-Marie. 1997. Cannibalism in the snow crab, *Chionoecetes opilio* (O. Fabricius) (Brachura: Majidae), and its potential importance to recruitment. Journal of Experimental Marine Biology and Ecology 211:225-245.

Mcbride, J., D. Fraser, and J. Reeves. 1982. Information on the distribution and biology of the golden (brown) king crab in the BS and AI Area. NWAFC Processed Report 82-02. 23 p.

McLaughlin, P.A., and J. Hebard. 1961. Stomach contents of the BS king crab. International North Pacific Fisheries Commission. Bulletin 5:5-8.

McMurray, G., A.H. Vogel, P.A. Fishman, D.A. Armstrong, and S.C. Jewett. 1984. Distribution of larval and juvenile red king crabs (*Paralithodes camtschatica*) in Bristol Bay. Final Report, Outer Continental Shelf Environmental Assessment Program, Research Unit 639.

Miyahara, T., H. Sakuda, and H. Shippen. 1962. EBS king crab investigation, 1962. Annual report 1962. International North Pacific Fisheries Commission. P. 120-123.

NOAA. 1987. Bering, Chukchi, and Beaufort Seas. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce, NOAA, NOS.

NOAA. 1990. West coast of North America. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce, NOAA, NOS.

Otto, R.S. 1981. EBS crab fisheries. In: Hood, D.W. and J.A. Calder. The EBS shelf: oceanography and resources, vol. 2:1037-66

Otto, R.S. *In press*. Assessment of the EBS snow crab, *Chionoecetes opilio*, stock under the terminal molting hypothesis. *In*: G. S. Jamieson and A. Cambell [eds.] North Pacific Symposium on Invertebrate Stock Assessment and Management. Can. Spec. Publ. Fish. and Aquatic. Sci.

Palacios, R., D.A. Armstrong, J.L. Armstrong, and G. Williams. 1985. Community analysis applied to characterization blue king crab habitat around the Pribilof Islands. *In:* Proceedings of the International King Crab Symposium UA Sea Grant report No. 85-12:193-210.

Pereyra, W.T., J.E. Reeves, and R.G. Bakkala. 1976. Demersal fish and shellfish resources of the EBS in the Baseline Year 1975. NWAFC Processed Report.

Pereyra, W.T. 1966. The bathymetric and seasonal distribution, and reproduction of adult Tanner crabs, *Chionoecetes tanneri*, Rathbun, off the northern Oregon coast. Deepsea Res. 13:1185-1205.

Reeves, J.E. 1987. Incidental crab catches associated with rock sole. NWAFC Processed Report 87-02.

Reeves, J.E. 1994. Shellfish resources. *In*: Status of living marine resources off Alaska, 1993. NOAA Tech. Memo. NMFS-AFSC-27,65-75.

Slizkin, A.G., and S.D. Bukin. 1989. Distribution, biology and abundance of blue crab, *Paralithodes platypus* in the BS. Pages 306-315 *In* Proceedings of the International Scientific Symposium on BS Fisheries. NOAA Tech. Memo NMFS F/NWC-163.

Somerton, D.A. 1981. Contribution to the life history of the deep-sea king crab, *Lithodes couesi*, in the GOA. Fish. Bull 79(2):259-69.

Somerton, D.A. 1981. Life history and population dynamics of two species of Tanner crab, *Chionoecetes bairdi* and *C. opilio*, in the EBS with implications for the management of the commercial harvest. UW dissertation, 220 p.

Somerton, D.A., and R.S. Otto. 1986. Distribution and reproductive biology of the golden king crab, *Lithodes aequispina*, in the EBS. Fish. Bull 84(3):571-84.

Somerton, D.A., and W. Donaldson. 1996. Contribution to the biology of the grooved and triangle Tanner crabs, *Chionoecetes tanneri* and *C. angulatus*, in the EBS. Fishery Bulletin

Tracy, D.A. 1995. Alaska Department of Fish and Game summary of the 1994 mandatory shellfish observer program database. ADFG Regional Information Report No. 4K95-32, 96 p.

Tyler, A.V., and G.H. Kruse. 1995. Report of the modeling workshop on year-class strength formation of red king crab. ADFG Regional Information Report No. 5J95-11, 20 p.

Tyler, A.V., and G.H. Kruse. 1997. Modeling workshop on year-class strength of Tanner crab, *Chionoecetes bairdi*. ADFG Regional Information Report No. 5J97-02, 46 p.

U.S. Department of the Interior. 1986. Outer Continental Shelf Environmental Assessment Program, Final Report of Principle Investigators, Volume 53. Mineral Management Service, OCS Study, MMS 86-0115.

Wainwright, T.C., D.A. Armstrong, H.B. Andersen, P.A. Dinnel, D.W. Herren, G.C. Jensen, J.M. Orensanz, and J.A. Shaffer. Coastal fisheries oceanography of the southern BS and north Aleutian Basin: Port Moller king crab studies. OCS Study MMS 92-0040.

White, L.E., and C. Nielson. 1992. Proceedings of the International Crab Rehabilitation and Enhancement Symposium. Alaska Department of Fish and Game, Fisheries Rehabilitation, Enhancement and Development Division.

Witherell, D., and G. Harrington. 1995. Evaluation of alternative management measures to reduce the impacts of trawling and dredging on BS crab stocks. Council Discussion Paper, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage AK, 99501. 13 p.

Witherell, D. 1996. King and Tanner crabs of the BS and AI area: Species profiles. North Pacific Fishery Management Council, 13 p.

APPENDIX F.4

ESSENTIAL FISH HABITAT ASSESSMENT REPORT

for Scallop Resources of the Gulf of Alaska, Bering Sea, and Aleutian Islands Regions

April 2005

NOAA Fisheries
NMFS Alaska Region
709 West 9th Street
Juneau, AK 99802

NOAA Fisheries
National Marine Fisheries Service

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Habitat Description for Weathervane Scallops F.4-8

Note:

Limited biological and site-specific scientific information may exist for the species. However, information is not adequate to describe accurate life histories for the species.

Introduction

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to require the description and identification of Essential Fish Habitat (EFH) in Fishery Management Plans (FMPs), adverse impacts on EFH, and actions to conserve and enhance EFH. National Marine Fisheries Service (NMFS) developed guidelines to assist Fishery Management Councils in fulfilling the requirements set forth by the Act.

Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, “waters” includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle.

With respect to type, the information available for almost all species is primarily broad geographic distributions based on specific samples from surveys and fisheries, which have not been linked with habitat characteristics. Furthermore, NMFS’ ability to precisely define the habitat (and its location) of each life stage of each managed groundfish species in terms of its oceanographic (temperature, salinity, nutrient, current), trophic (presence of food, absence of predators), and physical (depth, substrate, latitude, and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions for each species and life stage is restricted primarily to their position in the water column (e.g., demersal, pelagic), broad biogeographic and bathymetric areas (e.g., 100 to 200 meter [m] zone, south of the Pribilof Islands and throughout the Aleutian Islands [AI]) and occasional references to known bottom types associations.

Identification of EFH for some species included historical range information. Traditional knowledge and sampling data have indicated that fish distributions may contract and expand due to a variety of factors including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution.

Background

In preparation of the 1999 EFH Environmental Assessment, EFH Technical Teams, consisting of scientific stock assessment authors, compiled scientific information and prepared the 1999 Habitat Assessment Reports. These reports provided the scientific information baseline to describe EFH. Recent scientific evidence has not proved to change existing life history profiles of the federally managed species. However, where new information does exist, new data help fill information gaps in the region’s limited habitat data environment.

Stock assessment authors used information contained in these summaries and personal knowledge, along with data contained in reference atlases (NOAA 1987, 1990; Council 1997a,b), fishery and survey data (Allen and Smith 1988, Wolotira et al. 1993, NOAA 1998), and fish identification books (Hart 1973, Eschmeyer and Herald 1983, Mecklenburg and Thorsteinson 2002), to describe EFH for each life stage using best scientific judgment and interpretation; see Table 1.

Species Profiles and Habitat Descriptions

FMPs must describe EFH in text, map EFH distributions, and include tables, which provide information on habitat and biological requirements for each life history stage of the species; see Tables 2 to 4. Information contained in this report details life history information for federally managed fish species. This collection of scientific information is interpreted, then referenced to describe and delineate EFH for each species by life history stage using the geographic information system (GIS). EFH text and map descriptions are not compiled in this report due to differences in the characteristics of a species life history and the overall distribution of the species. Specific EFH text descriptions and maps are in Appendix D.

References

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Council (North Pacific Fishery Management Council). 1997a. Essential fish habitat assessment report for the groundfish resources of the BS and AI regions. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Council. 1997b. Essential fish habitat assessment report for the groundfish resources of the GOA region. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Eschmeyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes. Houghton Mifflin Co., Boston. 336 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180. Ottawa. 740 p.

Mecklenburg, Commerce., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fish Society. Bethsda, Maryland. 1037 p.

NOAA (National Oceanic and Atmospheric Administration). 1987. Bering, Chukchi, and Beaufort Seas. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1990. West coast of North America. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1998. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the BS, AI, and GOA regions based on groundfish fishery observer data. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-88.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Table 1. Summary of Major References and Atlases

	References				
Species	Allen and Smith 1988	NOAA 1987	NOAA 1990	Wolotira et al. 1993	NOAA 1998
Weathervane scallop	X	X	X	X	X
Pink scallop - see note					
Spiny scallop - see note					
Rock scallop - see note					

Note:

Limited biological and site-specific scientific information may exist for the species. However, information is neither available nor adequate to describe accurate life histories for the species.

Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.

Location
ICS = inner continental shelf (1-50 m)
MCS = middle continental shelf (50-100 m)
OCS = outer continental shelf (100-200 m)
USP = upper slope (200-1000 m)
LSP = lower slope (1000-3000 m)
BSN= basin (>3000 m)

BCH = beach (intertidal)
BAY = nearshore bays, give depth if appropriate (e.g., fjords)
IP = island passes (areas of high current), give depth if appropriate

Water column
D = demersal (found on bottom)
SD/SP =semi-demersal or semi-pelagic if slightly greater or less than 50 percent on or off bottom
P = pelagic (found off bottom, not necessarily associated with a particular bottom type)
N = neustonic (found near surface)

Bottom Type
M = mud
SM = sandy mud
MS = muddy sand
S = sand
CB = cobble
G = gravel
R = rock
C = coral
K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features
UP = upwelling
G = gyres
F = fronts
E = edges
CL = thermocline or pycnocline

General
U = Unknown
N/A = not applicable

Table 2. Summary of Habitat Associations for Scallops

Scallop		Nearshore				Shelf			Slope						Stratum Reference						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin							
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully
WV Scallop	M					x	x	x													
	J					x	x	x													
	L					x	x	x													
	E					x	x	x													

Scallop		Location							Physical Oceanography				
							Pelagic						
Species	Life Stage	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)
WV Scallop	M				x				x				
	J				x								
	L					x							
	E				x								

Scallop		Substrate												
Species	Life Stage	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock
WV Scallop	M		x	x	x	x	x	x	x	x	x	x		
	J		x	x	x	x	x	x	x	x	x	x		
	L													
	E													

Scallop		Structure										Community Associations													Oceanographic			
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
WV Scallop	M																						3-9.6			M
	J																									J
	L																									L
	E																									E

Table 3. Summary of Reproductive Traits for Scallops

Scallop		**Reproductive Traits**																										
		Age at Maturity				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	**50%**	**100%**	**50%**	**100%**	**External**	**Internal**	**Oviparous**	**Ovoviviparous**	**Viviparous**	**Batch Spawner**	**Broadcast Spawner**	**Egg Case Deposition**	**Nest Builder**	**Egg/Young Guarder**	**Egg/Young Bearer**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
WV Scallop	M					X						X									X	X	X					
	LJ																											
	EJ																											
	L																											
	E																											

Table 4. Summary of Predator and Prey Relationships for Scallops

Scallop		Predator to																														Prey of																											
Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Salmon	Cod	Pollock	Halibut		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pac fic Cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
WV Scallop	M			x																													x																										
	LJ																																x																										
	EJ																																x																										
	L																																																											
	E																																																											

Habitat Description for Weathervane Scallops

(*Patinopectin caurinus*)

Management Plan and Area BSAI GOA

Scallops are managed under the Fishery Management Plan for the Scallop Fishery off Alaska. Scallops occur throughout the area covered by the FMP and extend south to California.

Life History and General Distribution

Weathervane scallops are distributed from Point Reyes, California, to the Pribilof Islands, Alaska. The highest known densities in Alaska have been found to occur in the BS, off Kodiak Island, and along the eastern gulf coast from Cape Spencer to Cape St. Elias. Weathervane scallops are found from intertidal waters to depths of 300 m, but abundance tends to be greatest between depths of 40 to 130 m on beds of mud, clay, sand, and gravel. Beds tend to be elongated along the direction of current flow. A combination of large-scale (overall spawning population size and oceanographic conditions) and small-scale (site suitability for settlement) processes influence recruitment of scallops to these beds. Sexes are separate and mature male and female scallops are distinguishable based on gonad color. Although spawning time varies with latitude and depth, weathervane scallops in Alaska spawn in May to July depending on location. Eggs and spermatozoa are released into the water, where the eggs become fertilized. After a few days, eggs hatch, and larvae rise into the water column and drift with ocean currents. Larvae are pelagic and drift for about one month until metamorphosis to the juvenile stage when they settle to the bottom.

Several other species of scallops found in the EEZ off Alaska have commercial potential. These scallops grow to smaller sizes than weathervanes, and thus have not been extensively exploited in Alaska. Pink scallops, *Chlamys rubida*, range from California to the Pribilof Islands. Pink scallops are found in deep waters (to 200 m) in areas with soft bottom, whereas spiny scallop occur in shallower (to 150 m) areas characterized by hard bottom and strong currents. Pink scallops mature at age 2 and spawn in the winter (January to March). Maximum age for this species is 6 years. Spiny scallops, *Chlamys hastata*, are found in coastal regions from California to the GOA. Spiny scallops grow to slightly larger sizes (75 mm) than pink scallops (60 mm). Spiny scallops also mature at age 2 (35 mm) and spawn in the autumn (August to October). Rock scallops, *Crassadoma gigantea*, range from Mexico to Unalaska Island. Rock scallops are found in relatively shallower water (0 to 80 m) with strong currents. Apparently, distribution of these animals is discontinuous, and the abundance in most areas is low. These scallops attach themselves to rocks, attain a large size (to 250 mm), and exhibit fast growth rates. Rock scallops are thought to spawn during two distinct periods, one in the autumn (October to January), and one in the spring-summer (March to August).

Fishery

The weathervane scallop resource consists of multiple, discrete, self sustaining populations that are managed as separate stock units. Scallop stocks in Alaska have been managed under a federal fishery management plan (FMP) since 1995. The FMP controls the fishery through permits, registration areas and districts, seasons, closed waters, gear restrictions, efficiency limits, crab bycatch limits, scallop catch limits, inseason adjustments, and observer monitoring. Most of these regulations were developed by the State prior to 1995. Dredge size is limited to a maximum width of 15 feet, and only two dredges may be used at any one time. In the Kamishak District of Cook Inlet, only one dredge with a 6-foot maximum width is allowed. Dredges are required to have rings with a 4-inch minimum inside diameter. To reduce incentives to harvest small scallops, crew size on scallop vessels is limited to 12 persons, and all scallops must be manually shucked. Dredging is prohibited in areas designated as crab habitat protection areas, similar to the groundfish FMPs.

Since 1967, when the first landings were made, fishing effort and total scallop harvest (weight of shucked meats) have varied annually. Total commercial harvest of weathervane scallops has fluctuated from a high of 157 landings totaling 1,850,187 pounds of shucked meats by 19 vessels in 1969 to no landings in 1978. Prices and demand for scallops have remained high since fishery inception. Prior to 1990, about two-thirds of the scallop harvest has been taken off Kodiak Island, and about one-third has come from the Yakutat area; other areas had made minor contributions to overall landings. Harvests in 1990 and 1991 were the highest on record since the early 1970s. The 1992 scallop harvest was even higher at 1,810,788 pounds. The increased harvests in the 1990s occurred with new exploitation in the BS.

Relevant Trophic Information

Scallop predators have not been well studied. Scallops are likely prey to various fish and invertebrates during the early part of their life cycle. Flounders are known to prey on juvenile weathervane scallops, and seastars may also be important predators.

Approximate Upper Size Limit of Juvenile Fish (in cm): Weathervane scallops begin to mature by age 3 at about 7.6 cm (3 inches) in shell height (SH), and virtually all scallops are mature by age 4. Growth, maximum size, and size at maturity vary significantly within and between beds and geographic areas. Weathervane scallops are long-lived; individuals may live 28 years or more. The natural mortality rate is thought to be about 15 percent annually (M = 0.16).

Habitat and Biological Associations

Scallops are found from intertidal waters and to 300 m. Abundance tends to be greatest between 45 and 130 m on beds of mud, clay, sand, and gravel (Hennick 1973). Weathervane scallops are associated with other benthic species, such as red king crabs, Tanner crabs, shrimps, octopi, flatfishes, Pacific cod, and other species of benthic invertebrates and fishes.

Additional Information Source

Distributional information is contained in the Literature cited section.

Literature

Barnhart, J.P., I.W. Vining, and L.C. Byrne. 1996. A summary of data collected by scallop observers from the 1994/1995 commercial scallop fishery in Alaska’s westward region. ADF&G, Commercial Fisheries Management & Development Division, Regional information report 4K96-33, Kodiak, AK.

Haynes, E.B., and G.C. Powell. 1968. A preliminary report on the Alaska sea scallop—fishing exploration, biology and commercial processing. ADF&G, Division of Commercial Fisheries, Informational leaflet 125, Juneau, AK.

Hennick, D.P. 1973. Sea scallop, *Patinopectin caurinus*, investigations in Alaska. ADF&G, Division of Commercial Fisheries Completion Report 5-23-R, Juneau, AK.

Kaiser, R.J. 1986. Characteristics of the Pacific Weathervane Scallop, *Patinopectin caurinus* (Gould, 1850), Fishery in Alaska, 1967-1981. Alaska Department of Fish and Game.

Kruse, G.H. 1994. DRAFT Fishery Management Plan for Commercial Scallop Fisheries in Alaska. Alaska Department of Fish and Game, Draft Special Publication No. 5.

Shirley, S.M., and G.H. Kruse. 1995. Development of the fishery for weathervane scallops, *Patinopectin caurinus* (Gould, 1850), in Alaska. Journal of Shellfish Research 14(1):71-78.

SPECIES: Weathervane Scallops off Alaska

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	several days	None	May-July	MCS, ICS	D		N/A	
Larvae	2-3 weeks		May-August	ICS, MCS, OCS	P		N/A	
Juveniles	Age 0 to Age 3		August +	MCS	D	CL, M, S, G	N/A	
Adults	Age 3 - 28		Spawning May-July	MCS	D	CL, M, S, G	UNK	

APPENDIX F.5

ESSENTIAL FISH HABITAT ASSESSMENT REPORT

for the Salmon Fisheries in the

EEZ off the Coast of Alaska

April 2005

NOAA Fisheries
NMFS Alaska Region
709 West 9th Street
Juneau, AK 99802

NOAA Fisheries
National Marine Fisheries Service

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Introduction

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to require the description and identification of Essential Fish Habitat (EFH) in Fishery Management Plans (FMPs), adverse impacts on EFH, and actions to conserve and enhance EFH. National Marine Fisheries Service (NMFS) developed guidelines to assist Fishery Management Councils in fulfilling the requirements set forth by the Act.

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

With respect to type, the information available for almost all species is primarily broad geographic distributions based on specific samples from surveys and fisheries, which have not been linked with habitat characteristics. Furthermore, NMFS' ability to precisely define the habitat (and its location) of each life stage of each managed groundfish species in terms of its oceanographic (temperature, salinity, nutrient, current), trophic (presence of food, absence of predators), and physical (depth, substrate, latitude, and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions for each species and life stage is restricted primarily to their position in the water column (e.g., demersal, pelagic), broad biogeographic and bathymetric areas (e.g., 100 to 200 m zone, south of the Pribilof Islands and throughout the AI) and occasional references to known bottom type associations.

Identification of EFH for some species included historical range information. Traditional knowledge and sampling data have indicated that fish distributions may contract and expand due to a variety of factors including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution.

Background

In preparation of the 1999 EFH Environmental Assessment, EFH Technical Teams, consisting of scientific stock assessment authors, compiled scientific information and prepared the 1999 Habitat Assessment Reports. These reports provided the scientific information baseline to describe EFH. Recent scientific evidence has not proved to change existing life history profiles of the federally managed species. However, where new information does exist, new data help fill information gaps in the region's limited habitat data environment.

Stock assessment authors used information contained in these summaries and personal knowledge, along with data contained in reference atlases (NOAA 1987, 1990; Council 1997a,b), fishery and survey data (Allen and Smith 1988, Wolotira et al. 1993, NOAA 1998), and fish identification books (Hart 1973, Eschmeyer and Herald 1983, Mecklenburg and Thorsteinson 2002), to describe EFH for each life stage using best scientific judgment and interpretation; see Table 1.

Species Profiles and Habitat Descriptions

FMPs must describe EFH in text, map EFH distributions, and include tables, which provide information on habitat and biological requirements for each life history stage of the species; see Tables 2 to 4. Information contained in this report details life history information for federally managed fish species. This collection of scientific information is interpreted, then referenced to describe and delineate EFH for each species by life history stage using the geographic information system (GIS). EFH text and map descriptions are not compiled in this report due to differences in the characteristics of a species life history and the overall distribution of the species. Specific EFH text descriptions and maps are in Appendix D.

References

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Council (North Pacific Fishery Management Council). 1997a. Essential fish habitat assessment report for the groundfish resources of the BS and AI regions. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Council. 1997b. Essential fish habitat assessment report for the groundfish resources of the GOA region. Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Eschmeyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes. Houghton Mifflin Co., Boston. 336 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180. Ottawa. 740 p.

Mecklenburg, Commerce., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fish Society. Bethsda, Maryland. 1037 p.

NOAA (National Oceanic and Atmospheric Administration). 1987. Bering, Chukchi, and Beaufort Seas. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1990. West coast of North America. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerce., NOAA, NOS.

NOAA. 1998. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the BS, AI, and GOA regions based on groundfish fishery observer data. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-88.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Information Specific to Salmon

Freshwater EFH for the salmon fisheries in Alaska includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in the state. This represents a vast array of diverse aquatic habitats over an extremely large geographic area. Alaska contains over 3,000 rivers and has over 3 million lakes > 8 ha. Over 14,000 water bodies containing anadromous salmonids identified in the state represent only part of the salmon EFH in Alaska because many likely habitats have not been surveyed. In addition to current and historically accessible waters used by Alaska salmon, other potential spawning and rearing habitats exist beyond the limits of upstream migration due to barrier falls or steep-gradient rapids. Salmon access to existing or potential habitats can change over time due to many factors, including glacial advance or recession, post-glacial rebound, and tectonic subsidence or uplifting of streams in earthquakes.

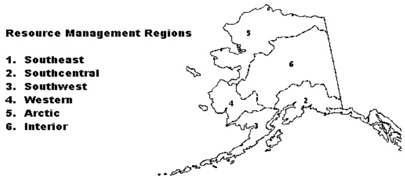

Figure 1. Regional boundaries of the Resource Management Regions established by the Joint Boards of Fisheries and Game.

A significant body of information exists on the life histories and general distribution of salmon in Alaska. The location of many freshwater water bodies used by salmon are contained in documents organized and maintained by the Alaska Department of Fish and Game (ADF&G). Alaska Statute 16.05.870 requires ADF&G to specify the various streams that are important for spawning, rearing, or migration of anadromous fishes. This is accomplished through the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes* and the *Atlas to the Catalog of Waters Important for Spawning, Returning or Migration of Anadromous Fishes*. The Catalog lists water bodies documented to be used by anadromous fish. The Atlas shows locations of these waters and the species and life stages that use them. The Catalog and Atlas are divided into six volumes for the six resource management regions established in 1982 by the Joint Boards of Fisheries and Game; see figure at right.

The Catalog and Atlas, however, have significant limitations. The location information and maps are derived from U.S. Geological Survey quadrangles which may be out of date because of changes in channel and coastline configurations. In southeast Alaska, for example, new streams are colonized by salmon in Glacier Bay as glaciers rapidly recede. Polygons are sometimes used to specify areas with a number of salmon streams that could not be depicted legibly on the maps. Waters within these polygons are often productive for juvenile salmon.

Data for the Catalog come from personal, in-field surveys by aircraft, boat, and foot for purposes of managing fish habitat and fisheries, and the upper limit of salmon is not always observed. Upper points specified in the Catalog usually reflect the extent of surveys or known fish usage rather than actual limits of anadromous fish. Upper areas used by salmon are further limited due to the remoteness and vastness of the Alaska regions. Comparably, the Alaska region has identified salmon for freshwater reaches in an area that would span between the states of Washington and Ohio and between the northern and southern borders of the United States.

In addition, only a limited number of water bodies have actually been surveyed. Virtually all coastal waters in the State provide important habitat for anadromous fish, as do many unsurveyed small- and medium-sized tributaries to known anadromous fish-bearing water bodies in remote parts of the State. Small tributaries, flood channels, intermittent streams, and beaver ponds are often used for juvenile rearing. Because of their remote location, small size, or ephemeral nature, most of these systems have not been surveyed and are not included in the Catalog or Atlas.

Marine EFH for the salmon fisheries in Alaska includes all estuarine and marine areas utilized by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. EEZ. This habitat includes waters of the Continental Shelf, which extends to about 30 to 100 km offshore from Dixon Entrance to Kodiak Island, then becomes more narrow along the Pacific Ocean side of the Alaska Peninsula and AI chain. In BS areas of southwest and western Alaska and in Chukchi and Beaufort Seas areas of northwest and northern Alaska, the Continental Shelf becomes much wider. In oceanic waters beyond the Continental Shelf, the documented range of Alaska salmon extends from lat. 42° N north to the Arctic Ocean and to long. 160° E. In the deeper waters of the Continental Slope and ocean basin, salmon occupy the upper water column, generally from the surface to a depth of about 50 m. Chinook and chum salmon, however, use deeper layers, generally to about 300 m, but on occasion to 500 m. The range of EFH for salmon is the subset of this habitat that occurs within the 320 km EEZ boundary of the United States. Foreign waters (i.e., off British Columbia in the GOA and off Russia in the BS) and international waters are not included in salmon EFH because they are outside United States jurisdiction. The marine EFH for Alaska salmon fisheries described above is also EFH for the Pacific coast salmon fishery for those salmon stocks of Pacific Northwest origin that migrate through Canadian waters into the Alaska EFH zone.

Literature

Alaska Department of Fish and Game. 2002. An atlas to the catalog of waters important for spawning, rearing, or migration of anadromous fishes. ADF&G, Habitat and Restoration Division, 333 Raspberry Road, Anchorage, AK. 99518-1599.

Alaska Department of Fish and Game (ADF&G). 1986. Alaska habitat management guide; guidelines for the protection of fish and their habitat. ADF&G, Habitat Division, 142 p. Juneau, AK 99801

Groot, C., and L. Margolis. (eds.) 1991. Pacific salmon life histories. Univ. British Columbia Press.

Gustafson, R.G., T.C. Wainwright, G.A. Winans, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. NOAA Tech. Memo. NMFS-NWFSC-33. NMFS, 2725 Montlake Blvd. E., Seattle, WA 98112-2097

Halupka, K.C., M. F. Wilson, M. D. Bryant, F. H. Everest, and A.J. Gharrett. in press. Intraspecific diversity of Pacific salmon in Southeast Alaska. Forestry Sci. Lab., Pacific Northwest Research Station, USDA. 2770 Sherwood Lane, Suite 2A Juneau, AK 99801-8545

Hard, J.J., R.G. Kope, W.S. Grant, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1996. Status review of pink salmon from Washington, Oregon, and California. NOAA Tech. Memo. NMFS-NWFSC-25. NMFS, 2725 Montlake Blvd. E., Seattle, WA 98112-2097

Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. NOAA Tech. Memo. NMFS-NWFSC-32. NMFS, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.

Myers, K.W., K.Y. Aydin, R.V. Walker, S. Fowler, and M.L. Dalhberg. 1996. Known ocean ranges of stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. (NPAFC Doc. 192.) FRI-UW-9614. Univ. Wash., Fisheries Research Institute, Box 357980, Seattle, WA 98195-7980.

USDA Forest Service, Geographic Information System, Streams Layer. U.S. Forest Service, Juneau, AK 99801.

Weitkamp, L.A., T.W. Wainwright, G.J. Bryant, G.B. Miller, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. NOAA Tech. Memo. NMFS-NWFSC-24. NMFS, 2725 Montlake Blvd. E., Seattle, WA 98112-2097

Wertheimer, W.C. 1996. The status of Alaska salmon. Pages 179-197 *In* J. D. Stroder, P. A. Bisson, and R. J. Naiman (eds.). Pacific salmon and their ecosystems: status and future options. Symposium Proc., Seattle, WA., Jan. 10-12, 1994. Chapman Hall, NY.

Table 1. Summary of Major References and Atlases

	References					
Species	Allen and Smith 1988	Wolotira et al. 1993	NOAA 1997b	NOAA 1997a	Meckelenburg and Thorsteinson 2002	ADF&G Anadromous Waters Catalogue 2002
Pink salmon	X	X	X	X	X	X
Chum salmon	X	X	X	X	X	X
Sockeye salmon	X	X	X	X	X	X
Chinook salmon	X	X	X	X	X	X
Coho salmon	X	X	X	X	X	X

Abbreviations used in the EFH Reports.

Location: WC = water courses, rivers, streams, sloughs; LK = lakes, ponds (some are temporary); BCH = beach (intertidal); EST = estuarine, intermediate salinity, nearshore bays with inlet watercourses, eelgrass and kelp beds; ICS = inner continental shelf (1-50 m deep); MCS = middle continental shelf (1-100 m deep); OCS = outer continental shelf (1-200 m); BAY = nearshore bays (e.g., fjords); IP = island passes (areas of high current).

Water Column: P = pelagic (found off bottom, not necessarily associated with a particular bottom type); N = neustonic (found near surface).

Bottom Type: G = gravel; K = kelp; SAV = subaquatic vegetation (e.g., eelgrass).

Oceanographic/Riverine Features: UP = upwelling; G = gyres; F = fronts; CL = thermo- or pycnocline; E = edges.

General: U = Unknown; NA = not applicable

Table 2. Summary of Habitat Associations for Salmon

Salmon		Nearshore				Shelf			Slope						Stratum Reference						
						Inner	Middle	Outer	Upper		Inter- mediate		Lower	Basin							
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully
Chinook	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
	LJ														x	x	x	x			
	EJ	x	x	x											x	x	x				
	L	x																			
	E	x																			
Chum	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
	LJ				x	x	x	x	x	x						x	x	x			
	EJ	x	x	x	x	x	x								x	x	x	x			
	L	x		x																	
	E	x		x																	
Coho	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	LJ		x	x		x	x									x	x				
	EJ	x	x	x		x									x						
	E/L	x																			
Pink	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	LJ		x		x		x	x	x						x	x	x				
	EJ		x	x	x	x	x	x	x						x	x	x				
	L	x																			
	E	x																			
Sockeye	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	LJ		x	x	x	x	x	x	x							x	x				
	EJ	x				x															
	L	x																			
	E	x				x															

Salmon		Location							Physical Oceanography					Substrate												
						Pelagic																				
Species	Life Stage	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock
Chinook	M	x	x	x	x	x			x	x	x	x	x													
	LJ	x	x	x	x	x			x	x	x	x	x													
	EJ	x	x	x	x									x		x						x			x	x
	L				x												x								x	
	E				x												x								x	
Chum	M	x	x	x	x	x	x		x	x	x	x	x	x			x					x			x	
	LJ	x	x	x	x	x	x		x	x	x	x	x													
	EJ	x	x	x		x			x	x		x		x	x	x	x					x		x	x	x
	L													x		x	x					x			x	x
	E													x		x	x					x			x	
Coho	M	x	x			x						x	x	x			x					x			x	
	LJ	x	x			x																				
	EJ	x		x											x	x	x					x			x	
	E/L													x			x									
Pink	M	x	x			x			x	x	x	x		x			x					x			x	
	LJ	x	x						x	x	x	x														
	EJ	x													x	x	x					x		x	x	
	L													x			x									
	E													x			x					x			x	
Sockeye	M	x	x			x											x					x			x	
	LJ	x	x			x																				
	EJ				x																					
	L																x					x			x	
	E																x					x			x	

Salmon		Structure										Community Associations												Oceanographic Properties			
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Chinook	M	x		x	x	x	x		x	x	x								x					<15			M
	LJ	x		x	x	x	x		x	x	x							x	x					<15			LJ
	EJ																	x	x		x			<20			EJ
	L																							0-14			L
	E																							0-14	0		E
Chum	M	x		x	x	x	x		x	x	x							x	x		x			<15		8	M
	LJ	x			x	x	x	x	x	x	x							x	x					<15		8	LJ
	EJ	x		x	x	x	x		x	x	x	x						x	x		x			<15		8	EJ
	L																							>4		>4	L
	E																							>4		>4	E
Coho	M	x		x	x	x	x		x	x	x								x					<15		8	M
	LJ																	x	x		x			<15		8	LJ
	EJ	x		x	x	x	x		x	x	x							x	x		x			<15		>4	EJ
	E/L																							>4		>4	E/L
Pink	M	x		x	x	x	x		x	x	x								x					<15		8	M
	LJ							x																<15		8	LJ
	EJ	x		x	x	x	x		x	x	x	x						x	x		x			<15		8	EJ
	L																							>4		>4	L
	E																							>4		>4	E
Sockeye	M																							<15			M
	LJ							x																<15			LJ
	EJ																							<15			EJ
	L																										L
	E																										E

Table 3. Summary of Reproductive Traits for Salmon

Salmon		Reproductive Traits																										
		Age at Maturity				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	50%	100%	50%	100%	External	Internal	Oviparous	Ovoviviparous	Viviparous	Batch Spawner	Broadcast Spawner	Egg Case Deposition	Nest Builder	Egg/Young Guarder	Egg/Young Bearer	January	February	March	April	May	June	July	August	September	October	November	December
Chinook	M	4	7	4	7	X		X						X			X						X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Chum	M	4	7	4	7	X		X						X			X	X					X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Coho	M		4		4	X		X						X									X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Pink	M		2		2	X		X						X									X	X	X	X		
	LJ																											
	EJ																											
	L																											
	E																											
Sockeye	M	5	6	5	6	X		X						X									X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											

Table 4. Summary of Predator and Prey Associations for Salmon

		Predator to																													Prey of																											
Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Salmon	Cod	Pollock	Halibut		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific Cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Chinook	M							x						x						x	x	x	x	x			x	x	x		M															x		x	x			x		x					x
	LJ							x												x	x	x	x	x			x	x	x		LJ															x			x			x							
	EJ				x			x		x	x		x	x				x		x											EJ						x	x	x																x		x	x	x
	L																														L																												
	E																														E																												
Chum	M			x	x			x		x	x			x						x	x	x	x	x	x			x	x		M															x	x	x	x					x				x	x
	LJ			x	x			x		x	x			x				x		x	x	x	x	x	x			x	x		LJ															x	x	x	x		x	x							
	EJ			x	x			x		x	x		x					x		x	x	x	x					x	x		EJ						x	x	x																x			x	x
	L			x	x																			x							L																									x		x	
	E																														E																											x	
Coho	M							x						x						x	x	x	x								M															x			x		x	x		x					
	LJ				x			x													x						x				LJ																x											x	
	EJ				x			x		x	x									x					x		x				EJ				x		x																		x	x	x	x	x
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Habitat Description for Pink Salmon

(*Oncorhynchus gorbuscha*)

Management Plan and Area(s) Salmon fisheries in the EEZ off the coast of Alaska, Council, 1990

Life History and General Distribution

The natural freshwater range of pink salmon includes the Pacific rim of Asia and North America north of about 40°N. Within this vast area, spawning pink salmon are widely distributed in coastal streams of both continents up to the Bering Strait. North, east, and west of the Bering Strait, spawning populations become more irregular and occasional. Centers of large spawning populations occur at roughly parallel positions along the two continents from about lat. 44°N to 65°N in Asia and about 48°N to 64°N in North America. In marine environments along both the Asian and North American coastlines pink salmon occupy ocean waters south of the limits of spawning streams.

Pink salmon are distinguished from other Pacific salmon by having a fixed 2-year life span, being the smallest of the Pacific salmon as adults (averaging 1.0 to 2.5 kg), the fact that the young migrate to sea soon after emerging from the gravel, and developing a marked hump in large maturing males. This last characteristic is responsible for the vernacular name humpback salmon used in some areas. Because of the fixed 2-year life cycle, pink salmon spawning in a particular river system in old and even years are reproductively isolated from each other and have developed into genetically different lines. In some river systems, like the Fraser River in British Columbia, only the odd-year line exists; returns in even years are negligible. In Bristol Bay, Alaska, the major runs occur in even years, whereas the coastal area between these two river systems is characterized by runs in both even and odd years. In different parts of the range populations are sometimes characterized by the phenomena of dominance where one brood line is much stronger than the other brood line. Upon emergence, pink salmon fry migrate quickly to sea and grow rapidly as they make extensive feeding migrations. After 18 months in the ocean the maturing fish return to their river of origin to spawn and die.

Pink salmon are considered to be have either the simplest or most specialized life cycle within the genus, depending on whether Pacific salmon originated from marine or freshwater ancestors. One view holds that *Oncorhynchus* evolved from an ancestral freshwater form of Pacific *Salmo* during the Pleistocene, probably in the vicinity of the present-day Sea of Japan. Under this scenario, pink salmon that rely least on the freshwater environment are the most specialized. Pink salmon have 52 chromosomes, fewer than other Pacific salmon, which also may suggest specialization. Another view considers Salmonidae as relatively primitive teleosts, of probable marine pelagic origin, and about five million years old. This alternative view to freshwater origin of Pacific salmon is supported, in part, by Pliocene fossils from California and Oregon. The marine origin view holds that during evolution salmonids tended towards greater dependence on fresh water and away from dependence on the sea. Under this scenario, pink salmon, with the least dependence on the freshwater environment, is considered the least advanced extant *Oncorhynchus* species.

Fisheries

Pink salmon are the most abundant Pacific salmon, contributing about 40 percent by weight and 60 percent in numbers of all salmon caught commercially in the North Pacific Ocean and adjacent waters. Coastal fisheries for pink salmon presently occur in Asian (Japan and Russia) and North America (Canada and the United States) with major fisheries in both Russia and the United States. Historically some pink salmon were caught in high seas fisheries by Japan and Russia. Most pink salmon in the United States are caught in Alaska where major fisheries occur in the southeast Alaska, Prince William Sound, and Kodiak regions. Lesser fisheries for pink salmon occur in Cook Inlet, Alaska Peninsula, and Bristol Bay regions. Alaska fisheries for pink salmon occur primarily within State of Alaska territorial seas (inside 3 miles).

Pink salmon catches have been at historic records in Alaska over the past decade with catches exceeding 100 million fish in several years. Most pink salmon in Alaska are caught by purse seines with smaller commercial catches made by set and drift gill net and troll fisheries. Recreational fisheries in Alaska usually harvest between 200 and 400 thousand pink salmon annually. Historically, pink salmon in Alaska have been harvested, on average, at between 60 and 75 percent of the total annual run.

Purse seine fisheries for pink salmon have some bycatch associated with them, primarily other salmon. The most important bycatch issue is in the southeast Alaska region where younger marine-age Chinook salmon, similar in size to adult pink salmon, are caught in pink salmon purse seine fisheries. The total harvest of Chinook salmon in this region is controlled by quotas under auspices of the Pacific Salmon Treaty. The Alaska Board of Fisheries allocates a portion of the quota for Chinook salmon as an allowable bycatch in purse seine fisheries targeted on pink salmon.

Measured marine survivals of pink salmon, from entry of fry into stream mouth estuaries to returning adults, have ranged from 0.2 to over 20 percent. Scientist, in general, believe that much of the natural mortality of pink salmon in the marine environment occurs within the first few months before advanced juveniles move offshore into more pelagic ocean waters. Pink salmon populations can be very resilient, rebounding from weak to strong run strength in regional stock groups within one or two generations.

Because pink salmon are primarily caught in purse seines, there are no known gear impacts to the marine habitats where these fisheries occur.

Relevant Trophic Information

Pink salmon eggs, alevins, and fry in freshwater streams provide an important nutrient input and food source for aquatic invertebrates, other fishes, birds and small mammals. In the marine environment, pink salmon fry and juveniles are food for a host of other fishes and coastal sea birds.

Subadult and adult pink salmon are known to be eaten by 15 different marine mammals, sharks, other fishes such as Pacific halibut and humpback whales. Because pink salmon are the most abundant salmon in the North Pacific, it is likely they comprise a significant portion of the salmonids eaten by marine mammals.

Millions of pink salmon adults returning to spawn in thousands of streams throughout Alaska provide significant nutrient input into the trophic level of these coastal watersheds. Adult pink salmon in streams are major food sources for gulls, eagles, and other birds, along with bear, otter, mink, and other mammals.

Approximate Upper Size Limit of Juvenile Fish (in cm): Roughly 25 cm

Habitat and Biological Associations

Eggs and Spawning: Pink salmon choose a fairly uniform spawning bed in small and large streams in both Asia and North America. Generally, these spawning beds are situated on riffles with clean gravel, or along the borders between pools and riffles in shallow water with moderate to fast currents. In large rivers, they may spawn in discrete sections of main channels or in tributary channels. Pink salmon avoid spawning in quiet deep water, in pools, in areas with a slow current, or over heavily silted or mud-covered streambeds. Places selected for egg deposition is determined by the optimal combination of two main interconnecting variables: depth of water and velocity of current.

On both the Asian and North American sides of the Pacific Ocean, pink salmon generally spawn at depths of 30 to 100 cm. Well populated spawning grounds of pink salmon are mainly at depths of 20 to 25 cm, less often reaching depths of 100 to 150 cm. In dry years, when spawning grounds are crowded, nests can be found at shallower depths of 10 to 15 cm. Current velocities in pink salmon spawning grounds varied from 30 to 100 cm/s, sometimes reaching 140 cm/s. Directly over the redds, about 5 to 7 cm from the surface, the velocity can range from 30 to 140 cm/s but usually averages from 60 to 80 cm/s.

In general, pink salmon select sites in gravel where the gradient increases and the currents are relatively fast. In these areas, surface stream water must have permeated sufficiently to provide intragravel flow for dissolved oxygen delivery to eggs and alevins. Chum salmon, by contrast, tended to select spawning sites in areas with upwelling spring water and a relatively constant water temperature, without much regard to surface stream water. Pink salmon spawning beds consist primarily of coarse gravel with a few large cobbles, a large mixture of sand, and a small amount of silt. High quality spawning grounds of pink salmon can best be summarized as clean, coarse gravel.

Larvae/Alevins: Fertilized eggs begin their 5- to 8-month period of embryonic development and growth in intragravel interstices. To survive successfully, the eggs, alevins, and pre-emergent fry must first be protected from freezing, desiccation, stream bed scouring or shifting, mechanical injury and predators. Water surrounding them must be non-toxic and of sufficient quality and quantity to provide basic requirements of suitable temperatures, adequate supply of oxygen, and removal of waste materials. Collectively, these requirements are, on average, only partially met even under the most favorable natural conditions. Overall freshwater survival of pink salmon from egg to advanced alevin and emerged fry, even in highly productive streams, commonly reaches only 10 to 20 percent and at times is as low as about 1 percent.

Rates of egg development, survival, size of hatched alevins and percentage of deformed fry are related to temperature and oxygen levels during incubation. Temporary low stream temperatures or dissolved oxygen concentrations, however, may be relatively unimportant at some developmental stages, but lethal at others. Generally, low oxygen levels are non-lethal early, but lethal late in development. Eggs subjected to low dissolved oxygen levels hatched prematurely at a rate dependent on the degree of hypoxia. Spinal deformities occurred in eggs incubated at 3.0° and 4.5°C before gastrulation. In one study, over 50 percent of developing pink salmon eggs died at dissolved oxygen levels of 3 to 4 mg/l, and among those that hatched many alevins were deformed.

Juveniles: Newly emerged pink salmon fry show a preference for saline water over fresh water, which may, in some situations, facilitate migration from the natal stream area. Schools of pink salmon fry may move quickly from the natal stream area or remain to feed along shorelines up to several weeks. The timing and pattern of seaward dispersal is influenced by many factors, including general size and location of the spawning stream, characteristics of adjacent shoreline and marine basin topography, extent of tidal fluctuations and associated current patterns, physiological and behavioral changes with growth, and, possibly, different genetic characteristics of individual stocks.

Early marine schools of pink salmon fry, often in tens or hundreds of thousands of fish, tend to follow shorelines and, during the first weeks at sea, spend much of their time in shallow water of only a few centimeters deep. It has been suggested that this onshore period involves a distinct ecological life history stage in both pink and chum salmon. In many areas throughout their ranges, pink salmon and chum salmon fry of similar age and size co-mingle in both large and small schools during early sea life. Juvenile pink salmon in the BS off the northeastern Kamchatka coast are found in one of three hydrological zones during their first three to four months of marine life: (1) the littoral zone, up to 150 m from shore; (2) open parts of inlets and bays from 150 m to 3.2 km from shore; and (3) the open parts of the large Karaginskiy Gulf, 3.2 to 96.5 km from shore. Distribution within these regions is seasonally related to the size of pinks, with an offshore movement of larger fish in August and September.

Pink salmon juveniles routinely obtain large quantities of food sufficient to sustain rapid growth from a broad range of habitats providing pelagic and epibenthic foods. Collectively, diet studies show that pink salmon are both opportunistic and generalized feeders and on occasion they specialize in specific prey items. Diel sampling of stomachs showed fewer and more digested food items at night than during the day indicating that juvenile pinks are primarily diurnal feeders.

Adults: Ocean growth of pink salmon is a matter of considerable interest because, although this species has the shortest life span among Pacific salmon, it also is among the fastest growing. Entering the estuary as fry at around 3 cm in length, maturing adults return to the same area 14 to 16 months later ranging in length from 45 to 55 cm.

The population biology of pink salmon revolves around the 2-year life cycle. A phenomenon of cycle dominance between odd- and even-year brood lines within specific regions is common. Dominance can be weak or strong, complete, or non-existent. It can also shift between brood lines. With complete dominance, the “off-year” line is absent while non-dominance is characterized by similar population strength between odd- and even-year runs. Although many causes for dominance and its various characteristics in pink salmon populations have been proposed, none satisfactorily explains the event. Genetically, pink salmon are more similar within odd- or even-year brood lines across broad geographic regions than across brood lines within the same stream. It has been suggested for some geographic areas that present odd- and even-year pink salmon populations arose from separate glacial refuges during late Pleistocene times.

Scientists have recognized six distinct ocean migration patterns for regional stock groups of pink salmon throughout the North Pacific. Only two of these stock groups, those originating in Washington state and British Columbia and those originating in southeast, central, and southwest Alaska, occur in marine waters where they might interact in some way with the salmon fisheries off the coast of southeast Alaska. Pink salmon from these two broad stock groups co-mingle in the GOA during their second summer at sea while migrating towards natal areas.

Additional Information Sources

Karl Hofmeister, Alaska Department of Fish and Game.
Chris Kondzela, NMFS, Auke Bay Laboratory.

Literature

Alderdice, D.F., and F.P.J. Velsen. 1978. Relation between temperature and incubation time for eggs of Chinook salmon *(Oncorhynchus tshawytscha).* J. Fish. Res. Board Can. 35:69-75.

Alderdice, D.F., W.P. Wickett, and J.R. Brett. 1958. Some effects of temporary exposure to low dissolved oxygen levels on Pacific salmon eggs. J. Fish. Res. Board Can. 15:229-249.

Allen, G.H., and W. Aron. 1958. Food of salmonid fishes of the western North Pacific Ocean. U.S. Fish Wild. Serv. Spec. Sci. Rep. Fish. 237:11 p.

Aron, W.I. 1956. Food of salmonid fishes of the North Pacific Ocean. C. Food of pink salmon *Oncorhynchus gorbuscha. D.* Preliminary comparative study of the feeding behavior of the pink, sockeye and chum salmons. Univ. Wash. Dep. Oceanogr. Fish. Rep. 4:10 p.

Aspinwall, N. 1974. Genetic analysis of North American populations of pink salmon, *Oncorhynchus gorbuscha,* possible evidence for the neutral mutation-random drift hypothesis. Evolution 28:295-305.

Atkinson, C.E., T.H. Rose, and T.O. Duncan. 1967. Pacific salmon in the United States, p. 43-223. *In:* Salmon of the North Pacific Ocean. Part IV. Spawning populations of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 23.

Baggerman, B. 1960. Salinity preference, thyroid activity and the seaward migration of four species of Pacific salmon *(Oncorhynchus). J.* Fish. Res. Board Can. 17:295-322.

Bailey, J.E. 1969. Alaska's fishery resources - the pink salmon. Fish Leafl. (U.S.) 619:8 p.

Bailey, J.E., and D.R. Evans. 1971. The low-temperature threshold for pink salmon eggs in relation to a proposed hydroelectric installation. Fish. Bull. (U.S.) 69:587-593.

Bailey, J.E., S.D. Rice, J.J. Pella, and S.G. Taylor. 1980. Effects of seeding density of pink salmon, *Oncorhynchus gorbuscha,* eggs on water chemistry, fry characteristics, and fry survival in gravel incubators. Fish. Bull. (U.S.) 78:649-658.

Bailey, J.E., B.L. Wing, and C.R. Mattson. 1975. Zooplankton abundance and feeding habits of fry of pink salmon, *Oncorhynchus gorbuscha,* and chum salmon, *Oncorhynchus keta,* in Traitors Cove, Alaska, with speculations on the carrying capacity of the area. Fish. Bull. (U.S.) 73:846-861.

Baitey, J.E., B.L. Wing, and J.H. Landingham. 1983. juvenile Pacific sandfish, *Trichodon trichodon,* associated with pink salmon, *Oncorhynchus gorbuscha,* fry in the nearshore area, southeast Alaska. Copeia. 1983(2):549-551.

Baker, TT; A.C. Wertheimer, R.D. Burkett, R. Dunlap, D.M. Eggers, E.I. Fritts, A.J. Gharrett*; R.A. Holmes, and R.L. Wilmot. 1996. Status of Pacific salmon and steelhead escapements in southeast Alaska. Fisheries, vol. 21, no. 10, pp. 6-19.

Beamish, R.J., I.A. Pearsall, and M.C. Healey. 2003. A history of the research on the early marine life of pacific salmon off Canada's Pacific coast. N. Pac. Anadr. Fish Comm. Bull. 3:1-40.

Boldt, J.L., and L.J. Haldorson. 2002. A bioenergetics approach to estimating consumption of zooplankton by juvenile pink salmon in Prince William Sound, Alaska. Alaska Fishery Research Bulletin 9(2), 111-127.

Bradford, M.J. 1995. Comparative review of Pacific salmon survival rates. Canadian Journal of Fisheries and Aquatic Sciences 52, 1327-1338.

Brodeur, R.D., K.W. Myers, and J.H. Helle. 2003. Research conducted by the United States on the early ocean life history of Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:89-131.

Brodeur, R.D., G.W. Boehlert, E. Casillas, M.B. Eldridge, J.H. Helle, W.T. Peterson, W.R. Heard, S.T. Lindley, and M.H. Schiewe. 2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. Fisheries 25, 7-16.

Carlson, H.R., E.V. Farley, Jr., K.W. Myers. 2000. The use of otolith marks to determine stock-specific ocean distribution and migration patterns of Alaskan pink and chum salmon in the North Pacific Ocean 1996-1999. N. Pac. Anadr. Fish. Comm. Bull. No. 2:291-300

Cooney, R.T., T.M. Willette, S. Sharr, D. Sharp, and J. Olsen. 1995. The effect of climate on North Pacific pink salmon (*Oncorhynchus gorbuscha*) production: examining some details of a natural experiment. In: Beamish, R.J. (Ed.), Climate change and northern fish populations. Canadian Special Publication of Fisheries and Aquatic Sciences 121, pp. 475-482.

Cooney, R.T., and R.D. Brodeur. 1998. Carrying capacity and North Pacific salmon production: stock-enhancement implications. Bulletin of Marine Science 62, 443-464.

Cooney, R.T., J.R. Allen, M.A. Bishop, D.L. Eslinger, T. Kline, B.L. and Norcross.

Davidson, F.A. 1934. The homing instinct and age at maturity of pink salmon *(Oncorhynchus gorbuscha).* Bull. Bur. Fish. (U.S.) 48:27-29.

Davidson, F.A. 1935. The development of the secondary sexual characters in the pink salmon (*Oncorhynchus gorbuscha*). J. Morphol. 57:169-183.

Davidson, F.A., E. Vaughan, S.J. Hutchinson, and A.L. Pritchard. 1943. Factors influencing the upstream migration of the pink salmon *(Oncorhynchus gorbuscha).* Ecology 24:149-168.

Donnelly, R.F. 1983. Factors affecting the abundance of Kodiak Archipelago pink salmon *(Oncorhynchus gorbuscha,* Walbaum). Ph.D. thesis. University of Washington, Seattle, WA. 157 p.

Dubrovskaia, N.V. 1934. The life cycle of the pink salmon of Primorye. Rybn. Khoz. 1-2:65-68 (Transl. from Russian; Fish. Res. Board Can. Transl. Ser. 542).

Eniutina, R.I. 1954. Local stocks of pink salmon in the Amur Basin and neighboring waters. Vopr. Ikhtiol. 2:139-143. (Transl. from Russian; Fish. Res. Board Can. Transl. Ser. 284).

Farley, E.V., Jr., and H.R. Carlson. 2000. Spatial variations in early marine growth and condition of thermally marked juvenile pink and chum salmon in the coastal waters of the GOA. N. Pac. Anadr. Fish. Comm. Bull. No. 2:317-324.

Fiscus, C.H. 1980. Marine mammal-salmonid interactions: a review. P. 121-132. *In:* W.J. McNeil and D.C. Himsworth (eds.). Salmonid ecosystems of the North Pacific. Oregon State University Press, Corvallis, OR.

Gerke, R.J., and V.W. Kaczynski. 1972. Food of juvenile pink and chum salmon in Puget Sound, Washington. Wash. Dep. Fish. Tech. Rep.10:27 p.

Gharrett, A.J., C. Smoot, and A.J. McGregor. 1988. Genetic relationships of even-year northwestern Alaskan pink salmon. Trans. Am. Fish. Soc. 117:536-545.

Godin, J.G.J. 1980a. Temporal aspects of juvenile pink salmon *(Oncorhynchus gorbuscha* Walbaum) emergence from a simulated gravel redd. Can. J. Zool. 58:735-744.

Godin, J.G.J. 1980b. Ontogenetic changes in the daily rhythms of swimming activity and of vertical distribution in juvenile pink salmon *(Oncorhynchus gorbuscha* Walbaum). Can. J. Zool. 58:745-753.

Godin, J.G.J. 1981. Daily patterns of feeding behavior, daily rations, and diets of juvenile pink salmon *(Oncorhynchus gorbuscha)* in two marine bays of British Columbia. Can. J. Fish. Aquat. Sci. 38: 10-15.

Hanavan, M.G., and B.E. Skud. 1954. Intertidal spawning of pink salmon. Fish. Bull. Fish Wild. Serv. 56:167-185.

Hawkins, S.L., N.V. Varnavskaya, E.A. Matzak, V.V. Efremov, C.M. Guthrie III, R.L Wilmot, H. Mayama, F. Yamazaki, and A.J. Gharrett. 2002. Population structure of odd-broodline Asian pink salmon and its contrast to the even-broodline structure. J. Fish Biol.,Vol.60,no.2, pp. 370-388.

Healey, M.C. 1967. Orientation of pink salmon (*Oncorhynchus gorbuscha*) during early marine migration from Bella Coola River system. J. Fish. Res. Board Can. 24:2321-2338.

Heard, W.R. 1978. Probable case of streambed overseeding: 1967 pink salmon, *Oncorhynchus gorbuscha,* spawners and survival of their progeny in Sashin Creek, southeast Alaska Fish. Bull. (U.S.) 76:569-582.

Heard, W.R. 1991. Life history of pink salmon, *Oncorhynchus gorbuscha*, p 119-230 *in* C. Groot and L. Margolis, eds. Pacific salmon life histories. UBC Press, Vancouver.

Heintz, R.A., S.D. Rice, A.C. Wertheimer, R. Bradshaw, F.P. Thrower, J.E. Joyce, and J.W. Short. 2000. Delayed effects on growth and marine survival of pink salmon after exposure to crude oil during embryonic development. Marine Ecology Progress Series 208: 205-216.

Helle, J.H., R.S. Williamson, and J.E. Bailey. 1964. Intertidal ecology and life history of pink salmon at Olsen Creek, Prince William Sound, Alaska. U.S. Fish Wild. Serv. Spec. Sci. Rep. Fish. 483: 26 p.

Helle, J.H. 1966. Behavior of displaced adult pink salmon. Trans. Am. Fish. Soc. 95:188-195.

Helle, J.H. 1970. Biological characteristics of intertidal and fresh-water spawning pink salmon at Olsen Creek, Prince William Sound, Alaska, 1962- 63. U.S. Fish Wild. Serv. Spec. Sci. Rep. Fish. 602: 19 p.

Hilborn, R., and D. Eggers. 2000. A review of the hatchery programs for pink salmon in Prince William Sound and Kodiak Island, Alaska. Transactions of the American Fisheries Society 129(2), 333-350.

Hoar, W.S. 1951. The chum and pink salmon fisheries of British Columbia 1917-1947. Bull. Fish. Res. Board Can. 90:46 p.

Hoar, W.S. 1956. The behaviour of migrating pink and chum salmon fry. J. Fish. Res. Board Can. 13:309-325.

Hoar, W.S. 1958. The evolution of migratory behaviour among juvenile salmon of the genus *Oncorhynchus.* J. Fish. Res. Board Can. 15:391-428.

Hunter, J.G. 1959. Survival and production of pink and chum salmon in a coastal stream. J. Fish. Res. Board Can. 16:835-886.

Ishida, T. 1966. Pink salmon in the Far East. P. 29-39. *In:* Salmon of the North Pacific Ocean. Part III. A review of the life history of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 18.

Jaenicke, H.W., and A.G. Celewycz. 1994. Marine distribution and size of juvenile Pacific salmon in Southeast Alaska and northern British Columbia. Fishery Bulletin 92(1), 79-90.

Karpenko, V.I. 2003. Review of Russian marine investigations of juvenile Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:69-88.

Karpenko, V.I. 1979. Feeding habits of juvenile Pacific salmon in the coastal waters of Kamchatka. Sov. J. Mar. Biol. 5:398-405.

Karpenko, V.I. 1987. Growth variation of juvenile pink salmon, *Oncorhynchus gorbuscha,* and chum salmon *Oncorhynchus keta,* during the coastal period of life. J. Ichthyol. 27:117-125.

Kirkwood, J.B. 1962. Inshore-marine and freshwater life history phases of pink salmon, *Oncorhynchus gorbuscha* (Walbaum), and the chum salmon, *O. keta* (Walbaum), in Prince William Sound, Alaska. Ph.D. thesis. University of Kentucky, Louisville, KY. 300 p.

Kron, T.M., and H.J. Yuen. 1978. Zooplankton abundance and the feeding habits and migration of juvenile pink salmon, Tutka Bay, Alaska, 1975. Alaska Department of Fish and Game, FRED Division. Anchorage. AK. 25 p.

Krupitskiy, Yu. G., and A.F. Ustyugov. 1977. The pink salmon, *Oncorhynchus gorbuscha,* in the rivers of the north of Krasnoyarsk territory. J. Ichthyol. 17:320-322.

Landingham, J.H. 1982. Feeding ecology of pink and chum salmon fry in the nearshore habitat of Auke Bay, Alaska. M.Sc. thesis. University of Alaska, Juneau, AK. 132 p.

Landingham, J.H., M.V. Sturdevant, and R.D. Brodeur. 1998. Feeding habits of juvenile Pacific salmon in marine waters of southeast Alaska and northern British Columbia. Fishery Bulletin 96(2):285-302.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78, 1069-1079.

Martin, J.W. 1966. Early sea life of pink salmon. P. 111-125. *In:* W.L. Sheridan (ed.). Proceedings of the 1966 Northeast Pacific Pink Salmon Workshop. Alaska Dep. Fish Game Inf. Leafl. 87.

Mayama, H., and Y. Ishida. 2003. Japanese studies on the early ocean life of juvenile salmon. N. Pac. Anadr. Fish Comm. Bull. 3:41-67.

McDonald, J. 1960. The behaviour of Pacific salmon fry during their downstream migration to freshwater and saltwater nursery areas. J. Fish. Res. Board Can. 17:655-676.

McIntyre, J.D., R.R. Reisenbichler, J.M. Emlen, R.L. Wilmot, and J.E. Finn. 1988. Predation of Karluk River sockeye salmon by coho salmon and char. FISH. BULL., vol. 86, no. 3, pp. 611-616.

McNeil, W.J. 1962. Mortality of pink and chum salmon eggs and larvae in southeast Alaska streams. Ph.D. thesis. University of Washington, Seattle, WA. 270 p.

McRoy, C.P., J. Milton, J. Olsen, V. Patrick, A.J. Paul, D. Salmon, D. Scheel, G.L. Thomas, S.L. Vaughan, and T.M. Willette. 2001a. Ecosystem controls of juvenile pink salmon (*Oncorhynchus gorbuscha*) and Pacific herring (*Clupea pallasi*) populations in Prince William Sound, Alaska. Fisheries Oceanography 10(1), 1-13.

Merrell, T.R. 1962. Freshwater survival of pink salmon at Sashin Creek. P. 59-72. *In:* N.J. Wilimovskv (ed.). Symposium on Pink Salmon. H.R. MacMillan Lectures in Fisheries. Institute of Fisheries, University of British Columbia, Vancouver, BC.

Meuter, F.J., R.M. Peterman, and B.J. Pyper. 2002. Opposite effects of ocean temperature on survival rates of 120 stocks of Pacific salmon (Oncorhynchus spp.) in northern and southern areas. Canadian Journal of Fisheries and Aquatic Sciences 59, 456-463.

Mortensen, D., A. Wertheimer, S. Taylor, and J. Landingham. 2000. The relation between early marine growth of pink salmon, *Oncorhynchus gorbuscha*, and marine water temperature, secondary production, and survival to adulthood. Fishery Bulletin 98, 319-335.

Mortensen, D.G. 1983. Laboratory studies on factors influencing the first feeding of newly emerged pink salmon *(Oncorhynchus gorbuscha)* fry. M.Sc. thesis. University of Alaska, Juneau, AK. 108 p.

Mortensen, D.G., A.C. Wertheimer, J.M. Maselko, and S.G. Taylor. 2002. Survival and straying of Auke Creek, Alaska, pink salmon marked with coded-wire tags and thermally induced otolith marks. Transactions of the American Fisheries Society, Volume 131: 14- 26.

Moulton, L.L. 1997. Early marine residence, growth, and feeding by juvenile salmon in Northern Cook Inlet, Alaska. Alaska Fishery Research Bulletin 4(2):154-177.

Murray, C.B., and T.D. Beacham. 1986. Effect of varying temperature regimes on the development of pink salmon *(Oncorhynchus gorbuscha)* eggs and alevins. Can. J. Zool. 64:670-676.

Neave, F., T. Ishida, and S. Murai. 1967. Salmon of the North Pacific Ocean. Part VI. Pink salmon in offshore waters. Int. North Pac. Fish. Comm. Bull. 22:33 p.

Neave, F., T. Ishida, and S. Murai. 1952. “Even-year” and “odd-year” pink salmon populations. Proc. Trans. R. Soc. Can. Ser. 3 46(5):55-70.

Neave, F., T. Ishida, and S. Murai. 1953. Principles affecting the size of pink and chum salmon populations in British Columbia. J. Fish. Res. Board Can. 9:450-491.

Neave, F., T. Ishida, and S. Murai. 1955. Notes on the seaward migration of pink and chum salmon fry. J. Fish. Res. Board Can. 12:369-374.

Neave, F., T. Ishida, and S. Murai. 1958. The origin and speciation of *Oncorhynchus.* Proc. Trans. R. Soc. Can. Ser. 3 52(5):25-34.

Neave, F., T. Ishida, and S. Murai. 1962. The observed fluctuations of pink salmon in British Columbia. P. 3-14. *In*: N.J. Wilimovsky (ed.). Symposium on Pink Salmon. H.R. MacMillan Lectures in Fisheries. Institute of Fisheries, University of British Columbia, Vancouver, BC.

Neave, F. 1948. Fecundity and mortality in Pacific salmon. Proc. Trans. R. Soc. Can. Ser. 3 42(5):97-105.

Nicola, S.J. 1968. Scavenging *by Alloperla (Plecop*tera: Chloroperlidae) nymphs on dead pink *(Oncorhynchus gorbuscha)* and chum (O. *keta)* salmon embryos. Can. J. Zool. 46:787-796.

Olson, J.M., and W.J. McNeil. 1967. Research on pink salmon at Little Port Walter, Alaska, 1934-64. U.S. Fish Wild. Serv. Data Rep. 17:301 p.

Parker, R.R. 1962a. A concept of the dynamics of pink salmon populations. P. 203-211. *In*: N.J. Wilimovsky (ed.). Symposium on Pink Salmon. H.R. MacMillan Lectures in Fisheries. Institute of Fisheries, University of British Columbia, Vancouver, BC.

Parker, R.R. 1962b. Estimations of ocean mortality rates for Pacific salmon *(Oncorhynchus). J.* Fish. Res. Board Can. 19:561-589.

Parker, R.R. 1968. Marine mortality schedules of pink salmon of the Bella Coola River, central British Columbia. J. Fish. Res. Board Can. 25:757-794.

Perry, R.I., N.B. Hargreaves, B.J. Waddell, and D.L. Mackas. 1996. Spatial variations in feeding and condition of juvenile pink and chum salmon off Vancouver Island, British Columbia. Fisheries Oceanography 5(2):73-88.

Pirtle, R.B. 1977. Historical pink and chum salmon estimated spawning escapements from Prince William Sound, Alaska streams, 1960-1975. Alaska Dept. Fish Game, ADF&G Tech. Data Rep. 35:332 p.

Pritchard, A.L. 1934a. Do caddis fly larvae kill fish? Can. Field-Nat. 48:39 p.

Pritchard, A.L. 1939. Homing tendency and age at maturity of pink salmon *(Oncorhynchus gorbuscha)* in British Columbia. J. Fish. Res. Board Can. 4:233-251.

Pritchard, A.L. 1948b. A discussion of the mortality in pink salmon *(Oncorhynchus gorbuscha)* during their period of marine life. Proc. Trans. R. Soc. Can. Ser. 3 42(5):125-133.

Ricker, W.E. 1962. Regulation of the abundance of pink salmon populations. P. 155-206. *In:* N.J. Wilimovsky (ed.). Symposium on Pink Salmon. H.R. MacMillan Lectures in Fisheries. Institute of Fisheries, University of British Columbia, Vancouver, BC.

Royce, W.F. 1962. Pink salmon fluctuations in Alaska. P. 15-23. *In:* N.J. Wilimovsky (ed.). Symposium on Pink Salmon. H.R. MacMillan Lectures in Fisheries. Institute of Fisheries, University of British Columbia, Vancouver, BC.

Ruggerone, G.T., M. Zimmermann, K.W. Myers, J.L. Nielsen, and D.E. Rogers. 2003. Competition between Asian pink salmon (Oncorhynchus gorbuscha) and Alaskan sockeye salmon (O. nerka) in the North Pacific Ocean. Fish. Oceanogr. 12:3. 209-219.

Sakagawa, G.T. 1972. The dynamics of juvenile salmon, with particular emphasis on pink salmon *(Oncorhynchus gorbuscha),* during their early marine life. Ph.D. thesis. University of Washington, Seattle, WA. 352 p.

Shershnev, A.P., V.M. Chupakhin, and V.A. Rudnev. 1982. Ecology of juvenile pink salmon, *Oncorhynchus gorbuscha* (Salmonidae), from Sakhalin and Iturup islands during the marine period of life. J. Ichthyol. 22:90-97.

Skud, B.E. 1958. Relation of adult pink salmon size to time of migration and freshwater survival. Copeia 1958:170-176.

Smoker, W.W., R.A. Heintz, A.C. Wertheimer, and S.D. Rice. 2001. Genetic Analysis of Development Mortality in Oiled and Unoiled Lines of Pink Salmon. *In* Proc. 23rd Northeast Pacific Pink and Chum Salmon Workshop. Seattle, Washington.

Takagi, K., K.V. Aro, A.C. Hartt, and M.B. Dell. 1981. Distribution and origin of pink salmon *(Oncorhynchus gorbuscha)* in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 40:195 p.

Taylor, S.G. 1980. Marine survival of pink salmon fry from early and late spawners. Trans. Am. Fish. Soc. 109:79-82.

Thorsteinson, F.V. 1959. Pink salmon migrations along the Alaska Peninsula. P. 1-7. *In:* Alaska fisheries briefs. U.S. Fish Wild. Serv. Circ. 59.

Trudel, M. E.V. Farley, Jr., B.L. Wing, and D.W. Welch. 2002. Prevalence and intensity of sea lice (Lepeophtheirus salmonis) infestation on juvenile pink salmon (Oncorhynchus gorbuscha) in the BS - September 2002. Canadian Data Report of Fish. Aquat. Scienc. XXXX

Vallion, A.C., A.C. Wertheimer, W.R. Heard, and R.M. Martin. 1981. Summary of data and research pertaining to the pink salmon population at Little Port Walter, Alaska, 1964-80. NWAFC Processed Rep. 81-10:102 p.

Walters, C.J., R. Hilborn, R.M. Peterman, and M. Staley. 1978. A model for examining early ocean limitation of Pacific salmon production. Journal of the Fisheries Research Board of Canada 35, 1303-1315.

Wertheimer, A.C, W.R. Heard, and W. W. Smoker. 2002. Effects of hatchery releases and environmental variation on wild-stock productivity: Consequences for hatchery enhancement of pink salmon in Prince William Sound, Alaska. pp. 64-71. *In* C. Orr, P. Gallaugher, and J. Penikett (Eds.) Speaking for the salmon: hatcheries and the protection of wild salmon. Simon Fraser University Continuing Studies in Science. Vancouver, B.C.

Wertheimer A.C., W.W. Smoker, T.L. Joyce, and W.R. Heard. 2001. Hatchery pink salmon in Prince William Sound: enhancement or replacement? Transactions American Fisheries Society 130: 712-720.

Wertheimer, A.C., J.F. Thedinga, R.A. Heintz, R.Bradshaw, and A.G. Celewycz. 2002. Comparative effects of pectoral fin removal and half-length coded-wire tagging of pink salmon fry on survival and size. North American Journal Aquaculture. 64:150-157.

Willette, T.M. 2001. Foraging behavior of juvenile pink salmon (*Oncorhynchus gorbushca*) and size-dependent predation risk. Fisheries Oceanography 10 (Suppl. 1):110-131.

Willette, M. 1996. Impacts of the *Exxon Valdez* oil spill on the migration, growth, and survival of juvenile pink salmon in Prince William Sound. American Fisheries Society Symposium 18, 533-550.

Wilmot, R.L., and C.V. Burger. 1985. Genetic differences among populations of Alaskan sockeye salmon. TRANS. AM. FISH. SOC., vol. 114, no. 2, pp. 236-243.

Yefanov, V.N., and V.M. Chupakhin. 1982. The dynamics of some population indices of pink salmon, *Oncorhynchus gorbuscha,* from Iturup (Kuril Islands). J. Ichthyol. 22:42-50.

SPECIES: Pink salmon, *Onchorynchus gorbuscha*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs and larvae	90 to 125 days	eggs predated by birds, fish, and mammals	late summer, fall, winter, and early spring	intragravel in stream beds WC, LK, BHC	15 to 50 cm in gravel depth	medium to coarse gravel CB, G	NA	Develop at 1-10°C, eggs hatch at about 100 d, larvae emerge from gravel about 125 d post hatch
Juveniles, freshwater	1 to 15 days; short streams = 1 day, longer rivers=15 day	fry are predated by birds, fish, and mammals	spring	rivers and streams WC, LK, BHC	generally migrating in upper portion of water column	varied	NA	downstream migration is mostly in darkness
Juveniles, estuarine	2 to 3 months	copepods, euphausiids, decapod larva, amphipods	summer	EST, initially nearshore, then offshore in bays and inlets, along kelp beds	generally occupying the upper portion of water column	varied: K, SAV	NA	Preference for increasing salinities, school with other salmon and Pacific sandfish
Juveniles, marine	3 to 6 months	copepods, euphausiids, decapod larva, amphipods	summer, fall, and early, pre anulus winter	coastal, ICS, MCS, OCS; moving further offshore with growth	generally migrating in upper portion of water column	varied: K, SAV	UP, F, CL, E	Coastal and shelf migrations move into oceanic waters in later stages

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other **Page 2 of 2**
Immature and maturing adults marine	6 to 10 months	fish, squid, euphausiids, amphipods, and copepods	spring, summer, and early fall	Oceanic to nearshore in final migration	P, N	NA	UP, F, CL, E: Regional stocks have specific oceanic migratory patterns	Rapid marine growth; onset of maturation timing varies among stocks; earlier north, later south
Adults, freshwater	2 years of age from egg to mature adult, final stage 1 to 2 months	Active feeding ceases, digestive organs atrophy	spawning (Aug-Oct)	WC, LK, BCH	Varied, holding in pools, spawning on shallow riffles	medium to coarse gravel CB, G	NA	sexual dimorphism in spawning males, called humpback salmon

Habitat Description for Chum Salmon

(*Oncorhynchus keta)*

Management Plan and Area(s) Salmon fisheries in the EEZ off the coast of Alaska, Council, 1990

Life History and General Distribution

Chum salmon spawn in streams emptying into the North Pacific Ocean north of about 40°N in both Asia and North America. In Asia, chum salmon spawn in streams on the east side of the Korean peninsula in both South and North Korea northward, including Japan, China (tributaries to the Amur River), Russia and westward into the Arctic Ocean as far west as the Lena River. In North America, chum salmon spawn in streams entering the North Pacific Ocean as far south as northern California and northward in streams along the coasts of Oregon, Washington, British Columbia, and Alaska on into the BS, Arctic Ocean, and Beaufort Sea as far east as the Mackenzie River in Northwest Territory. Chum salmon spawn in Yukon Territory, Canada, in tributaries of the Yukon River. Only populations small in numbers spawn north and east of the Noatak River, which enters the ocean at Kotzebue, Alaska, and south of Tillamook Bay, Oregon.

In general, chum salmon spawn in the lower reaches of coastal streams less than 100 miles upstream from the ocean. Two notable exceptions are the Yukon River in North America and the Amur River in Russia and China where chum salmon migrate upstream more than 1,500 miles to spawning areas. In Prince William Sound, and to a lesser extent southeast Alaska, chum salmon will spawn in the intertidal portions of streams in areas where ground water upwells into the streams. Chum salmon throughout their range tend to build their redds in areas of streams where ground water (about 4 to 7ºC) upwells.

In North America, chum salmon return from the ocean to spawn, for the most part, between June and January. In general, spawning starts earlier in the north and ends later in the southern part of their range. Of course, major exceptions in this pattern occur. The latest spawning in southeast Alaska occurs in the Chilkat River, near Haines, Alaska, from September through January. Most chum salmon spawning in Alaska is usually finished by early November. Most spawning in Washington/Oregon takes place from August through November; however, August spawners have been declining in recent years. Chum salmon return to the Quilcene National Fish Hatchery in December, and the Nisqually River near Olympia, Washington, has spawners during January and February and sometimes into March.

So called summer and fall races of chum salmon occur in Asia and North America. Summer and fall races both enter the Yukon River. The summer chum salmon start entering the river in May and the fall chum enter the river in June and July. The fall stocks tend to spawn farthest up river in September through November. Summer chum are more abundant than fall chum in the Yukon River; however, the fall chum are larger. In southern southeast Alaska and northern British Columbia summer chum enter mostly mainland rivers in mid-June and spawning may extend into late October and early November. Fall chum in southern southeast Alaska and northern British Columbia spawn mostly in streams on the Islands and spawning typically occurs during September and October. Unlike the Yukon River, summer chum salmon in southern Southeast Alaska and northern British Columbia are larger than the fall stocks for the same age, even though the summer stocks may spawn more than 3 months earlier.

Chum salmon return to spawn as 2- to 7-year-olds. Two-year-old chum are rare in North America and occur primarily in the southern part of their range, e.g., Oregon. Seven-year-old chum are also rare and occur mostly in the northern areas. In general, chum salmon get older from south to north. Three- and four-year-olds tend to dominate in the southern areas and 4-, 5-, and 6-year-olds tend to dominate in the more northern areas. For the most part older chum salmon are larger than younger fish but much overlap occurs between the age groups. The largest chum salmon in North America (and probably the world) occur in the Portland Canal area, which forms the border between Alaska and British Columbia.

Chum salmon fry, like pink salmon, do not overwinter in the streams but migrate (mostly at night) out of the streams directly to the sea shortly after emergence. The range of this outmigration occurs between February and June but most fry leave the streams during April and May. Chum salmon do tend to linger and forage in the intertidal areas at the head of bays. Estuaries are very important for chum salmon rearing during the spring and summer.

Juvenile chum salmon are present in the coastal waters mostly during July through October, and generally move to the north and west along the coasts of Oregon, Washington, British Columbia, and Alaska. Most juvenile chum salmon are thought to leave the coastal waters and move south into the North Pacific Ocean between Kodiak and False Pass during late fall. After chum salmon form an annulus on their scales (January to March) they are considered immature. They may remain immature for several years until they start maturing and begin their migration to their spawning streams.

Both Asian and North American chum salmon winter in the North Pacific but Asian chum salmon migrate much further east than North American chum salmon migrate to the west. North American chum salmon are seldom found west of 175°E; however, Asian salmon are found eastward to at least 140°W. However, Asian and North American stocks of chum salmon are intermingled on the high seas.

After the 1976 to 1977 Regime Shift in the North Pacific Ocean, most chum salmon stocks increased in abundance through the mid-1990s. The Regime Shift apparently created very favorable ocean conditions for all species of salmon from northern British Columbia to northern Alaska. However, as the abundance increased, age at maturity increased, and size at age decreased drastically. Chum salmon of the same age in the early 1990s weighed up to 46 percent less than they weighed in the early 1970s. During this same time, Asian chum salmon also matured older and their size at age declined. These changes in size and age at maturity as population numbers increased suggests that the North Pacific Ocean may have carrying capacity limits for chum salmon under certain conditions.

Fisheries

Chum salmon are captured primarily in purse seines and gill-nets in North America after traps were outlawed in Alaska in 1960. Some chum salmon are captured in troll fisheries, primarily in Canada.

Major fisheries occur for chum salmon from southern Washington to the Noatak River in northwestern Alaska. Significant declines of chum salmon in Oregon in the 1940s caused the state to abandon net fisheries and the stocks still have not recovered.

Most net fisheries for chum salmon occur in the coastal waters in Alaska, but some in-river gill-net fisheries occur in the larger rivers for both commercial and subsistence fisheries. Chum salmon are often captured incidently in fisheries targeting pink or sockeye salmon. Large incidental catches of chum salmon occur in southeast Alaska and Prince William Sound. When the Pacific Salmon Treaty between the United States and Canada was signed in 1984, chum salmon in the Portland Canal (on both sides of the border but particularly in Canada) were identified as a major conservation concern. The cause of this problem was blamed on incidental capture of chum salmon in fisheries targeting pink and sockeye salmon.

Chum salmon have also been captured incidentally in the trawl fisheries for pollock in the BS. Apparently, the chum are "scooped" at the surface when the trawl is being let out and brought in. In some years this can be a major problem, e.g., in 1994 when about 250,000 chum were estimated to be part of the bycatch.

Chum salmon fisheries utilize seines, gill-nets, and troll gear and there are no apparent impacts of the gear on marine or freshwater habitats.

Relevant Trophic Information

Chum salmon eggs, alevins, and juveniles in freshwater streams provide an important food source for many birds (e.g., gulls, crows, magpies, ouzels, kingfishers), small mammals, other fishes, and many invertebrates. Chum salmon carcasses provide nutrients for the freshwater watersheds and estuaries. Carcasses are also highly important for food for many birds (e.g., eagles, ravens, crows, gulls, magpies). The late chum salmon return to the Chilkat River system near Haines, Alaska, is the reason that large numbers of bald eagles congregate on the spawning grounds every year in September through December. Adult chum salmon and spawned carcasses provide a major food source for brown and black bears, wolverines, wolves, and many other small mammals. Many species of invertebrates utilize carcasses for food.

Approximate Upper Size Limit of Juvenile Fish (in cm): If the term juvenile chum salmon refers to the fry stage up to the time of the first annulus formation in the ocean, which occurs in January-March, the upper size limit is about 30 cm. Juvenile chum salmon in the outside waters of Southeast Alaska in mid to late August range in size up to about 25 cm.

Habitat and Biological Associations

Eggs/Spawning: Chum salmon spawn in gravel in streams, side-channel sloughs, and intertidal portions of streams when the tide is below the spawning area. In all of these areas upwelling ground water is often the common denominator. Many side-channel sloughs have very little current on the surface and can be very silty; however, the upwelling ground water keeps the silt in suspension in the intragravel water. The upwelling water also keeps these spawning areas with slow moving surface water from freezing in the winter. The depth that eggs are deposited in the streams varies according to the gravel size, current, and size of the female, but the range is about 8 to 50 cm. Eggs and sperm are deposited in the redd simultaneously and each female spawns with up to six males at the same time. Several redds are constructed by each female and different males may be involved in the spawning act in subsequent redds. Stream life of both sexes varies and is longer in the early stages of the run (about 14 days) and shorter near the end of the run (as few as 6 days) in coastal streams.

Larvae/Alevins: Fertilized eggs incubate in the streambed gravel for about 5 to 8 months. Eggs, alevins, and pre-emergent fry can be killed by desiccation, freezing, mechanical injuries due to streambed shifting, e.g., during floods, and predators. The intragravel water during incubation and rearing must be of suitable temperatures and be free of toxins with adequate oxygen and flow to remove waste products. Survival from deposited eggs to emergent fry is highly variable, ranging from about 1 to 20 percent. The health of the eggs and emerging fry is also dependent on gravel composition, spawning time, spawning density, and genetic characteristics. In general, chum salmon eggs have to be fertilized in water above 4ºC and in salinity less than 2 parts per thousand. Dissolved oxygen levels during incubation need to be above 3 to 4 mg/l.

Juveniles: After emerging from the streambed (as early as February and as late as June) schooling chum salmon fry migrate downstream, mostly at night, to the estuaries where they tend to feed in the intertidal grass flats and along the shore. Chums can utilize these intertidal wetlands for several months before actively migrating out of bays and into channels on the way to the outside waters. Pink salmon on the other hand tend to move more directly to more open water areas. Chum salmon utilize a wide variety of food items, including mostly invertebrates (including insects), and gelatinous species. Offshore movement of larger juveniles occurs mostly in July to September.

Adults: Chum salmon reside in the ocean for about 1 to 6 years. Adults mature at ages 2 through 7 years; however, 2- and 7-year-old chum salmon are rare. Throughout their range 3-, 4-, and 5-year olds are common but 3- and 4-year-old salmon dominate the southern stocks and 4-, 5-, and 6-year-old chum salmon dominate the northern stocks. Slow or rapid growth in the ocean can modify age at maturity. Slower growth during the second year at sea causes some chum salmon to mature 1 or 2 years later. Chum salmon eat a variety of foods during their ocean life, e.g., amphipods, euphausiids, pteropods, copepods, fish, and squid larvae. Chum salmon also utilize gelatinous zooplankton for food more often than any of the other species of salmon. Chum salmon have a much larger stomach than the other species of salmon and this large capacity may allow them to utilize the nutrients from the gelatinous zooplankton more efficiently.

Asian and North American chum salmon are intermingled on the high seas as immature and during their last year at sea. Recently, immature and maturing chum salmon from Washington, British Columbia, and southeast Alaska have been identified in the BS in August. Chum salmon spawn mostly in November in Washington and southern British Columbia so these fish are capable of long distant migrations in their last year in the sea.

Special Habitat Concerns: Chum salmon are subject to the same habitat concerns as the other species of salmon, e.g., habitat destruction or silting due to logging and road building activities, blockages due to dams, and pollution. In addition, chum salmon have two habitat requirements that are essential in their life history that make them very vulnerable: (1) reliance on upwelling ground water for spawning and incubation, and (2) reliance on estuaries/tidal wetlands for juvenile rearing after migrating out of the streams. The hydrology of upwelling ground water into stream gravel is highly complex and poorly understood. Whatever activities change the amount and quality of groundwater that upwells would very likely affect chum salmon survival in a negative manner. Drilling activities and uplift of land masses due to earthquakes are two phenomena known to affect groundwater. Wetlands and estuaries near communities are very vulnerable to pollution and filling activities that would negatively affect essential chum salmon rearing areas.

Chum salmon will spawn in intertidal portions of streams, most notably in Prince William Sound. The intertidal portion of streams is very vulnerable to coastal pollution from oil spills et al. In Prince William Sound, chum salmon spawners are active in the intertidal zone of streams from late June through September. Eggs, alevins, and fry are in the intertidal gravel from late June through May. That leaves a very narrow “window” in June when the intertidal zone may be free of adults, eggs, alevins, or fry.

Additional Information Sources

Ben van Alen, Alaska Department of Fish and Game, Douglas.
Christene Kondzela, NMFS, Auke Bay Laboratory, Juneau.

Literature

Alderdice, D.F., W.P. Wickett, and J.R. Brett. 1958. Some effects of temporary exposure to low dissolved oxygen levels on Pacific salmon eggs. J. Fish. Res. Board Can. 15: 229-249.

Aro, K.V., and M.P. Shepard. 1967. Pacific salmon in Canada, p. 225-327. *In*: Salmon of the North Pacific Ocean. Part IV. Spawning populations of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 23.

Atkinson, C.E., J.H. Rose, and R.O. Duncan. 1967. Pacific salmon in the United States, p. 43-224. *In*: Salmon of the North Pacific Ocean. Part IV. Spawning populations of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 23.

Bailey, J.E., B.L. Wing, and C.R. Mattson. 1975. Zooplankton abundance and feeding habits of fry of pink salmon, *Oncorhynchus gorbuscha*, and chum salmon, *Oncorhynchus keta*, in Traitors Cove, Alaska, with speculation on the carrying capacity of the area. Fish. Bull. (U.S.) 73: 846-861.

Bakkala, R.G. 1970. Synopsis of biological data on the chum salmon, *Oncorhynchus keta* (Walbaum) 1792. FAO Fish. Synop. 41: U.S. Fish. Wildl. Serv. Circ. 315: 89 p.

Bams, R.A. 1970. Evaluation of a revised hatchery method tested on pink and chum salmon fry. J. Fish. Res. Board Can. 27: 1429-1452.

Beacham, T.D. 1982. Fecundity of coho salmon (*Oncorhynchus kisutch*) and chum salmon (*O. keta*) in the northeast Pacific Ocean. Can. J. Zool. 60: 1463-1469.

Beacham, T.D. 1984a. Age and morphology of chum salmon in southern British Columbia. Trans. Am. Fish Soc. 113: 727-736.

Beacham, T.D., and C.B. Murray. 1986. Comparative developmental biology of chum salmon (*Oncorhynchus keta*) from the Fraser River, British Columbia. Can. J. Fish. Aquat. Sci. 43: 252-262.

Beacham, T.D., and C.B. Murray. 1987. Adaptive variation in body size and developmental biology of chum salmon (*Oncorhyunchus keta*) in British Columbia. Can. J. Fish. Aquat. Sci. 44: 244-261.

Beacham, T.D., and P. Starr. 1982. Population biology of chum salmon, *Oncorhynchus keta*, from the Fraser River, British Columbia. Can. J. Fish. Aquat. Sci. 43: 252-262.

Beacham, T.D., F.C. Withler, and R.B. Morley. 1985. Effect of egg size on incubation time and alevin and fry size in chum salmon (*Oncorhynchus keta*) and coho salmon. (*O. kisutch*). Can. J. Zool. 63: 847-850.

Beacham, T.D., R.E. Withler, and A.P. Gould. 1985. Biochemical genetic stock identification of chum salmon (*Oncorhynchus keta*) in southern British Columbia, 1985. Can. J. Fish. Aquat. Sci. 43: 437-448.

Beamish, RJ., and D.R. Bouillon. 1993. Pacific salmon production trends in relation to climate. Can. J. Fish. Aquat. Sci. 50: 1004-1016.

Beamish, R.J., I.A. Pearsall, and M.C. Healey. 2003. A history of the research on the early marine life of pacific salmon off Canada's Pacific coast. N. Pac. Anadr. Fish Comm. Bull. 3:1-40.

Bigler, B.S., D.W. Welch, and J.H. Helle. 1996. A review of size trends among North Pacific salmon *(Oncorhynchus* spp.). Can J. Fish. Aquatic. Sci. 53: 455-465.

Bilton, H.T., and S.A.M. Ludwig. 1966. Times of annulus formation on scales of sockeye, pink, and chum salmon in the GOA. J. Fish. Res. Board Can. 23: 1403-1410.

Birman, I.B. 1951. Qualitative characteristics of the stocks and the dynamics of abundance of the autumn chum salmon in the Amur River. Izv. Tikhookean. Nauchno-lssled. Inst. Rybn. Khoz. Okeanogr. 35: 17-31. (Transl. from Russian; Fish. Res. Board Can. Transl. Ser. 349).

Bradford, M.J. 1995. Comparative review of Pacific salmon survival rates. Canadian Journal of Fisheries and Aquatic Sciences 52, 1327-1338.

Brodeur, R.D., G.W. Boehlert, E. Casillas, M.B. Eldridge, J.H. Helle, W.T. Peterson, W.R. Heard, S.T. Lindley, and M.H. Schiewe. 2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. Fisheries 25, 7-16.

Brodeur, R.D., K.W. Myers, and J.H. Helle. 2003. Research conducted by the United States on the early ocean life history of Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:89-131.

Carlson, H.R., E.V. Farley, Jr., and K.W. Myers. 2000. The use of otolith marks to determine stock-specific ocean distribution and migration patterns of Alaskan pink and chum salmon in the North Pacific Ocean 1996-1999. N. Pac. Anadr. Fish. Comm. Bull. No. 2:291-300.

Cooney, R.T., and R.D. Brodeur. 1998. Carrying capacity and North Pacific salmon production: stock-enhancement implications. Bulletin of Marine Science 62, 443-464.

Dill, L.M., and T.G. Northcote. 1970. Effects of some environmental factors on survival, condition, and timing of emergence of chum salmon fry (*Oncorhyunchus keta*). J. Fish. Res. Board Can. 27: 196-201.

Farley, E.V., Jr., and H.R. Carlson. 2000. Spatial variations in early marine growth and condition of thermally marked juvenile pink and chum salmon in the coastal waters of the GOA. N. Pac. Anadr. Fish. Comm. Bull. No. 2:317-324.

Forbes, L.S., and R.M. Peterman. 1994. Simple size-structured models of recruitment and harvest in Pacific salmon *(Oncorhynchus* spp.). Can. J. Fish. Aquat. Sci. 51: 603-616.

Freeland, H.J. 1990. Sea surface temperatures along the coast of British Columbia: regional evidence for a warming trend. Can. J. Fish. Aquat. Sci. 47: 346-350.

Gilbert, C.H., and W.H. Rich. 1927. Second experiment in tagging salmon in the Alaska Peninsula fisheries reservation, summer of 1923. Fish. Bull. U.S. 42: 27-75.

Hare, S.R., and R.C. Francis. 1995. Climate change and salmon production in the northeast Pacific Ocean. Can. Spec. Publ. Fish. Aquat Sci. 121: 357-372.

Healey, M.C. 1982b. Timing and relative intensity of size selective mortality of juvenile chum salmon *(Oncorhynchus keta)* during early sea life. Can. J. Fish. Aquat. Sci. 39:952-957.

Helle, J.H. 1979. Influence of marine environment on age and size-at-maturity, growth, and abundance of chum salmon, *Oncorhynchus keta* (Walbaum), from Olsen Creek, Prince William Sound, Alaska. Ph.D. thesis, Oregon State University, Corvallis, OR. 118 p.

Helle, J.H. 1981. Significance of the stock concept in artificial propagation of salmonids in Alaska. Can. J. Fish. Aquat. Sci. 38: 1665-1671.

Helle, J.H. 1984. Age and size-at-maturity of some populations of chum salmon in North America, p. 126-143. *In P.* A. Moiseev [ed.], Proceedings of the Pacific Salmon Biology Conference, 3-13 Oct. 1978, Yuzhno-Sakhalinsk, USSR. Pacific Scientific Institute of Fisheries and Oceanography (TINRO), 4 Shevchenko Alley, 690600, Vladivostok, USSR.

Helle, J.H. 1989. Relation between size-at-maturity and survival of progeny in chum salmon, *Oncorhynchus keta* (Walbaum). J. Fish. Biol. 35 (Suppl. A): 99-107.

Helle, J.H., and M.S. Hoffman. 1995. Size decline and older age-at-maturity of two chum salmon *(Oncorhynchus keta)* stocks in western North America, 1972-92. *In* Climate change and northern fish populations. Edited by R. J. Beamish. Can. Spec. Publ. Fish. Aquat. Sci. 121: 245-260.

Helle, J.H., and M.S. Hoffman. 1998. Changes in size and age at maturity of two North. American stocks of chum salmon (*Oncorhynchus keta)* before and after a major regime shift in the North Pacific Ocean. North Pacific Anadromous Fish Commission. Bulletin No. 1, 81-89.

Henry, K.A. 1953. Analysis of factors affecting the production of chum salmon (*Oncorhynchus keta*) in Tillamook Bay. Fish. Comm. Oreg. Contrib. 18: 37 p.

Henry, K.A. 1954. Age and growth study of Tillamook Bay chum salmon (*Oncorhynchus keta*). Fish. Comm. Oreg. Contrib. 19: 28 p.

Hoar, W.S. 1958. The evolution of migratory behaviour among juvenile salmon of the genus *Oncorhynchus*. J. Fish. Res. Board Can. 15: 391-428.

Hunter, J.G. 1959. Survival and production of pink and chum salmon in a coastal stream. J. Fish. Res. Board Can. 16: 835-886.

Ishida, Y., S. Ito, M. Kaeriyama, S. McKinnell, and K. Nagasawa. 1993. Recent changes in age and size of chum salmon *(Oncorhynchus keta)* in the North Pacific Ocean and possible causes. Can. J. Fish. Aquat. Sci. 50: 290-295.

Jaenicke, H.W., and A.G. Celewycz. 1994. Marine distribution and size of juvenile Pacific salmon in Southeast Alaska and northern British Columbia. Fishery Bulletin 92(1), 79-90.

Kaeriyama, M. 1989. Aspects of salmon ranching in Japan. Physiol. Ecol. Jpn. Spec. Vol. 1: 625-638.

Kaeriyama, M. 1996. Population dynamics and stock management of hatchery-reared salmons in Japan. Bull. Natl. Res. Inst. Aquacult. (Suppl. 2): 11-15.

Karpenko, V.I. 2003. Review of Russian marine investigations of juvenile Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:69-88.

Kondzela, C.M., C.M. Guthrie, S.L. Hawkins, C.D. Russell, J.H. Helle, and A.J. Gharrett. 1994. Genetic relationships among chum salmon populations in southeast Alaska and northern British Columbia. Can. J. Fish. Aquat. Sci. 51(Suppl. 1):50-64

Koski, K.V. 1975. The survival and fitness of two stocks of chum salmon (*Oncorhynchus keta*) from egg deposition to emergence in a controlled-stream environment at Big Beef Creek. Ph.D. thesis. University of Washington, Seattle, WA. 212 p.

LaLanne, J.J. 1971. Marine growth of chum salmon. Int. North Pac. Fish. Comm. Bull. 27: 71-91.

Landingham, J.H., M.V. Sturdevant, and R.D. Brodeur. 1998. Feeding habits of juvenile Pacific salmon in marine waters of southeast Alaska and northern British Columbia. Fishery Bulletin 96(2):285-302.

LeBrasseur, R.J. 1969. Growth of juvenile chum salmon (*Oncorhynchus keta*) under different feeding regimes. J. Fish. Res. Board Can. 26: 1631-1645.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78, 1069-1079.

Manzer, J.I., T. Ishida, A.E. Peterson, and M.G. Hanavan. 1965. Salmon of the North Pacific Ocean. Part V. Offshore distribution of salmon. Int. North Pac. Fish. Comm. Bull. 15.

Marr, J.C. 1943. Age, length and weight studies of three species of Columbia River salmon *(Oncorhynchus keta, O. gorbuscha* and *O. kisutch).* Stanford Ichthyol. Bull. 2: 157-197.

Mason, J.C. 1974. Behavioral ecology of chum salmon fry (*Oncorhynchus keta*) in a small estuary. J. Fish. Res. Board Can. 31: 83-02.

Mayama, H., and Y. Ishida. 2003. Japanese studies on the early ocean life of juvenile salmon. N. Pac. Anadr. Fish Comm. Bull. 3:41-67.

McNeil, W.J. 1966. Effect of the spawning bed environment on reproduction of pink and chum salmon. Fish. Bull. (U.S.) 65: 495-523.

Meuter, F.J., R.M. Peterman, and B.J. Pyper. 2002. Opposite effects of ocean temperature on survival rates of 120 stocks of Pacific salmon (Oncorhynchus spp.) in northern and southern areas. Canadian Journal of Fisheries and Aquatic Sciences 59, 456-463.

Miller, A.J., D.R. Cayan, T.P. Barnett, N.E. Graham, and J.M. Oberhuber. 1994. The 1976-77 climate shift of the Pacific Ocean. Oceanography 7(1): 21-26.

Moulton, L.L. 1997. Early marine residence, growth, and feeding by juvenile salmon in Northern Cook Inlet, Alaska. Alaska Fishery Research Bulletin 4(2):154-177.

Myers, K.W., K.Y. Aydin, R.V. Walker, S. Fowler, and M.L. Dahlberg. 1996. Known ocean ranges of stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. NPAFC Doc. No. 192. Fisheries Research Institute, University of Washington, Seattle, WA.

Neave, F. 1953. Principles affecting the size of pink and chum salmon populations in British Columbia. J. Fish. Res. Board Can. 9: 450-491.

Neave, F. 1958. The origin and speciation of *Oncorhynchus.* Proc. Trans. R. Soc. Can. Ser. 3 52(5): 25-39.

Neave, F., T. Yonemori, and R.G. Bakkala. 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 35. 79 p.

Oakley, A.L. 1966. A summary of information concerning chum salmon in Tillamook Bay. Res. Briefs Fish Comm. Oreg. 12(1): 5-21.

Ogura, M., and S. Ito. 1994. Change in the known ocean distribution of Japanese chum salmon, *Oncorhynchus keta*, in relation to the program of stock enhancement. Can. J. Fish. Aquat. Sci. 51: 501-505.

Pearcy, W.G. 1992. Ocean ecology of North Pacific salmonids. Washington Sea Grant Program, University of Washington Press, Seattle, WA. 179 p.

Perry, R.I., N.B. Hargreaves, B.J. Waddell, and D.L. Mackas. 1996. Spatial variations in feeding and condition of juvenile pink and chum salmon off Vancouver Island, British Columbia. Fisheries Oceanography 5(2):73-88.

Pirtle, R.B. 1977. Historical pink and chum salmon estimated spawning escapements from Prince William sound, Alaska streams, 1960-1975. Alaska Dept. Fish & Game, ADF&G Tech. Data Rep. 35:332P.

Ricker, W.E. 1964. Ocean growth and mortality of pink and chum salmon. J. Fish. Res. Board Can. 21: 905-931.

Ricker, W.E. 1972. Hereditary and environmental factors affecting certain salmonid populations. P. 19-160 *In* R. C. Simon and P. A. Larkin [ed.} The stock concept in Pacific salmon. H. R. MacMillan Lectures in Fisheries, University of British Columbia.

Salo, E.O. 1988. Chum salmon as indicators of ocean carrying capacity, p. 81-85. *In* W.J. McNeil [ed.], Salmon production, management, and allocation. Oregon State University Press, Corvallis.

Salo, E.O. 1991. Life history of chum salmon *(Oncorhynchus keta), p.* 233-309. *In C.* Groot and L. Margolis [eds.], Pacific salmon life histories. University of British Columbia Press, Vancouver, B.C.

Sano, S. 1966. Chum salmon in the Far East, p. 4-58. *In*: Salmon of the North Pacific Ocean. Part III. A review of the life history of the North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 18.

Sano, S. 1967. Chum salmon in the Far East, p. 23-42. *In*: Salmon of the North Pacific Ocean. Part IV. Spawning populations of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 23.

Schroder, S.L. 1981. The role of sexual selection in determining overall mating patterns and mate choice in chum salmon. Ph.D. thesis. University of Washington, Seattle, WA. 274 p.

Shepard, M.P., A.C. Hartt, and T. Yonemori. 1968. Salmon of the North Pacific Ocean. Part VIII. Chum salmon in offshore waters. Int. North Pac. Fish. Comm. Bull. 25: 69 p.

Thorsteinson, F.V., J.H. Helle, and D.G. Birkholz. 1971. Salmon survival in intertidal zones of Prince William Sound streams in uplifted and subsided areas, p.194-219. *In:* The great Alaska earthquake of 1964: biology. Natl. Acad. Sci. NAS Publ. 1604.

Thorsteinson, F.V., W.H. Noerenberg, and H.D. Smith. 1963. The length, age, and sex ratio of chum salmon in the Alaska Peninsula, Kodiak Island, and Prince William Sound areas of Alaska. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. 430:84 p.

Walters, C.J., R. Hilborn, R.M. Peterman, and M. Staley. 1978. A model for examining early ocean limitation of Pacific salmon production. Journal of the Fisheries Research Board of Canada 35, 1303-1315.

Welch, D.W. 1997. Anatomical specialization in the gut of Pacific salmon (*Oncorhynchus)*: evidence for oceanic limits to salmon production? Can. J. Zool. 75: 936-942.

Wilmot, R.L., R.J. Everett, W.J. Spearman, R. Baccus, N.V. Varnavskaya, and S.V. Putivkin. 1994. Genetic stock structure of western Alaska chum salmon and a comparison with Russian far east stocks. International Symposium on Genetics of Subarctic Fish and Shellfish, Juneau, AK (USA), 17-19 May 1993 CAN. J. FISH. AQUAT. SCI.], vol. 51, no. Supplement 1, pp. 84-94.

SPECIES: Chum Salmon, *Onchorhynchus keta* **Page 1 of 2**

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs and larvae	90 to 125 days	eggs predated by birds, fish, and mammals	early summer, fall, winter, and early spring	intragravel in stream beds WC, LK, BCH	7.5 to 50 cm in gravel depth	small to coarse gravel CB, G	NA	Develop at 1-10°C, eggs hatch at 52-173 d, larvae emerge from gravel 146-325 d
Juveniles (freshwater)	1 to 15 days; short streams = 1 day, longer rivers=30 days	fry are predated by birds, fish, and mammals	spring	rivers and streams WC, LK, BCH	generally migrating in upper portion of water column	varied	NA	downstream migration is mostly in darkness
Juveniles (estuarine)	2 to 3 months	copepods, euphausiids, decapod larva, amphipods, gelatinous zooplankton	summer	EST, initially nearshore, then offshore in bays and inlets, along kelp beds	generally occupying the upper portion of water column	varied: K, SAV	NA	Preference for increasing salinities, school with other salmon and Pacific sandfish
Juveniles, (marine)	3 to 6 months	copepods, euphausiids, decapod larva, amphipods, gelatinous zooplankton	summer, fall, and winter prior to annulus formation in Jan.-Mar.	coastal, ICS, MCS, OCS; moving further offshore with growth	generally migrating in upper portion of water column	varied: K, SAV	UP, F, CL, E	Coastal and shelf migrations move into oceanic waters in later stages

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Immature and maturing adults (marine)	6 to 10 months	fish, squid, euphausiids, amphipods, copepods, and gelatinous zooplankton	spring, summer, and early fall	Oceanic to nearshore in final migration	P, N	NA	UP, F, CL, E: Regional stocks have specific oceanic migratory patterns	Rapid marine growth; onset of maturation timing varies widely among stocks; generally earlier north, later south
Adults (freshwater)	2 to 7 years of age from egg to mature adult, final stage 1-2 months	Active feeding ceases, digestive organs atrophy	spawning (June-January)	WC, LK, BCH	Varied, holding in pools, spawning on shallow riffles, pools or side-channel sloughs	small to coarse gravel CB, G	NA	sexual dimorphism in spawners, males develop large teeth, called dog salmon

Habitat Description for Sockeye Salmon

(*Oncorhynchus nerka*)

Management Plan and Area(s) Salmon fisheries in the EEZ off the coast of Alaska, Council, 1990

Life History and General Distribution

The natural freshwater range of sockeye salmon includes the Pacific rim of Asia and North America north of about 40°N. Within this area, the primary spawning grounds of sockeye salmon in North America extend from tributaries of the Columbia River to the Kuskokwim River in western Alaska, and on the Asian side, the spawning areas are found mainly on the Kamchatka Peninsula. Spawning populations become more irregular and occasional north of the Bering Strait, on the north coast of the Sea of Okhotsk, and in the Kuril Islands. Centers of the two largest spawning complexes in the North Pacific rim occur in the Bristol Bay watershed of southwestern Alaska and the Fraser River drainage of British Columbia. In marine environments along both the Asian and North American coastlines, sockeye salmon occupy ocean waters south of the limits of spawning systems.

Sockeye salmon exhibit a greater variety of life history patterns than other members of the genus *Oncorhynchus,* and characteristically make more use of lake rearing habitat in juvenile stages. Although sockeye salmon are primarily anadromous, there are distinct populations called kokanee, which mature, spawn, and die in fresh water without a period of sea life. Typically, but not universally, juvenile anadromous sockeye utilize lake rearing areas for 1 to 3 years after emergence from the gravel; however, some populations utilize stream areas for rearing and migrate to sea soon after emergence. Anadromous sockeye may spend from 1 to 4 years in the ocean before returning to fresh water to spawn and die in late summer and fall.

The adaptations of sockeye salmon to lake environments appear to require more precise homing to spawning areas, both as to time and location than is found in the other species of Pacific salmon. Although available spawning localities are more restricted because of the usual requirement of a lake rearing environment for the juveniles, the overall success of this adaptation is indicated by the fact that sockeye are much more abundant than Chinook (*O. tshawytscha*) and coho salmon (*O. kisutch*), which utilize stream rearing environments as juveniles. Juvenile sockeye salmon in fresh water do not need the territorial stream behavior displayed by juvenile Chinook and coho salmon, but do exhibit schooling tendencies more characteristic of pelagic feeding fishes.

Other distinctions of sockeye salmon include growth rate and size at maturity. Sockeye do not exhibit the rapid marine growth of coho or pink salmon (*O. gorbuscha*), which mature and return to fresh water after a single winter in the ocean, or of Chinook or chum salmon (*O. keta*), which attain a much larger average size at maturity. The flesh of sockeye is a darker red than that of the other salmon species, a color long considered to be a marketing attribute of the canned and, more recently, the fresh or fresh-frozen product.

Fisheries

Sockeye salmon are an important component, and often the most lucrative fishery for Pacific salmon. Coastal fisheries for sockeye salmon presently occur in North America (Canada and the United States) and Asia (Japan and Russia) with major fisheries in all areas except Japan. From 1920 through 1945, sockeye salmon were caught on the high seas by a Japanese mother ship fishery. This fishery started again in 1953 and a land based driftnet fishery moved sufficiently offshore to begin substantial catches of sockeye in 1958. Restrictions in fishing areas resulting from renegotiation of international fishery treaties ended the high seas fisheries in the mid 1980s. In recent years, about 22 percent of the numbers and 28 percent by weight of all salmon caught commercially in the North Pacific Ocean and adjacent waters were sockeye. Catches in North America, primarily Alaska and British Columbia, have always been greater than Asian catches. North American catches averaged about 30 million through 1940, declined to 10 to 15 million in the early 1960s and surged to 40 million and more in the 1990s. The recent record high catches resulted primarily from an increase in run magnitudes of natural stocks in central and western Alaska. Historically, Asian catches of sockeye salmon have averaged fewer than 10 million fish. Most sockeye salmon in the United States are caught in Alaska where major fisheries occur in southeast, central, and westward areas. In Alaska, sockeye fisheries occur primarily within State territorial seas (inside 3 miles).

Sockeye salmon catches have been at historic records in Alaska over the past decade with catches exceeding 60 million fish in several years. Most sockeye salmon in Alaska are caught by set and drift gill net fisheries. Recreational fisheries in Alaska usually harvest between 200,000 and 400,000 sockeye salmon annually, mostly in river system of the Kenai Peninsula in central Alaska. Subsistence catches of sockeye salmon are not universally maintained, but the catches are important, particularly to native people in a number of localities. The Fraser River Indian tribes recorded annual subsistence catches for the years 1970 to 1982 of 240,000. The subsistence catch of sockeye salmon in the United States was 315,000 in 1993, and over 307,000 was caught in Alaskan waters.

Gill net fisheries for sockeye salmon have some bycatch associated with them, primarily other salmon. The most important bycatch issue is in the southeastern region where younger marine-age Chinook salmon, similar in size to sockeye, are caught in sockeye net fisheries. The total harvest of Chinook salmon in this region is controlled by quotas under auspices of the Pacific Salmon Treaty. The Alaska Board of Fisheries allocates a portion of the quota for Chinook salmon as an allowable bycatch in gill net fisheries.

Measured marine survivals of sockeye salmon, from entry of smolts into stream mouth estuaries to returning adults, have ranged from about 5 percent to over 50 percent. Scientists, in general, believe that much of the natural mortality of sockeye salmon juveniles in the marine environment occurs within the first few months, and is probably influenced by three factors of unknown relative importance: (1) size and age at seaward migration; (2) timing of entry into the marine environment; and (3) length of stay in the ocean. Variations in oceanographic conditions and in marine predator populations (fish, mammals, and birds) undoubtedly have affected the marine survival of sockeye populations in different ways around the North Pacific rim, but these effects are poorly understood.

Because sockeye salmon are primarily caught in gill nets, there are no known gear impacts to the habitats where these fisheries occur.

Relevant Trophic Information

Sockeye salmon eggs, alevins, and juveniles in freshwater streams and lake systems provide an important nutrient and food source for aquatic invertebrates, other fishes, birds, and small mammals. In the marine environment sockeye salmon juveniles are food for many other fishes and coastal sea birds. Adult sockeye salmon are known to be eaten by marine mammals and sharks.

Millions of sockeye salmon adults returning to spawn in thousands of streams throughout Alaska provide significant nutrient input into the trophic level of these coastal watersheds. Adult sockeye salmon in streams are major food sources for gulls, eagles, and other birds, along with bear, otter, mink, and other mammals.

Approximate Upper Size Limit of Juvenile Fish (in cm): Roughly 25 cm

Habitat and Biological Associations

Eggs/Spawning: Sockeye salmon generally spawn in late summer and autumn. Within this period, time of spawning for different stocks can vary greatly, apparently because of adaptations to the most favorable survival conditions for spawning, egg and alevin incubation, emergence, and subsequent juvenile feeding. Although timing of spawning varies little from year to year within a specific spawning area, there are great differences in timing among spawning areas. The timing of spawning appears to be dependent to some degree on the temperature regimen in the gravel where the eggs are incubated. This varies distinctly among spawning area types. In the Bristol Bay region of Alaska, spawning begins in late July in the smaller streams, in early to mid-August in the tributaries of some lakes, and in late August to mid-September in most lake beach areas. In Lake Kuril and its tributaries, spawning continues from the end of June until early February with the main spawning occurring from September to November.

Among the species of Pacific salmon, the sockeye salmon exhibits the greatest diversity in adaptation to a wide variety of spawning habitats. The selection of habitats and timing of spawning by a sockeye stock are linked to success of survival, not only during spawning and incubation of the eggs and alevins, but also in the chain of freshwater and marine environments to which the progeny are subsequently exposed. In most instances, but not all, the subsequent environment of the juveniles is a lake or lake chain, and the behavior of the juveniles after emergence depends on the location of the spawning area in relation to the lake rearing area to be utilized. Lake-beach spawning has been recorded in most sockeye lake systems, and is apparently important habitat. Sockeye are also known to spawn in areas that lack lake rearing habitat. These “river spawning” or “sea type” sockeye lay their eggs in river systems with no lake, and emergent fry apparently feed in the stream or low-salinity estuaries for several months before migrating to offshore ocean areas. The circumstances surrounding the initial establishment of a spawning colony and the subsequent adaptive behavior of the progeny can only be surmised. However, the continued use of a specific spawning environment by a sockeye stock depends on the precise homing ability of the species, in which straying to other potential spawning locations is minimal.

The composition of spawning substrate utilized by sockeye salmon varies widely. Some lake-beach spawning occurs to a depth of nearly 30 m in areas of strong upwelling groundwater. In some lakes, mass spawning takes place over large angular gravel too large to be moved by salmon in the normal digging process. The eggs settle in the crevices between the rocks. Generally, however, spawning along lake beaches and in streams takes place in gravel small enough to be readily dislodged by digging, and the digging process tends to remove the silt and clean the gravel where the eggs are deposited. Water depth does not seem to be a critical factor to sockeye in selecting a spawning site. In the small streams and spring ponds, it is common to observe pairs of salmon in the spawning process with their dorsal surfaces protruding from the water. In larger rivers, spawning depths are generally not great because riffle areas are preferred. Spawning on lake beaches can extend to considerable depths. It is clear that sockeye can detect upwelling groundwater areas along lake beaches and in spring ponds areas in which to spawn. Generally, the spawning beds are situated in areas with clean gravel, or along the borders between pools and riffles in shallow water with moderate to fast currents. In large rivers, they may spawn in discrete sections of main channels or in tributary channels.

Superimposition is minimized by the territorial defense of the redd by the female following egg deposition, which protects the redd for a few days. Female territory is partly a function of spawner density. Estimates of the capacity of streams to support spawning sockeye were based on density of one female/2 m^2. In spawning channels, maximum fry production was achieved at the spawner density of one female/m^2.

Larvae/Alevins: Fertilized eggs begin their 5- to 8-month period of embryonic development and growth in intragravel interstices. To survive successfully, the eggs, alevins and pre-emergent fry must first be protected from freezing, desiccation, stream bed scouring or shifting, mechanical injury and predators. Water surrounding them must be non-toxic and of sufficient quality and quantity to provide basic requirements of suitable temperatures, adequate supply of oxygen, and removal of waste materials. Collectively, these requirements are, on average, only partially met even under the most favorable natural conditions. Overall freshwater survival of sockeye salmon from egg to advanced alevin and emerged fry, even in highly productive streams, commonly reaches only 10 to 20 percent, and at times is as low as 1 percent.

Rates of egg development, survival, size of hatched alevins, and percentage of deformed fry are related to temperature and oxygen levels during incubation. Temporary low stream temperatures or dissolved oxygen concentrations, however, may be relatively unimportant at some developmental stages, but lethal at others. Generally, low oxygen levels are non-lethal early, but lethal late in development.

Juveniles: Fry emergence apparently begins in early to mid-April in most instances, peaks in early to mid-May, and ends in late May to early June. Newly emerged sockeye salmon fry show a marked negative rheotaxis and actively swim downstream to lakes. In some lake outlet spawning areas, the emerging fry swim laterally in an attempt to reach the river banks and avoid being swept downstream. The emergence behavior of fry in lakeshore spawning areas has not been reported. It has been suggested that the seasonal timing of sockeye fry emergence optimizes the timing of dispersal into their feeding habitat, particularly to take advantage of the seasonal peak abundance of zooplankton of appropriate size. It is postulated that fry emerging earlier or later than the optimum may suffer greater mortality, and thus that timing is a response to this selective pressure. The survival value in entering the lake early is to take advantage of feeding in the lake as long as possible during the summer, thus achieving larger size in preparation for spring smoltification. Annual timing of fry migration and its seasonal pattern is a function of the seasonal timing of the adult spawning period, ecological factors within the incubation habitat that affects development rate and alevin behavior, and transit time needed by the fry to reach their feeding habitat.

Upon entering nursery lakes, sockeye fry disperse quickly into their lake feeding areas. Movement of fry into the nursery areas may be direct and immediate, or sequential, the latter involving occupation of intermediate feeding areas for a period of time. The plasticity of response suggests definite racial adaptations to a variety of different environmental conditions. Intermediate feeding and growth can occur along outlet river banks before migration into the nursery lake. In-lake dispersions of fry is probably a mechanism whereby the lake zooplankton is effectively utilized as food for the juvenile fish.

Sockeye salmon juveniles typically spend one or more growing seasons in the limnetic zone of a nursery lake before smoltification. The transition in feeding behavior and diet from the time of emergence of the fry from stream or lakeshore to the time of smoltification takes many forms. In general, it is a shift from dependence on dipteran insects to pelagic zooplankton. The annual growth attained by juvenile sockeye and length of residence in fresh water varies greatly among populations in different lake systems, as well as between years within individual lakes. Factors affecting growth are highly complex and include (1) size and species composition of the food supply; (2) water temperature and thermal stratification of the lake; (3) photoperiod and length of growing season; (4) relative turbidity of the lake and available light intensity in the water column; (5) intra- and interspecific competition; (6) parasitism and disease; (7) feeding behavior of juvenile sockeye to minimize predation; and (8) migratory movements to seek favorable feeding environments. Growth influences durations of stay in fresh water before smoltification, and within many lake populations the larger members of a year class tend to migrate to sea earlier the spring or migrate a year earlier than smaller members. In the more southern systems, smoltification after 1 year is nearly universal. Size is not strictly the determinant for duration of stay in fresh water, because some populations with very poor freshwater growth in their first year migrate as yearlings, whereas other populations exhibiting good first-year growth migrate predominantly after a second year of growth. Emergent fry of "river spawning" or "sea type" sockeye, which spawn in systems lacking lake rearing habitat, feed in the stream or low-salinity estuaries for several months before migrating to offshore ocean areas.

Sockeye fry at the beginning of lake life are between 25 and 31 mm and weigh between 0.1 and 0.2 g. Yearling smolts vary greatly in size; average range 60 to 125 mm and 2.0 to 30.0 g. After a second year of growth in a lake, 2-year-old smolts often overlap the size range of yearlings, and have been reported at an average of 200 mm and 84.0 g at Hidden Lake in central Alaska. Sea type sockeye smolts are typically the same size as yearling smolts when they migrate to offshore ocean areas.

After smoltification and exodus from natal river systems in spring or early summer, juvenile sockeye enter the marine environment where they reside for 1 to 4 years, usually 2 or 3 years, before returning to spawn. Depending on the stock, they may reside in the estuarine or nearshore environment before moving into oceanic waters. They are typically distributed in offshore waters by autumn following outmigration. During the initial marine period, yearling sockeye forage actively on a variety of organisms, apparently preferring copepods and insects, but also eating amphipods, euphausiids, and fish larvae when available. Their growth rate is about 0.6 mm/d.

After entering the open sea during their first summer, juvenile sockeye salmon remain in a band relatively close to the coast. Off the outer coast of British Columbia and southeast Alaska, the juveniles are often recorded on the open sea in late June. By July, the fish are found moving northwestward into the GOA. Sampling in the North Pacific has shown that by October juvenile sockeye are still somewhat distributed primarily nearshore. Evidence indicates the northwestward movement up the eastern Pacific rim is followed by a southwestward movement along the Alaska Peninsula. An offshore movement into the GOA in late autumn or winter is conjectured for the location of age 1 sockeye in early spring.

Adults: Sockeye salmon from different regions differ in growth rate and age and size at maturity. Growth in length is greatest during the first year at sea, and increase in weight is greatest during the second year. Most sockeye spend 2 to 3 years feeding in the ocean before their final summer of return. There is substantial variation in size among populations within an age class. In Alaska, the average size of females that had spent 2 years in the ocean ranged from 45 to 54 cm, and of those that had spent 3 years the average ranged from 51 to 60 cm.

Additional Information Sources

Karl Hofmeister, Alaska Department of Fish and Game.
Andy MacGregor, Alaska Department of Fish and Game.
David Barto, Alaska Department of Fish and Game.

Literature

Atkinson, C.E., T.H. Rose, and T.O. Duncan. 1967. Pacific salmon in the United States, p. 43-223. *In:* Salmon of the North Pacific Ocean. Part IV. Spawning populations of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 23.

Baggerman, B. 1960. Salinity preference, thyroid activity and the seaward migration of four species of Pacific salmon *(Oncorhynchus). J.* Fish. Res. Board Can. 17:295-322.

Bakkala, R.G. 1971. Distribution and migration of immature sockeye salmon taken by United States research vessels with gillnets in offshore waters, 1956-67. Int. North Pac. Fish. Comm. Bull. 27:170.

Beamish, R.J., I.A. Pearsall, and M.C. Healey. 2003. A history of the research on the early marine life of pacific salmon off Canada's Pacific coast. N. Pac. Anadr. Fish Comm. Bull. 3:1-40.

Bergander, F. 1985. Sockeye salmon (*Oncorhynchus nerka)* stock assessment and evaluation in southeast Alaska, 1982-1983. Alaska Dep. Fish Game ADF&G Tech Rep. 142:27 p.

Bill, D. 1984. 1982 Kwichak River sockeye smolt studies, p. 2-13. In: D.M. Eggers and H.J. Yuen (eds.) 1982 Bristol Bay sockeye salmon smolt studies. Alaska Dep. Fish Game ADF&G Tech Rep. 103.

Birman, I.B. 1960. New information on the marine period of life and the marine fishery of Pacific salmon, p. 151-164. In: Trudy Soveshchaniia po bioligicheskim osnovam okeanicheskovo rybolovostva, 1958. Tr. Soveshch. Iktiol. Komm. Akad. Nauk SSSR 10 (Trans. From Russian; Fish. Res. Board Can. Transl. Ser. 357).

Blair, G.R., D.E. Rogers, and T.P. Quinn. 1993. Variation in history characteristics and morphology of sockeye salmon in the Kvichak River system, Bristol Bay, Alaska. Transactions of the American Fisheries Society: Vol. 122, No. 4, pp. 550-559.

Bradford, M.J. 1995. Comparative review of Pacific salmon survival rates. Canadian Journal of Fisheries and Aquatic Sciences 52, 1327-1338.

Brannon, E.L. 1965. The influence of physical factors on the development and weight of sockeye salmon embryos and aliveness. Int. Pac. Salmon Fish. Comm. Prog. Rep. 12:26 p.

Brett, J.R., and J.E. Shelbourn. 1975. Growth rate of young sockeye salmon, (*Oncorhynchus nerka)*, in relation to fish size and ration level. J. Fish. Res. Board Can. 32:2103-10.

Brodeur, R.D., G.W. Boehlert, E. Casillas, M.B. Eldridge, J.H. Helle, W.T. Peterson, W.R. Heard, S.T. Lindley, and M.H. Schiewe. 2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. Fisheries 25, 7-16.

Brodeur, R.D., K.W. Myers, and J.H. Helle. 2003. Research conducted by the United States on the early ocean life history of Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:89-131.

Bugaev, V.F. 1978. Using the structure of zones of converged sclerites on scales as a criterion for differentiation of local groupings of the sockeye salmon, (*Oncorhynchus nerka)*, of the Kamchatka River basin. J. Ichthyol. 18:826-836.

Burgner, R.L. 1991. Life history of sockeye salmon, *Oncorhynchus nerka*, p 3-117 *in* C. Groot and L. Margolis, eds. Pacific salmon life histories. UBC Press, Vancouver.

Chernenko, E.V., and G.D. Kurenkov. 1980. Differentiation of the stock of kokanee *Oncorhynchus nerka* (Walbaum) from Kronotsk Lake, p. 11-15. In: S.M. Konovalov (ed.) Populyatsionnaya biologiya I sistematika lososevykh. Db. Rab. Aakad. Nauk SSSR Dal'nev. Nauch. Tsentr. Inst. Biol. Morya 18 (In Russian).

Cooney, R.T., and R.D. Brodeur. 1998. Carrying capacity and North Pacific salmon production: stock-enhancement implications. Bulletin of Marine Science 62, 443-464.

Drucker, B. 1970. Red Salmon studies at Karluk Lake, 1968. U.S. Fish and Wildlife Service, Auke Bay, AK. 55 p.

Edmundson, J.A., and A. Mazumder. 2001. Linking growth of juvenile sockeye salmon to habitat temperature in Alaskan lakes. Transactions of the American Fisheries Society: Vol. 130, No. 4, pp. 644-662.

Ellis, R.J. 1974. Distribution, abundance, and growth of juvenile sockeye salmon, *Oncorhynchus nerka*, and associated species in the Naknek River system, 1961-1964. NOAA Tech Rep. NMFS SSRF-678:53p.

Flagg, L.C., P. Shields, and D.C. Waite. 1985. Sockeye salmon smolt studies, Kasilof River, Alaska 1984. Alaska Dep. Fish Game FRED Rep. 47:43 p.

Foerster, R.E. 1968. The sockeye salmon, *Oncorhynchus nerka*. Bull. Fish. Res. Board Can. 162:422 p.

French, R., H. Bilton, M. Osako, and A. Hartt. 1976. Distribution and origin of sockeye salmon *(Oncorhynchus nerka)* in offshore water of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 34: 113 p.

French, R.R., and J.E. Mason. 1964. Salmon distribution and abundance on the high seas-winter season 1962 and 1963. Int. North Pac. Fish. Comm. Annu. Rep. 1963:131-141.

French, R.R., and R.G. Bakkala. 1974. A new model of ocean migrations of Bristol Bay sockeye salmon. Fish. Bull. (U.S.) 72:589-614.

Fujii, T. 1975. On the relation between the homing migration of the western Alaska sockeye salmon *Oncorhynchus nerka* (Walbaum) and oceanic conditions in theEBS. Mem. Fac, Fish. Hokkaido Univ. 22:99-191.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River basin - past and present. U.S. Nat. Mar. Fish. Ser. Spec. Sci. Rep. Fish. 618:37 p.

Gard, R., and B. Drucker. 1985. Differentiation of subpopulations of sockeye salmon in the Karluk River system. Annu. Rep. School Fish. Sci. Univ. Alaska, Juneau 1983/84:7.

Groot, C., and K. Cooke. 1987. Homing migration of sockeye salmon, *Oncorhynchus nerka,* to the Fraser River. Fish. Bull. (U.S.) 85:455-469.

Guthrie, C.M. III., E.V. Farley, Jr., N.L Weemes, and E.C. Martinson. 2000. Genetic stock identification of sockeye salmon captured in the coastal waters of Unalaska Island during April/May and August 1998. N. Pac. Anadr. Fish. Comm. Bull. No. 2:309-316.

Hanamura, N. 1966. Sockeye salmon in the far east, p. 1-27. *In:* Salmon of the North Pacific Ocean. Part III. A review of the life history of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 18.

Harris, C. 1987. Catches of North American sockeye salmon *(Oncorhynchus nerka)* by the Japanese high seas salmon fisheries, 1972-1984, p. 458-479. In: H.D. Smith, L. Margolis, and C.C. Wood (eds.). Sockeye salmon *(Oncorhynchus nerka)* population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

Hartman, W.L., and R.L. Burgner. 1972. Limnology and fish ecology of sockeye salmon nursery lakes of the world. J. Fish. Res. Board Can. 29:699-715.

Healey, M.C. 1987. The adaptive significance of age and size at maturity in female sockeye salmon *(Oncorhynchus nerka)*, p. 110-117. In: H.D. Smith, L. Margolis, and C.C. Wood (eds.). Sockeye salmon *(Oncorhynchus nerka)* population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

Healey, M.C. 1991. Diets and feeding rates of juvenile pink, chum, and sockeye salmon in Hecate Strait, British Columbia. Transactions of the American Fisheries Society: Vol. 120, No. 3, pp. 303-318.

Hoag, S.H. 1972. The relationship between the summer food of juvenile sockeye salmon, *Oncorhynchus nerka*, and the standing stock of zooplankton in Iliamna Lake, Alaska. Fish. Bull. (U.S.) 70:355-362.

Huttunen, D.C. 1987. Abundance, age, sex and size of salmon (*Oncorhynchus* sp.) catches and escapements in the Kuskokwim area, 1985. Alaska Dep. Fish Game ADF&G Tech. Data Rep. 212:83 p.

Jaenicke, H.W., and A.G. Celewycz. 1994. Marine distribution and size of juvenile Pacific salmon in Southeast Alaska and northern British Columbia. Fishery Bulletin 92(1), 79-90.

Kaeriyama, M., M. Nakamura, M. Yamaguchi, H. Ueda, G. Anma, S. Takagi, K.Y. Aydin, R.V. Walker, and K.W. Myers. 2000. Feeding ecology of sockeye and pink salmon in the GOA. Recent changes in ocean production of Pacific salmon. No. 2, pp.55-63. [Bull.NPAFC].

Karpenko, V.I. 2003. Review of Russian marine investigations of juvenile Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:69-88.

Lander, A.H., and G.K. Tanonaka. 1964. Marine growth of western Alaskan sockeye salmon (*Oncorhynchus nerka* Walbaum). Int. North Pac. Fish. Comm. Bull. 14:1-31.

Landingham, J.H., M.V. Sturdevant, and R.D. Brodeur. 1998. Feeding habits of juvenile Pacific salmon in marine waters of southeast Alaska and northern British Columbia. Fishery Bulletin 96(2):285-302.

Lebida, R.C. 1984. Larson Lake sockeye and coho salmon smolt enumeration and sampling, 1982. Alaska Dep. Fish Game FRED Rep. 35:31p.

LeBrasseur, R.J. 1966. Stomach contents of salmon and steelhead trout in the northeastern Pacific Ocean. J. Fish. Res. Board Can. 23:85-100.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78, 1069-1079.

Manzer, J.I., T. Ishida, A.E. Peterson, and M.G. Hanavan. 1965. Salmon of the North Pacific Ocean. Part V. Offshore distribution of salmon. Int. North Pac. Fish. Comm. Bull. 15:452 p.

Mathisen, O.A., and N.J. Sand. 2001. Density-dependent ocean growth of some Bristol Bay sockeye salmon stocks. Spatial Processes and Management of Marine Populations, pp. 349-362. Lowell Wakefield Fisheries Symposium Series. No. 17. Univ. of Alaska Sea Grant, PO Box 755010, Fairbanks, Alaska, 99775.

Mayama, H., and Y. Ishida. 2003. Japanese studies on the early ocean life of juvenile salmon. N. Pac. Anadr. Fish Comm. Bull. 3:41-67.

Meuter, F.J., R.M. Peterman, and B.J. Pyper. 2002. Opposite effects of ocean temperature on survival rates of 120 stocks of Pacific salmon (Oncorhynchus spp.) in northern and southern areas. Canadian Journal of Fisheries and Aquatic Sciences 59, 456-463.

Moulton, L.L. 1997. Early marine residence, growth, and feeding by juvenile salmon in Northern Cook Inlet, Alaska. Alaska Fishery Research Bulletin 4(2):154-177.

Nelson, J.S. 1968. Distribution and nomenclature of North American kokanee, *Oncorhynchus nerka.* J. Fish. Res. Board Can. 25:409-414.

Olsen, J.C. 1968. Physical environment and egg development in a mainland beach area and an island beach area of Iliamna Lake, p. 169-197. In: R.L. Burgner (ed.). Further studies of Alaska sockeye salmon. Univ. Wash. Publ. Fish. New Ser. 3.

Peterson, D.P., and C.J. Foote. 2000. Disturbance of small-stream habitat by spawning sockeye salmon in Alaska. Transactions of the American Fisheries Society: Vol. 129, No. 4, pp. 924-934.

Raleigh, R.F. 1967. Genetic control in the lakeward migrations of sockeye salmon *(Oncorhynchus nerka)* fry. J. FISH. Res. Board Can. 24:2613-2622.

Rand, P.S., J.P. Scandol, and E.E. Walter. 1997. NerkaSim: A research and educational tool to simulate the marine life history of Pacific salmon in a dynamic environment. Fisheries 22 (10), 6-13.

Ricker, W.E. 1962. Comparison of ocean growth and mortality of sockeye salmon during their last two years. J. Fish. Res. Board Can. 19:531-560.

Ricker, W.E. Size and age of British Columbia sockeye salmon (*Oncorhynchus nerka*) in relation to environmental factors and the fishery. Can. Tech. Rep. Fish. Aquat. Sci.1115:32 p.

Rogers, D.E. 1987. The regulation of age at maturity in Wood River sockeye salmon (*Oncorhynchus nerka*), p. 78-89. In: H.D. Smith, L. Margolis, and C.C. Wood (eds.).Sockeye salmon *(Oncorhynchus nerka)* population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

Ruggerone, G.T., M. Zimmermann, K.W. Myers, J.L. Nielsen, and D.E. Rogers. 2003. Competition between Asian pink salmon (Oncorhynchus gorbuscha) and Alaskan sockeye salmon (O. nerka) in the North Pacific Ocean. Fish. Oceanogr. 12:3. 209-219.

Sharr, S. 1983. Catch and escapement statistics for Copper and Bering River sockeye (*Oncorhynchus nerka*), Chinook (*O. tshawytscha*), and coho salmon (*O. kisutch*), 1982. Alaska Dep. Fish Game. ADF&G Tech. Data Rep 98:45 p.

Simpson, K., L. Hop Wo, and I. Miki. 1981. Fish surveys of 15 sockeye salmon (*Oncorhynchus nerka*) nursery lakes in British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 1022:87 p.

Straty, R.R. 1974. Ecology and behavior of juvenile sockeye salmon (*Oncorhynchus nerka*), in Bristol Bay and theEBS, p. 285-320. In: D.W. Hood and E.J. Kelley (eds.) Oceanography of the BS with emphasis on renewable resources. Univ. Alaska Inst. Mar. Sci. Occ. Publ.2

Takeuchi, I. 1972. Food animals collected from the stomachs of three salmonid fishes (*Oncorhynchus*) and their distribution in the natural environments in the northern North Pacific. Bull. Hokkaido Reg. Fish. Res. Lab. 38:119 p.

Walters, C.J., R. Hilborn, R.M. Peterman, and M. Staley. 1978. A model for examining early ocean limitation of Pacific salmon production. Journal of the Fisheries Research Board of Canada 35, 1303-1315.

Welch, D.W., Y. Ishida, and K. Nagasawa. 1998. Thermal limits and ocean migrations of sockeye salmon (*Oncorhynchus nerka*): Long-term consequences of global warming. Canadian Journal of Fisheries and Aquatic Sciences 55(4), 937-948.

Wood, C.C., B.E. Riddell, and D.T. Rutherford. 1987. Alternative juvenile life histories of sockeye salmon *Oncorhynchus nerka*) and their contribution to production in the Stikine River, northern British Columbia, p. 12-24. In: H.D. Smith, L. Margolis, and C.C. Wood (eds.).Sockeye salmon *(Oncorhynchus nerka)* population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

SPECIES: Sockeye Salmon, *Onchorynchus nerka*

Stage	**Duration or Age**	**Diet/Prey**	**Season/ Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs and larvae (alevins)	eggs: 90 to 100 days larvae: 100 to 125 days	NA	late summer, fall and winter	WC, LK	Intragravel	CB, G	NA	Develop at 1-10°C, eggs hatch about 100 d, alevins emerge from gravel about 125 d post hatch
Juveniles, Freshwater	1 to 3 years, fry emerge and move quickly to lakes, or, rarely, 3 to 4 months in estuaries	copepods, bosminids, Daphnia chironomids dipterans, stoneflies	for yearling and older smolt, early to late summer for sea type run	WC, LK EST	P, N	NA	NA	Preference pelagic feeding in lakes, usually not with other fishes, except when predators present
Juveniles, estuarine	1 to 4 months	copepods, amphipods,	spring, summer, fall	BCH, EST, to 30 m	P, N	NA	UP, CL	larger fish progressively farther from shore
Juveniles, marine	6 to 8 months	copepods, amphipods, small fishes, squid mysids, euphausiids	early summer to late winter	BCH, ICS, MCS, IP BAY	P, N	NA	UP, CL	movements from near-shore to offshore areas
Adult, immature and maturing, marine	1 to 4 years from smolt to mature adult	copepods, amphipods, insects, small fishes, squid	immature: year round 1 to 3 years	BCH, ICS, MCS, OCS, USP, LSP, BSN, BAY, IP	P, N	NA	UP	migration timing for different regional stock groups varies; earlier in the north, later in the south
Adults, freshwater	2 to 4 months	no active feeding in freshwater	Spawning migration (May-August)	WC, LK	depth in streams <10 cm, depth in lakes to 20 m	CB, G	NA	migration timing for different regional stock groups varies; earlier in the north, later in the south

Habitat Description for Chinook Salmon

(*Oncorhynchus tshawytscha*)

Management Plan and Area(s) Salmon fisheries in the EEZ off the coast of Alaska, Council, 1990

Life History and General Distribution

Chinook salmon, also called king, spring, or tyee salmon, are the least abundant and largest of the Pacific salmon. They are distinguished from other species of Pacific salmon by their large size, the small black spots on both lobes of the caudal fin, black pigment at the base of the teeth, and a large number of pyloric caeca. The natural freshwater range of the species includes large portions of the Pacific rim of North America and Asia. In North America, Chinook salmon historically ranged from the Ventura River in California (lat. ~34°) to Kotzebue Sound in Alaska (~66° N); in addition, the species has been identified in North America in the Mackenzie River, which drains into the Arctic Ocean. In Asia, natural populations of Chinook salmon have been documented from Hokkaido Island, Japan (~42° N) to the Andyr River in Russia (~64° N). Within this range, the largest rivers tend to support the largest aggregate runs of Chinook salmon and have the largest individual spawning populations. Major rivers near the southern and northern extremes of the range support populations of Chinook salmon comparable to those near the middle of the range. For example, in North America, the Yukon River near the north edge of the range and the Sacramento-San Joaquin River system near the south edge of the range have historically supported Chinook salmon runs comparable to those of the Columbia River and the Fraser River, which are near the center of the species range along this Pacific coast.

In marine environments, Chinook salmon range widely throughout the North Pacific Ocean and the BS, from lat. 38°. The southern edge of the marine distribution expands and contracts seasonally and between years depending on ocean temperature patterns. While the marine distribution of Chinook salmon can be highly variable even within a population, there are general migration and ocean distribution patterns characteristic of populations in specific geographic areas. For example, Chinook salmon that spawn in rivers from the Rogue River in Oregon south to California disperse and rear in oceanic waters off the Oregon and California Coast, whereas those that spawn north of the Rogue River to southeast Alaska migrate north and westward along the Pacific coast. These migration patterns are of particular interest for the management of Chinook salmon in the EEZ off Alaska, as they result in the harvest of fish from Oregon, Washington, British Columbia, and Alaska within the management zone.

Pacific salmon have a generalized life history that includes the incubation and hatching of embryos and emergence and initial rearing of juveniles in freshwater; migration to oceanic habitats for extended periods of feeding and growth; and return to natal waters for completion of maturation, spawning, and death. Within this general life history strategy, Chinook salmon display diverse and complex life history patterns and tactics. Their spawning environments range from just above tidewater to over 3,200 km from the ocean, from coastal rainforest streams to arid mountain tributaries at elevations over 1,500 m. At least 16 age categories of mature Chinook salmon have been documented, involving three possible freshwater ages and total ages of 2 to 8 years, reflecting the high variability within and among populations in length of freshwater, estuarine, and oceanic residency. Chinook salmon also demonstrate variable ocean migration patterns and timing of spawning migrations.

This variation in life history strategy has been explained by separating Chinook salmon into two races: stream- and ocean-type fish. Stream-type fish have long freshwater residence as juveniles (1 to 2 years), migrate rapidly to oceanic habitats, enter freshwater as immature or "bright" fish, and spawn far upriver in late summer or early fall. Ocean-type fish have short, highly variable freshwater residency (from a few days to 1 year), extensive estuarine residency, enter fresh-water at a more advanced state of maturity, and spawn within a few weeks of freshwater entry in the lower portions of the watershed. Within these two types, there is also substantial variability due to a combination of phenotypic plasticity and genetic selection to local conditions. For example, adult run-timing is strongly influenced by in-river flow volumes and temperature levels.

Chinook salmon have distinctly different feeding habits and distribution and in ocean habitats than do other species of Pacific salmon. Chinook salmon are the most piscivorous of the Pacific salmon, and are also distributed deeper in the water column. While other species of salmon generally are surface oriented, utilizing primarily the upper 20 m, Chinook salmon tend to be at greater depths and are often associated with bottom topography. Because of their distribution in the water column, the majority of Chinook salmon harvested in commercial troll fisheries are caught at depths of 30 m or greater, and Chinook salmon is the most common salmon species taken as bycatch in mid-water and bottom trawl fisheries.

Declines in the abundance of Chinook salmon have been well documented throughout the southern portion of the range. Concern over coast-wide declines from southeast Alaska to the Pacific Northwest was a major factor leading to the signing of the Pacific Salmon Treaty between the United States and Canada in 1985. Wild Chinook salmon populations have been extirpated from large portions of their historic range in a number of watersheds in California, Oregon, Washington, Idaho, and southern British Columbia, and a number of evolutionarily significant units (ESUs) have been listed by National Marine Fisheries Service as at risk of extinction under the Endangered Species Act (ESA). Habitat degradation is the major cause for extinction of populations; most are related to dam construction. Urbanization, agricultural land use and water diversion, and logging are also factors contributing to habitat degradation and the decline of Chinook salmon. The development of large-scale hatchery programs, have, to some degree, mitigated the decline in abundance of Chinook in some areas. However, genetic and ecological interactions of hatchery and wild fish have also been identified as risk factors for wild populations, and the high harvest rates directed at hatchery fish may cause over-exploitation of co-mingled wild populations.

Fisheries

Because of their large size and excellent taste, Chinook salmon are highly prized by commercial, sport, and subsistence fishers. In Alaska, approximately 1 million Chinook salmon are harvested annually. While this is less than 1 percent of the annual salmon catch in the state, Chinook salmon typically are the focus of a disproportionately larger amount of management and regulatory effort because of the conservation concerns and intense allocation issues for this species.

In most of the state, there is no directed harvest of Chinook salmon in the EEZ. Most fishing effort takes place in the coastal or riverine waters of the state. The FMP for salmon in the Alaska EEZ prohibits commercial harvest in the EEZ, with a few exceptions. The most notable exception is the commercial troll harvest off of southeast Alaska. While much of this fishery is also in state waters, it has been traditionally managed since Alaska statehood (1959) with little recognition of the boundary separating state and federal waters. Chinook and coho salmon are the primary target species of this hook-and-line fishery.

The commercial troll fishery for Chinook salmon in southeast Alaska developed in the early 1900s. The fishery occurred all year with no overall catch limits. Peak harvests of Chinook were in the 1930s, when annual catch averaged over 600,000. Concurrent with the development of the Columbia River hydroelectric dams, catches declined to average 250,000 to 350,000 Chinook annually. Beginning in 1978, ADF&G and the Council set harvest limits for the fishery in the first FMP for salmon in Alaska. These limits were initially a harvest range of 286,000 to 320,000 Chinook salmon for the southeast Alaska troll fishery. The FMP also banned commercial salmon fishing in the EEZ west of long. 175° E, banned fishing for salmon with nets throughout the EEZ (with a few specific exceptions), and imposed time closures on commercial trolling in the EEZ east of long. 175°.

These harvest ranges became part of a 15-year stock rebuilding program begun in 1981 for stocks that spawn in southeast Alaska and in transboundary rivers that originate in Canada and flow through southeast Alaska. In 1985, the Pacific Salmon Treaty between the United States and Canada included specific provisions for rebuilding Chinook salmon stocks coast-wide. The Chinook Annex to the treaty established specific total catch limits for Chinook in southeast Alaska and in certain fisheries in British Columbia in 1985 and 1986; subsequently, the catch limits were to be negotiated annually. The catch ceiling in southeast Alaska was originally established at 263,000 "treaty fish," with a provision for additional harvest of fish produced by new enhancement operations in the region. The catch ceiling included an allocation for incidental catch of Chinook salmon in net fisheries directed at other salmon species, as well as the commercial and recreational troll harvests. It resulted in a reduction of approximately 100,000 Chinook in the commercial troll fishery relative to its average catches over the prior two decades.

In 1990, the Council revised the salmon FMP to reduce redundant regulation of the salmon fisheries in the EEZ with ADF&G and the Pacific Salmon Commission (PSC). While recognizing that the salmon fisheries require Federal participation and oversight stipulated in the Magnuson Act, the Council deferred setting harvest levels to ADF&G and the PSC, and regulation of the sport and commercial fishery to ADF&G providing the harvest levels and allocations are consistent with Council goals and objectives stated in the FMP and the National Standards of the Magnuson-Stevens Act. To date, the Council has not exercised its option of specifying management measures in the EEZ that differ from state regulation.

Management and catch limits in the southeast Alaska Chinook salmon fishery have continued to be a contentious issue. While Chinook salmon spawning in southeast Alaska and the transboundary rivers have been generally stable or increasing in abundance since the establishment of the PSC management regime, abundance of many wild populations of Chinook salmon in British Columbia and the Pacific Northwest have not recovered or have continued to decline. Fixed harvest levels were formulated to result in decreasing exploitation rates of Chinook salmon in mixed-stock fisheries: as wild stocks rebuilt and enhancement activities increased, general abundance of Chinook salmon in the mixed-stock fisheries, in concert with catch ceilings, would result in a lower proportion harvested by these fisheries. In the first few years after the Treaty, this concept seemed reasonable, but poor survivals due to ocean conditions in the early 1990s resulted in declining abundances in the ocean fisheries, so that fixed harvest levels result in increasing exploitation. Due to this and other allocation and conservation concerns, there has been no agreement on catch ceilings within the PSC since 1993. In 1995, ADF&G proposed a management regime based on the estimated abundance of Chinook salmon. ADF&G implemented this abundance-based management approach in 1995, but tribal groups and the state management agencies in the Pacific Northwest sued successfully for the closure of the fishery in August of 1995. In 1996, the fishery reopened with a management ceiling agreed to by the United States Commissioners (which represent both Alaska and Pacific Northwest interests) to the PSC. In 1997, the United States Commissioners agreed to apply an abundance-based management approach using a modified version of the original

ADF&G proposal. The agreement calls for setting preseason catch targets based on the forecasts made by the Chinook Technical Committee (CTC) of the PSC, then refining these preseason forecasts using catch per unit effort data from the summer troll fishery. This agreement has been implemented by ADF&G in 1997, but has not been agreed to by Canada in the PSC process.

Because fish from Chinook salmon ESUs that have been listed as threatened or endangered occur in the southeast Alaska troll fishery, NMFS reviews the fishery under Section 7 of the ESA and, in association with the Biological Opinion, issues an incidental take statement that covers the ESA listed fish that are inadvertently and unknowingly taken in the fishery. The biological assessment has found that the take of listed ESUs in the fishery has been incidental to other stocks and a small percentage of the total mortality, either on a single year or cohort basis. To date, NMFS has found that this fishery is not likely to jeopardize the continued existence or recovery of ESA-listed species.

Chinook salmon fisheries in Alaska have some bycatch associated with them. Generally, the numbers of other species taken during directed Chinook fishing is small and not considered a conservation issue. The most important bycatch issue in the commercial and recreational hook-and-line fisheries is the capture of undersized Chinook salmon that must be released. While the majority of these fish survive the hooking encounter, large numbers can be hooked and substantial mortality incurred. The Pacific Salmon Treaty requires accounting for the degree of such bycatch mortality, and the CTC uses this information in modeling the status and abundance of component stocks.

Directed fisheries of Chinook salmon in Alaska include marine commercial and recreational hook-and-line fisheries; marine commercial gill-net and seine fisheries; and estuarine and riverine gill-net (both set-net and drift), recreational, personal use, and subsistence fisheries. Two types of impacts can occur: (1) direct effects of the gear to habitat and (2) bycatch or entanglement of non-target species. In the marine fisheries, direct impact of the gear to marine habitats is limited, but some localized effects can occur, such as trolling weights damaging coral or purse seines damaging kelp beds or benthic structure. Because these types of impacts also endanger the gear itself, they are typically self-limiting. Bycatch and entanglement of non-target species can occur in the marine fisheries, such as bycatch of demersal rockfish in hook-and-line fisheries, and entanglement of seabirds and marine mammals in net fisheries. In the estuarine and riverine fisheries, direct impact to riparian vegetation and channel morphology can occur from the shore-based fishing gears, such as set-nets and recreational fishing. Where use levels are high, this type of impact can be sufficient to require restoration management initiatives. An example is the Kenai River restoration work needed to repair damage from recreational fishing for Chinook salmon and other salmonids.

Relevant Trophic Information

Chinook salmon eggs, alevins, and juveniles in freshwater streams provide an important nutrient input and food source for aquatic invertebrates, other fishes, birds, and small mammals. The carcasses of Chinook adults can also be an important nutrient input in their natal watersheds, as well as providing food sources for terrestrial mammals such as bears, otters, and minks, and birds such as gulls, eagles, and ravens. Because of their relatively low abundance in coastal and oceanic waters, Chinook salmon in the marine environment are typically only an incidental food item in the diet of other fishes, marine mammals, and coastal sea birds.

Approximate Upper size limit of juvenile fish (in cm): 71 cm total length. This is the regulatory minimum harvest size used in the Alaska hook-and-line fisheries in order to minimize catches of immature fish. However, because Chinook salmon can mature at ages of 2 to 8 total years, the term “juvenile” is better defined by physiological progress of maturation rather than a threshold size.

Habitat and Biological Associations

Chinook salmon occur over abroad geographic range, encompassing different ecotypes and very diverse habitats. Across the geographic range that the species has colonized, populations of Chinook salmon have developed localized adaptations to site specific characteristics. These local adaptations result in different and diverse characteristics of biological importance, including timing of spawning, adult and juvenile migration timing, age and size at maturity, duration of freshwater residency, and ocean distribution. Chinook salmon have been studied and managed intensively for decades. There is a large body of literature describing their biology and ecology. For freshwater habitats, however, habitat-specific information for Chinook salmon in particular watersheds is sparse, especially in the northern portion of the range, and for estuarine and marine habitats, there is little data beyond presence/absence or density information. The range in the amount of habitat specific information by life-history stage is reflected in the information levels assigned the different life-history stages. EFH is defined for this species on the basis of watershed-specific information available about the species’ distribution, and its known range of marine distribution within the EEZ.

Eggs/Spawning: Chinook salmon spawn in a broad range of habitats. They have been known to spawn in water ranging from a few centimeters deep to several meters deep, and in channel widths ranging from small tributaries 2 to 3 m wide to the main stems of large rivers such as the Columbia and Sacramento. Typically, redd (nest) size is 5 to 15 m^2, and water velocities are 40 to 60 cm/sec. The depth of the redd is inversely related to water velocity; generally the female buries her eggs in clean gravel, 20 to 36 cm deep. Because of their large size, Chinook salmon are able to spawn in higher water velocities and utilize coarser substrates than other salmon species. In general, female Chinook salmon select sections of the spawning stream with high subgravel flow. Because their eggs are the largest of the Pacific salmon, with a correspondingly small surface-volume ratio, they may be more sensitive to reduced oxygen levels and require a higher rate of irrigation. Fertilization of the eggs occurs simultaneous with deposition. Males compete for the right to breed with a spawning females. Chinook females remain on their redds 6 to 25 days after spawning, defending the area from superimposition of eggs from another female.

Larvae/Alevins: Fertilized eggs begin their 5- to 8-month period of embryonic development and growth in intragravel interstices. To survive successfully, the eggs, alevins and pre-emergent fry must first be protected from freezing, desiccation, stream bed scouring or shifting, mechanical injury, and predators. Water surrounding them must be non-toxic and of sufficient quality and quantity to provide basic requirements of suitable temperatures, adequate supply of oxygen, and removal of waste materials. Rates of egg development, survival, size of hatched alevins and percentage of deformed fry are related to temperature and oxygen levels during incubation. Generally, low oxygen levels are non-lethal early, but lethal late in development. Under natural conditions, 30 percent or less of the eggs survive to emerge from the gravel as fry.

Juveniles: Chinook salmon are typically 33 to 36 mm in length when they emerge from the incubation gravel. Residency in freshwater and size and timing of seawater migration are highly variable. Ocean-type fish can migrate seaward immediately after yolk absorption. The majority of ocean-type fish migrate at 30 to 90 days after emergence, but some fish move seaward as fingerlings in the late summer of their first year, while others overwinter and migrate as yearling fish. Stream-type fish, in contrast, generally spend at least 1 year in freshwater, migrating as 1- or 2-year-old fish. In Alaska, the stream-type life history predominates although ocean-type life histories have been documented in a few Alaska watersheds. Water and habitat quality and quantity determine the productivity of a watershed for Chinook salmon. Both stream- and ocean-type fish utilize a wide variety of habitats during their freshwater residency, and are dependent on the quality of the entire watershed, from headwater to salt water. The stream/river ecosystem must provide adequate rearing habitat, and migration corridors from spawning and rearing areas to the sea. Stream-type juveniles are more dependent on freshwater ecosystems because of their extended residence in these areas. The principal foods in freshwater are larval and adult insects. The seaward migration of smolts is timed so that the smolts arrive in the estuary when food is plentiful. Migration and rearing habitats overlap. Stream flows during the migratory period tend to be high, which facilitates seaward movement and provides some sheltering from predation.

After entering saltwater, Chinook juveniles disperse to oceanic feeding areas. Ocean-type fish have more extended estuarine residency, tend to be more coastal oriented, and do not generally migrate as far as stream-type fish. Food in estuarine areas include epibenthic organisms, insects, and zooplankton.

Adults: Chinook salmon typically remain at sea for 1 to 6 years. They have been found in oceanic waters at temperatures ranging from 1 to 15°C. They do not concentrate at the surface as do other Pacific salmon, but are most abundant at depths of 30 to 70 m. Fish make up the largest component of their diet at sea, although squid, pelagic amphipods, copepods, and euphausiids are also important at times.

Ocean distribution patterns have been shown to be influenced by both genetics and environmental factors. Migratory patterns in the ocean may have evolved as a balance between the benefits of accessing specific feeding grounds and the energy expenditure and dispersion risks necessary to reach them. Along the eastern Pacific rim, Chinook salmon originating north of Cape Blanco on the Oregon coast tend to migrate north towards and into the GOA, while those originating south of Cape Blanco migrate south and west into waters off Oregon and California. As a result, Chinook salmon that occur in the EEZ fishery in Alaska originate from the Oregon coast to southeast Alaska. Not all stocks within this large geographic area are distributed into the southeast Alaska fishery, however. For example, Puget Sound stocks do not normally migrate that far north.

Habitat Concerns

Habitat loss and alteration have reduced, and in some cases, extirpated Chinook salmon over a large portion of their range. Losses of Chinook habitat have occurred as a result of other resource development, such as hydroelectric power and logging, agriculture, and urbanization. Most habitat loss has occurred in freshwater ecosystems that support Chinook salmon development; estuarine rearing areas have also been affected in some areas by industrial development, urbanization, and dredging. The oceanic environment of Chinook salmon is considered largely unchanged by anthropogenic activities, although offshore petroleum production and local, transitory pollution events such as oil spills do pose some degree of risk.

Offshore petroleum production and large-scale transport of petroleum occurs in the Alaska EEZ, although at this time there is no offshore production of petroleum in the commercial troll area of the EEZ. Offshore oil and gas development and transport will inevitably result in some oil entering the environment at levels exceeding background amounts. The *Exxon Valdez* oil spill was shown to have direct effects on the survival and habitats of pink salmon. Chinook salmon were not directly affected, because of their different habitat utilization in the spill area. In general, the early life history stages of fish are more susceptible to oil pollution than juveniles or adults.

By far, the most serious habitat concern for Chinook salmon is the degradation of the freshwater watersheds that support those stages of their life history. Dams and impoundments for hydroelectric power and water diversion have caused large-scale extirpation of Chinook salmon in the Pacific Northwest by eliminating access to anadromous fish, and have altered the spawning, rearing, and migration corridors of Chinook salmon in many watersheds. There are presently no dams in place or in planning that would block rivers used by Chinook salmon in Alaska. However, because many Chinook salmon harvested under the FMP for Alaska originate in the Pacific Northwest, these types of habitat impacts in other regions directly affect the Alaska fishery.

Logging and associated road construction has resulted in degraded habitat by causing increased erosion and sedimentation, changes in temperature regimes, and changes in seasonal flow patterns. Timber harvest has been a major resource use in southeast Alaska, and it is increasing in southcentral Alaska. Timber harvest in the Pacific Northwest and British Columbia also impacts the Alaska fishery because of the presence of stocks from these regions in the Alaska EEZ.

Placer mining has caused serious degradation of Chinook habitats in some river systems, especially in Yukon River drainages. While these impacts are of concern, most of the stocks directly affected do not migrate into the Chinook fishery managed under the FMP.

Urbanization and coastal development can have pronounced effects on coastal ecosystems, particularly estuaries, through modification of the hydrography, biology, and chemistry in the developed area. Increased nutrient input, filling of productive wetlands, and influx of contaminants commonly occur with coastal development. These impacts can reduce or eliminate rearing potential for juvenile Chinook salmon. Increased levels of coastal development in Alaska as well as in the Pacific Northwest and British Columbia can be expected.

There is a definite south-north cline to the degree of habitat degradation and the status of Chinook populations in the eastern Pacific. Habitat degradation in Alaska is certainly a management concern, but to date has not had the degree of impacts on Chinook populations as in the Pacific Northwest. In southeast Alaska, logging is considered the largest potential threat to anadromous fish habitat. Relatively little logging has occurred, however, in watersheds supporting Chinook salmon in the region. However, because of the stock composition of the fish harvested in the EEZ of southeast Alaska, freshwater ecosystems in the Pacific Northwest represent essential fish habitat for sustaining the diversity and abundance of Chinook salmon in the Alaska EEZ.

Additional Information Sources

Dave Gaudet, Alaska Department of Fish and Game.
William Heard, NMFS, Auke Bay Laboratory.

Literature

Alderdice, D.F., and F.P.J. Velsen. 1978. Relation between temperature and incubation time for eggs of Chinook salmon *(Oncorhynchus tshawytscha).* J. Fish. Res. Board Can. 35:69-75.

Alderdice, D.F., W.P. Wickett, and J.R. Brett. 1958. Some effects of temporary exposure to low dissolved oxygen levels on Pacific salmon eggs. J. Fish. Res. Board Can. 15:229-249.

Atkinson, C.E., T.H. Rose, and T.O. Duncan. 1967. Pacific salmon in the United States, p. 43-223. *In:* Salmon of the North Pacific Ocean. Part IV. Spawning populations of North Pacific salmon. Int. North Pac. Fish. Comm. Bull. 23.

Baker, T.T., A.C. Wertheimer, R.D. Burkett, R. Dunlap, D.M. Eggers, E.I. Fritts, A.J. Gharrett, R.A. Holmes, and R.L. Wilmot. 1996. Status of Pacific salmon and steelhead escapements in southeast Alaska. Fisheries 21(10): 6-19.

Beamish, R.J., I.A. Pearsall, and M.C. Healey. 2003. A history of the research on the early marine life of pacific salmon off Canada's Pacific coast. N. Pac. Anadr. Fish Comm. Bull. 3:1-40.

Beamish, R.J., B.E. Riddell, C.E.M. Neville, B.L. Thomson, and Z. Zhang. 1995. Declines in Chinook salmon catches in the Strait of Georgia in relation to shifts in the marine environment. Fisheries Oceanography 4(3), 243-256.

Bradford, M.J. 1995. Comparative review of Pacific salmon survival rates. Canadian Journal of Fisheries and Aquatic Sciences 52, 1327-1338.

Brodeur, R.D., G.W. Boehlert, E. Casillas, M.B. Eldridge, J.H. Helle, W.T. Peterson, W.R. Heard, S.T. Lindley, and M.H. Schiewe. 2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. Fisheries 25, 7-16.

Brodeur, R.D., R.C. Francis, and W.G. Pearcy. 1992. Food consumption of juvenile coho (*Oncorhynchus kisutch*) and Chinook salmon (*O. tshawytscha*) on the continental shelf off Washington and Oregon. Canadian Journal of Fisheries and Aquatic Sciences 49, 1670-1685.

Brodeur, R.D., K.W. Myers, and J.H. Helle. 2003. Research conducted by the United States on the early ocean life history of Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:89-131.

Burger, C.V., R.L. Wilmot, and D.B. Wangaard. 1985. Comparison of spawning areas and times for two runs of Chinook salmon (Oncorhynchus tshawytscha) in the Kenai River, Alaska. CAN. J. FISH. AQUAT. SCI., vol. 42, no. 4, pp. 693-700.

Cooney, R.T., and R.D. Brodeur. 1998. Carrying capacity and North Pacific salmon production: stock-enhancement implications. Bulletin of Marine Science 62, 443-464.

Council. 1990. Fishery management plan for the salmon fisheries in the EEZ off the coast of Alaska. North Pacific Fishery Management Council, Anchorage, AK.

Cronin, M.A.; W.J. Spearman, R.L. Wilmot, J.C. Patton, and J.W. Bickham. 1993. Mitochondrial DNA variation in Chinook (Oncorhynchus tshawytscha) and chum salmon (O. keta) detected by restriction enzyme analysis of polymerase chain reaction (PCR) products. CAN. J. FISH. AQUAT. SCI.], vol. 50, no. 4, pp. 708-715.

Fiscus, C.H. 1980. Marine mammal-salmonid interactions: a review. P. 121-132. *In:* W. J. McNeil and D. C. Himsworth (eds.). Salmonid ecosystems of the North Pacific. Oregon State University Press, Corvallis, OR.

Gharrett, A.J., S.M. Shirley, and G.R. Tromble. 1987. Genetic relationships among populations of Alaskan Chinook salmon. Canadian Journal Fish. Aquat. Sci. 44:765-774.

Hartt, A.C. 1966. Migrations of salmon in the North Pacific Ocean and BS as determined by seining and tagging, 1959-1960. Int. North Pac. Fish. Comm. Bull. 19: 141p.

Hartt, A.C., and M.B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. Int. North Pac. Fish. Comm. Bull. 46: 105p.

Healey, M.C. 1991. Life history of Chinook salmon, *Oncorhynchus tshawytscha*, p 311-394 *in* C. Groot and L. Margolis (eds.), Pacific salmon life histories. UBC Press, Vancouver

Healey, M.C. 1980. The ecology of juvenile salmon in Georgia Strait, British Columbia. Pages 203-229 *in* W. J. McNeil and D.C. Hinsworth (eds.), Salmonid ecosystems of the North Pacific. Oregon State University Press, Corvallis, Or.

Healey, M.C. 1983. Coast-wide distribution and ocean migration patterns of stream-type and ocean-type Chinook salmon. Canadian Field-Naturalist 97:427-433.

Heard, W.R., R. Burkett, F. Thrower, and S. McGee. 1995. A review of Chinook salmon resources in southeast Alaska and development of an enhancement program designed for minimal hatchery-wild stock interactions. Amer. Fish. Soc. Symposium 15: 21-37.

Jaenicke, H.W., and A.G. Celewycz. 1994. Marine distribution and size of juvenile Pacific salmon in Southeast Alaska and northern British Columbia. Fishery Bulletin 92(1), 79-90.

Karpenko, V.I. 2003. Review of Russian marine investigations of juvenile Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:69-88.

Landingham, J.H., M.V. Sturdevant, and R.D. Brodeur. 1998. Feeding habits of juvenile Pacific salmon in marine waters of southeast Alaska and northern British Columbia. Fishery Bulletin 96(2):285-302.

Major, R.L., J. Ito, S. Ito, and H. Godfrey. 1978. Distribution and origin of Chinook salmon in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 38:54p.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78, 1069-1079.

Martin, R.M., A.C. Wertheimer, F. Thrower, and J.E. Joyce. 2001. Growth and survival of Alaska stream-type Chinook salmon cultured in estuarine net-pens or freshwater raceways. North American Journal Aquaculture 63: 256-261.

Mathews, G.M., and R.S. Waples. Status review for Snake River spring and summer Chinook salmon. NOAA Tech. Memo. NMFS F/NWC-200.

Mayama, H., and Y. Ishida. 2003. Japanese studies on the early ocean life of juvenile salmon. N. Pac. Anadr. Fish Comm. Bull. 3:41-67.

McIsaac, D.O., and T.P. Quinn. 1988. Evidence for a hereditary component in homing behavior of Chinook salmon (*Oncorhynchus tshawytscha*). Can. Journal Fish. Aquat. Sci. 45: 2201-2205.

Meacham, C.P., and J.H. Clark. 1994. Pacific salmon management - the view from Alaska. Alaska Fishery Research Bulletin 1(1): 76-80.

Meuter, F.J., R.M. Peterman, and B.J. Pyper. 2002. Opposite effects of ocean temperature on survival rates of 120 stocks of Pacific salmon (Oncorhynchus spp.) in northern and southern areas. Canadian Journal of Fisheries and Aquatic Sciences 59, 456-463.

Moulton, L.L. 1997. Early marine residence, growth, and feeding by juvenile salmon in Northern Cook Inlet, Alaska. Alaska Fishery Research Bulletin 4(2):154-177.

Nehlson, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

Orsi, J.A., and A.C. Wertheimer. 1995. Marine vertical distribution of juvenile Chinook and coho salmon in southeast Alaska. Tran. Amer. Fish. Soc. 124: 159-169.

Orsi, J.A., and H.W. Jaenicke. 1996. Marine distribution and origin of prerecruit Chinook salmon, *Oncorhynchus tshawytscha*, in southeast Alaska. Fish. Bull. 94: 482-497.

Pacific Salmon Commission. 1994. Joint Chinook Technical Committee 1993 Annual Report. Pacific Salmon Commission Report TCCHINOOK 94-1. Vancouver, British Columbia.

Pearcy, W. 1992. Ocean ecology of North Pacific salmonids. Univ. Wash. Press, Seattle, WA.

Rigby, P., J. McConnaughey, and H. Savikko. 1991. Alaska Commercial Salmon Fisheries, 1878-1991. Alaska Department of Fish and Game Regional Information Report 5J91-16.

Roni, P., and T.P. Quinn. 1995. Geographic variation in size and age of North American Chinook salmon. N. Am. J. Fish. Manag. 15: 325-345.

Taylor, E.B. 1990. Environmental correlates of life-history variation in juvenile Chinook salmon, *Oncorhynchus tshawytscha*. J, Fish. Biol. 31: 1-17.

Utter, F., G. Milner, G. Stahl, and D. Teel. 1989. Genetic population structure of the Chinook salmon, *Oncorhynchus tshawytscha*, in the Pacific northwest. Fish. Bull. 87: 239-264.

Walters, C.J., R. Hilborn, R.M. Peterman, and M. Staley. 1978. A model for examining early ocean limitation of Pacific salmon production. Journal of the Fisheries Research Board of Canada 35, 1303-1315.

Waples, R.S., J.R.P. Jones, B.R. Beckman, and G.A. Swan. 1991. Status review for Snake River fall Chinook salmon. NOAA Tech. Memo. NMFS F/NWC-201.

Wertheimer, A.C. 1996. The status of Alaska salmon. Pages 179-197 *In* D. J. Stouder, P.A. Bisson, and R.J. Naiman (eds), Pacific salmon and their ecosystems: status and future options. Proceedings of a Symposium, Seattle, Washington, Jan. 10-12, 1994. Chapman Hall, New York.

Wertheimer, A.C., and A.G. Celewycz. 1996. Abundance and growth of juvenile pink salmon in oiled and non-oiled locations of western Prince William Sound after the *Exxon Valdez* oil spill. Pp.518-532. *In* S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright (Eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18.

SPECIES: Chinook Salmon, *Oncorhynchus tshawytscha*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic/ Riverine Features	Other
Eggs and larvae (alevins)	50 to 250 days	NA	late summer, fall, winter, early spring	streambeds	intragravel 20 to 80 cm deep	G	Riverbed	**DO**< 3 mg/l lethal, optimum >7 **Temp** 0-17 C, Optimum 4-12 C
Juveniles (freshwater)	days-years	insect larvae and adults, zooplankton	year-round, depending on race	streams, sloughs, rivers	surface to several meters	varied	Pools, stream and river margins, woody debris	Extremely varied freshwater life history. **DO**< 2 mg/l lethal, optimum >7 **Temp** 0-22 C, Optimum 8-12 C
Juveniles (Estuary)	days-6-months	copepods, euphausiids, amphipods, juvenile fish	spring, summer, fall	BCH, BAY	N, P	All bottom types	estuarine, littoral	Sea-type can be estuarine dependent **Temp** 2-22 C, Optimum 8-12 C **Salinity** 0-33 ppt
Juvenile (marine)	6 to 9 months: Up to first marine annulus	epipelagic fish, euphasiids, large copepods, pelagic amphipods	spring-winter	IP, ICS, MCS, OCS, USP, BSN	P	All bottom types	UP, F, G, CL, E	Initially surface oriented; some stocks move rapidly offshore, some remain nearshore. **Temp:** 1-15 C, Optimum 5-12 C

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic/ Riverine Features	Other **Page 2 of 2**
Immature and Maturing Adults (marine)	2 to 8 years of age	epipelagic fish (herring, sand lance, smelt, anchovy), shrimp, squid	Year Round	BAY, IP, ICS, MCS, OCS, USP, BSN	N, P	All bottom types	UP, F, G, CL, E	Not surface oriented until maturing. Use salinity gradients, olfaction for terminal homing. **Temp:** 5-22 C
Adults (freshwater)	2 weeks to 4 months	little or none	Spawning: (July-Feb) Freshwater Migration: Year round, varies greatly among populations	Rivers, large streams and tributaries	0.5-10 m	Alluvial bottom types; G for spawning	Deep pools for resting, Riffles, pool-riffle transition for spawning	Entry timing to freshwater highly variable. **Temp:** 1-26 C, Optimum 4-15 C

Habitat Description for Coho Salmon

(Oncorhynchus kisutch)

Management Plan and Area(s) Salmon fisheries in the EEZ off the coast of Alaska, Council, 1990

General Distribution and Life History

Coho salmon are widely distributed in cool areas of the North Pacific Ocean and most adjoining fresh and estuarine waters. Coho use more diverse habitats than other anadromous salmonids. They spawn in most accessible freshwater streams throughout their range, rear for at least 1 year in fresh or estuarine waters, and spend about 18 months at sea before reaching maturity. In North America, coho range along the Pacific coast from Monterey Bay, California, to Point Hope, Alaska, through the Aleutians (Figure 1). The species is most abundant in coastal areas from central Oregon north through southeast Alaska. In the southern part of their range, coho stocks are generally depressed from historical levels, and hatcheries are often used to supplement wild runs. The Central California Coast ESU and the Southern Oregon/ Northern California Coast ESU are listed as threatened species under the Endangered Species Act. Coho are cultured for market in several countries; attempts to establish self-sustaining coho runs in other areas of the world have had limited success.

In the NMFS Alaska Region, most coho are wild fish with a distribution north to Point Hope on the eastern Chukchi Sea, west and south to the limits of United States territorial waters, and east to the Canadian border as far north as the Yukon River drainage. Coho catch in the Alaska Region is at historically high levels, and trends in abundance of most stocks are rated as stable.

Fishery

Important commercial, sport, and subsistence fisheries for coho occur from the Soviet Far East through the BS and along the west coast of North America as far south as central California. Trolling, gill nets, and purse seines are the primary commercial gear types. Gill nets, dip nets, rod and reel, traps, fish wheels, long lines, and snagging gear are used to harvest coho for subsistence and personal use. Subsistence fisheries are often cultural or traditional and take precedence over other fisheries. Personal use fisheries require a sport fishing license or exemption. Both subsistence and personal use fisheries are restricted to designated locations and specified bag limits. Sport catches of coho are taken by hook and line and snagging.

Most coho from the Alaska Region recruit to fisheries after 1 to 2 years in fresh water and about 16 months at sea. Fisheries in the Alaska Region primarily target adult coho and take place in coastal marine migration corridors, near the mouths of rivers and streams, and in freshwater migration areas. Those fisheries coincide with migrations toward spawning areas from July through October. A few areas are stocked annually with juvenile coho to provide put-and-take sport fishing.

Bycatch depends on gear type, but is usually limited to other salmon species. Chinook salmon bycatch is limited by regulation or treaty in most coho fisheries, but other salmon species are often targeted as part of the fishery. Species such as steelhead, Dolly Varden, pollock, Pacific cod, halibut, salmon sharks, and coastal rockfish make up a small part of the catch.

Directed fisheries on coho salmon in Alaska include marine commercial and recreational hook-and-line fisheries; marine commercial gill-net and seine fisheries; and estuarine and riverine gill-net (both set-net and drift), recreational, personal use, and subsistence fisheries. Two types of impacts can occur: (1) direct effects of the fishing gear on habitat and (2) bycatch or entanglement of non-target species. In the marine fisheries, direct impact of the gear on marine habitats is limited, but some localized effects can occur, such as trolling weights damaging coral or purse seines damaging kelp beds or benthic structure. Bycatch and entanglement of non-target species can occur in the marine fisheries, such as bycatch of demersal rockfish in hook-and-line fisheries, and entanglement of seabirds and marine mammals in net fisheries. In the estuarine and riverine fisheries, direct impacts on riparian vegetation and channel morphology can occur from fishing activities, such as damage to the stream bank from boat wakes and removal of woody debris to provide access. Trampling of stream banks and the stream channel can also damage coho habitat. Where use levels are high, this type of impact may require restoration or management initiatives. An example is the Kenai River where restoration work was needed to repair damage from recreational fishing for Chinook salmon and other salmonids.

Relevant Trophic Information

Adult coho provide important food for bald eagles, terrestrial mammals (e.g., brown bear, black bear, and river otter), marine mammals (e.g., Steller sea lion, harbor seal, beluga, and orca), and salmon sharks. Adults also transfer essential nutrients from marine to freshwater environments. Juveniles are eaten by a variety of birds (e.g., gulls, terns, kingfishers, cormorants, mergansers, herons), fish (e.g., Dolly Varden, steelhead, cutthroat trout, and arctic char), and mammals (e.g., mink and water shrew). Juvenile coho are also significant predators of pink salmon fry during their seaward migration.

Approximate Upper Size Limit of Juvenile Fish (in cm): 35 cm

Habitat and Biological Associations

Juvenile and adult coho are highly migratory and depend on suitable habitat in their migration routes. Unobstructed passage and suitable water depth, water velocity, water quality, and cover are important elements in all migration habitat. Soon after emergence in spring, fry may move around considerably seeking optimal, unoccupied habitat for rearing. In fall, juveniles may migrate from summer rearing areas to areas with winter habitat. Such juvenile migrations may be extensive within the natal stream basin or between basins through salt water or connecting estuaries. Seaward migration of coho smolts occurs usually after 1-2 years in fresh water. The migration is timed primarily by photoperiod and occurs in spring, usually coincident with a spring freshet. During this transition, coho undergo major physiological changes to enable them to osmoregulate in salt water and are at that time, especially sensitive to environmental stress. At sea, juvenile Alaska coho generally migrate north and offshore into the North Pacific Ocean and BS. After 12 to 14 months at sea, they migrate to coastal areas and then along the coast to their natal streams.

Egg/Larvae: Fertilized eggs and larvae require incubation in porous substrate that allows constant circulation of cool, high-quality water that provides oxygen and removes waste. Interstitial space in the substrate must be great enough to allow growth and movement through the gravel to accommodate emergence. Sand or silt in the substrate can limit intragravel flow and trap emerging fry. As the yolk sac is absorbed, the larvae become photopositive and move through the substrate into the water column. Fry emerge between March and July, depending on when the eggs were fertilized and water temperature during development.

<u>Juveniles (Fresh Water)</u>: In Alaska, juvenile coho usually spend 1-2 years in fresh or estuarine waters before migrating to sea, although they may spend up to 5 years where growth is slow. Coho need to attain a length of about 85 mm to become smolts. Coho smolt production is most often limited by the productivity of freshwater and estuarine habitats used for juvenile rearing. Survival from eggs to smolts is usually less than 2 percent. If spawning escapement is adequate, sufficient fry are usually produced to exceed the carrying capacity of rearing habitat. In this case, carrying capacity of summer habitat sets a density-dependent limit on the juvenile population. This summer population is then reduced by density-independent mortality over winter depending on the severity of winter conditions, fish size, and quality of winter habitat.

Coastal streams, lakes, estuaries, and tributaries to large rivers can all provide coho rearing habitat. The most productive habitats are in smaller streams less than fourth order having low-gradient alluvial channels with abundant pools often formed by large woody debris or fluvial processes. Beaver ponds can provide some of the best summer rearing areas for juvenile coho. Coho juveniles also may use brackish-water estuarine areas in summer and migrate upstream to fresh water to overwinter.

During the summer rearing stage, fish density tends to be highest in areas with abundant food (drifting aquatic invertebrates and terrestrial insects that fall into the water) and structural habitat elements (e.g., large woody debris and associated pools). Preferred habitats include a mixture of different types of pools, glides, and riffles with large woody debris, undercut banks, and overhanging vegetation, which provide advantageous positions for feeding. Coho grow best where water temperature is between 10 and 15°C, and dissolved oxygen (DO) is near saturation. Juvenile coho can tolerate temperatures between 0° and 26°C if changes are not abrupt. Their growth and stamina decline significantly when DO levels drop below 4 mg/l, and a sustained concentration less that 2 mg/l is lethal. Summer populations are usually constrained by density-dependent effects mediated through territorial behavior. In flowing water, juvenile coho usually establish individual feeding territories, whereas in lakes, large pools, and estuaries they are less likely to establish territories and may aggregate where food is abundant. Growth in summer is often density-dependent, and the size of juveniles in late summer is often inversely related to population density.

In winter, food is less important and territorial behavior fades. Juveniles aggregate in freshwater habitats that provide cover with relatively stable temperature, depth, velocity, and water quality. Winter mortality factors include hazardous conditions during winter peak stream flow, stranding of fish by ice damming, physiological stress from low temperature, and progressive starvation. In winter, juveniles prefer a narrower range of habitats than in summer, especially large mainstream pools, backwaters, and secondary channel pools with abundant large woody debris, and undercut banks and debris along riffle margins. Survival in winter, in contrast to summer, is generally not density-dependent, and varies directly with fish size and amount of cover and ponded water, and inversely with the magnitude of the peak stream flow.

The seaward migration of smolts in native stocks is typically in May and June, and is presumably timed so that the smolts arrive in the estuary when food is plentiful. Habitat requirements during seaward migration are similar to those of rearing juveniles, except that smolts tend to be more fragile and more susceptible to predation. High streamflow aids their migration by assisting them downstream and reducing their vulnerability to predators. Turbidity from melting glaciers may also provide cover from predators. Migration cover is also provided by woody debris and submerged riparian vegetation. Migrating smolts are particularly vulnerable to predation because they are concentrated and moving through areas of reduced cover where predators congregate. Mortality during seaward migration can exceed 50 percent.

Juveniles (Estuarine): Juvenile coho primarily use estuarine habitat during their first summer and also as they are leaving fresh water during their seaward migration. Intertidal sections of freshwater streams (i.e., stream-estuary ecotones) can be important rearing habitat for age 0 coho from May to October. These areas may account for one-quarter of the juvenile production in small streams. Growth in these areas is particularly rapid because of abundant invertebrate food. Habitats used include glides and pools during low tide, and coho occupy the freshwater lens during high tide. In fall, juvenile coho move upstream to fresh water to overwinter.

During seaward migration, coho smolts may be present in the estuary from May to August. Rapid growth during the early period in the estuary is critical to survival because of high size-dependent mortality from predation.

Juveniles (Marine): After leaving fresh water, coho in the Alaska Region spend up to 4 months in coastal waters before migrating offshore and dispersing throughout the North Pacific Ocean and BS. Southeast Alaska juvenile coho are ubiquitous in inside waters from June to August at depths up to 50 m, and move offshore by September. Offshore, juvenile salmon are concentrated over the continental shelf within 37 km of shore where the shelf is narrow, but may extend to at least 74 km from shore in some areas. Stock-specific aggregations have not been noted at this stage. Marine invertebrates are the primary food when coho first enter salt water, and fish prey increase in importance as the coho grow.

Immature and Maturing Adults (Marine): Most coho occupy epipelagic areas in the central GOA and BS during the 12 to 14 months after leaving coastal areas. Some coho also use coastal and inshore waters at this life stage, but those are likely to be smaller at maturity. The spatial distribution of suitable habitat conditions is affected by annual and seasonal changes in oceanographic conditions; however, coho generally use offshore areas of the North Pacific Ocean and the BS from lat. 40 to 60° N (Figure 2). The distribution of ocean harvest is generally more northerly than that for stocks from other regions (Figure 3).

Growth is the objective at this stage of the coho life cycle, and bioenergetics are controlled mainly by food quantity, food quality, and temperature. Food for salmon is most abundant above the halocline, which may range from 100 to 200 m in depth in the North Pacific. The bioenergetics of growth is best in epipelagic offshore habitat where forage is abundant and sea surface temperature is between 12 and 15°C. Coho rarely use areas where sea surface temperature exceeds 15°C.

Most coho remain at sea for about 16 months before returning to coastal areas and entering fresh water to spawn, although some precocious males will return to spawn after about 6 months at sea. Before entering fresh water to spawn, most coho slow their feeding and begin to lose weight as they develop secondary sex characteristics. Survival from smolt to adult averages about 10 percent.

Adults (Freshwater): Adult coho enter fresh water from early July through December and spawn from September through January. Fidelity to natal streams is high and straying rates are generally less than 5 percent. The fish feed little and migrate upstream using olfactory cues that were imprinted in early development.

Adult coho may travel for a short time and distance upstream to spawn in small streams or may enter large river systems and travel for weeks to reach spawning areas more than 2,000 km upstream. Upstream migrations are blocked where fall heights exceed 3.3 m or falls more than 1.2 m high have jumping pools less than 1.25 times the falls height. Blockages also occur where stream gradient exceeds

12 percent for more than 70 m, or 16 percent for more than 30 m, or 20 percent for more than 15 m, or 24 percent for more than 8 m.

Spawning sites selected for use have relatively silt-free gravels ranging from 2 mm to 10 cm in diameter, well-oxygenated intragravel flow, and nearby cover. In Alaska streams, between 2,500 and 4,000 eggs are deposited among several nests by each female coho. Several males may attend each female, but larger males usually dominate by driving off smaller males. Soon after spawning, adult coho die in or near the spawning areas.

Additional Information Sources

Adults: ADF&G, Commercial Fisheries Management and Development Division; ADF&G, Sport Fish Division; ADF&G, Subsistence Division.

Juveniles: ADF&G, Habitat and Restoration Division; USFS, Region 10 Office of Wildlife, Fish Ecology, and Watershed; NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, Mike Murphy.

The known distribution of adults and juveniles is given in the current ADF&G *Atlas to the Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes*. The Catalogue and Atlas are divided into six volumes corresponding to the state's six resource management regions (Arctic, Interior, Western, Southwest, Southcentral, and Southeast). The principal contact for the ADF&G catalogue/atlas project is Ed Weiss, ADF&G Regional Office in Anchorage. Copies of the entire Atlas and Catalogue are available for inspection at the ADF&G Habitat and Restoration Division Regional Offices in Fairbanks and Anchorage and the Headquarters Office in Juneau. Copies of a regional volume of the Atlas are available for inspection at ADF&G offices in Ketchikan, Wrangell, Petersburg, Sitka, Haines, Yakutat, Palmer, Cordova, Glennallen, Soldotna, Homer, Kodiak, Sand Point, King Salmon, Dillingham, Bethel, Delta Junction, Tok, Nome, and Dutch Harbor.

Literature

Baker, T.T., A.C. Wertheimer, R.D. Burkett, R. Dunlap, D.M. Eggers, E.L. Fritts, A.J. Gharrett, R.A. Holmes, and R.L. Wilmot. 1996. Status of Pacific salmon and steelhead escapements in Southeastern Alaska. Fisheries 21(10): 6-18.

Beamish, R.J., I.A. Pearsall, and M.C. Healey. 2003. A history of the research on the early marine life of pacific salmon off Canada's Pacific coast. N. Pac. Anadr. Fish Comm. Bull. 3:1-40.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. In: W.R. Meehan, ed. Influences of forest and rangeland management on salmonid fishes and their habitats. AFS Special Publication 19:83-138.

Bradford, M.J., 1995. Comparative review of Pacific salmon survival rates. Canadian Journal of Fisheries and Aquatic Sciences 52, 1327-1338.

Brodeur, R.D., G.W. Boehlert, E. Casillas, M.B. Eldridge, J.H. Helle, W.T. Peterson, W.R. Heard, S.T. Lindley, and M.H. Schiewe. 2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. Fisheries 25, 7-16.

Brodeur, R.D., K.W. Myers, and J.H. Helle. 2003. Research conducted by the United States on the early ocean life history of Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:89-131.

Burger, C.V., and A.C. Wertheimer. 1995. Pacific salmon in Alaska. Pages 343-347 *In*: E.T. LaRoe, G. S. Farris, C.E. Puckett, P.D. Doran, and M. J. Mac, eds. Our living resources: a report to the Nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S.D.I., NBS, Washington, D.C.

Burgner, R.L. 1980. Some features of ocean migrations and timing of Pacific salmon. Pages 153-164 *in*: W.J. McNeil and D.C. Himsworth, eds. Salmonid ecosystems of the North Pacific. OSU Press. Corvallis, Oregon.

Cooney, R.T., and R.D. Brodeur. 1998. Carrying capacity and North Pacific salmon production: stock-enhancement implications. Bulletin of Marine Science 62, 443-464.

Crone, R.A., and C.E. Bond. 1976. Life history of coho salmon, *Oncorhynchus kisutch*, in Sashin Creek, Southeastern Alaska. Fishery Bulletin 74(4):897-923.

Elliott, S. 1994. Coho salmon. Alaska Department of Fish and Game Wildlife Notebook Series. Alaska Dept. of Fish and Game, Juneau. 2 p.

Elliott, S.T., A.E. Schmidt, and D.A Sterritt. 1989. A study of coho salmon in southeast Alaska. Fishery Data Series No. 113, Alaska Dep. Fish and Game, Div. Sport Fish, Juneau.

Elliott, S.T., and D.A Sterritt. 1990. A study of coho salmon in southeast Alaska, 1989: Chilkoot Lake, Yehring Creek, Auke Lake, and Vallenar Creek. Fishery Data Series No. 90-53, Alaska Dep. Fish and Game, Div. Sport Fish, Anchorage.

Fraidenburg, M.E., M.A. Hunter, A.J. M. Stohr, and P.L. Pattillo. 1985. The ocean journeys of Pacific Northwest Chinooks and cohos, and steelheads, pages 109-126 *In* R.H, Stroud, ed., Proceedings of the tenth annual marine recreational fisheries symposium. National Coalition for Marine Conservation, Inc., Savannah, GA.

Geiger, H.J., and B. Frennette, eds. 1997. Run forecasts and harvest projections for 1997 Alaska salmon fisheries and review of the 1996 season: the short version. Alaska Dept. of Fish and Game, Regional Information Report No. 5197-01. 9 p.

Gray, P.L., J.F. Koerner, and R.A. Marriott. 1981. The age structure and length-weight relationship of southeast Alaska coho salmon (*Oncorhynchus kisutch*, 1969-1970. Alaska Department of Fish and Game, Div. Commercial Fisheries, Southeastern Alaska Coho Research, Juneau, AK.

Halupka, L.C., M.D. Bryant, M.F. Willson, J.K. Troyer, and F.H. Everest. 1996. Coho salmon (*Oncorhynchus kisutch*). Chapter 6 *In*: Biological characteristics and population status of anadromous salmon in Southeast Alaska. USDA Forestry Sciences Laboratory 2770 Sherwood Lane, Suite 2A, Juneau, AK 99801-8545.

Hasler, T.J. 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) -- coho salmon. U.S. Fish and Wildlife Serv. Biol. Rep. 82(11.70). U.S. Army Corps of Engineers, TR EL-82-4.

Hobday, A.J., and G.W. Boehlert. 2001. The role of coastal ocean variation in spatial and

Jaenicke, H.W., and A.G. Celewycz. 1994. Marine distribution and size of juvenile Pacific salmon in Southeast Alaska and northern British Columbia. Fishery Bulletin 92(1), 79-90.

Karpenko, V.I. 2003. Review of Russian marine investigations of juvenile Pacific salmon. N. Pac. Anadr. Fish Comm. Bull. 3:69-88.

Landingham, J.H., M.V. Sturdevant, and R.D. Brodeur. 1998. Feeding habits of juvenile Pacific salmon in marine waters of southeast Alaska and northern British Columbia. Fishery Bulletin 96(2):285-302.

Laufle, J.C., G.B. Pauley, and M.F. Shepard. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- coho salmon. U.S. Fish and Wildlife Service Biological Report 82(11.48). U.S. Army Corps of Engineers, TR EL-82-4. 18 pp.

Lorenz, J.M., M.L. Murphy, J.F. Thedinga, and K.V. Koski. 1991. Distribution and abundance of juvenile salmon in two main channel habitats of the Taku River, Alaska and British Columbia. NOAA Tech. Memo. NMFS F/NWC-206.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78, 1069-1079.

Manzer, J.I., T. Ishida, A.E. Peterson, and M.G. Hanavan. 1965. Salmon of the North Pacific Ocean. Part V. Offshore distribution of salmon. Int. North Pac. Fish. Comm. Bull. 15:452 pp.

Mayama, H., and Y. Ishida. 2003. Japanese studies on the early ocean life of juvenile salmon. N. Pac. Anadr. Fish Comm. Bull. 3:41-67.

McMahon, T.E. 1983. Habitat suitability index models: coho salmon. U.S. Dept. Of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.49. 29 pp.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 *in*: W.R. Meehan, ed. Influences of forest and rangeland management on salmonid fishes and their habitats. AFS Special Publication 19.

Meuter, F.J., R.M. Peterman, and B.J. Pyper. 2002. Opposite effects of ocean temperature on survival rates of 120 stocks of Pacific salmon (Oncorhynchus spp.) in northern and southern areas. Canadian Journal of Fisheries and Aquatic Sciences 59, 456-463.

Moulton, L.L. 1997. Early marine residence, growth, and feeding by juvenile salmon in Northern Cook Inlet, Alaska. Alaska Fishery Research Bulletin 4(2):154-177.

Murphy, J. 1995. Patterns in the spatial distribution of salmon *(Oncorhynchus* spp.) captured in the Pacific driftnet fishery for flying squid (*Ommastrephes bartrami*). M.S. Thesis. Univ. Of Alaska, Fairbanks. 110 p.

Murphy, M.L., J. Heifetz, J.F. Thedinga, S.W. Johnson, and K.V. Koski. 1989. Habitat utilization by juvenile Pacific salmon (*Oncorhynchus*) in the glacial Taku River, southeast Alaska. Can. J. Fish. Aquat. Sci. 46:1677-1685.

Murphy, M.L., J.F. Thedinga, K.V. Koski, and G.B. Grette. 1984. A stream ecosystem in an old-growth forest in Southeast Alaska. Part V: Seasonal changes in habitat utilization by juvenile salmonids, p. 89-98. In W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley [eds.] Fish and wildlife relationships in old-growth forests: proceedings of a symposium. Am. Inst. Fish. Res. Biol.

Murphy, M.L., K.V. Koski J. M. Lorenz, and J. F. Thedinga. In press. Downstream migrations of juvenile Pacific salmon (*Oncorhynchus* sp.) in a glacial transboundary river. Can. J. Fish. Aquat. Sci.

Myers, K.W., K.Y. Aydin, R.V. Walker, S. Fowler, and M.L. Dahlberg. 1996. Known ocean ranges of stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. (NPAFC Doc. 192.) FRI-UW-9614. University of Washington, Fisheries Research Institute, Box 357980, Seattle, WA 98195-7980.

Nickleson, T.E., and J.A. Lichatowich. The influence of the marine environment on the interannual variation in coho salmon abundance. Pages 24-36 *in*: W.G. Pearcy, ed. The influence of ocean conditions on the production of salmonids in the North Pacific. OSU Sea Grant Publication ORESU-W-83-001.

Olsen, J.C. 1994. Alaska salmon resources. Pages 77-89 *in* L. Low, J. Olsen, and H. Braham, eds. Status of living marine resources off Alaska. 1993. NOAA Tech. Memo. NMFS-AFSC-27. U.S.D.C. Alaska Fisheries Science Center, Seattle.

Orsi, J.A., J.M. Murphy, and A.L.J. Brase. 1997. Survey of juvenile salmon in the marine waters of southeast Alaska, May-August 1997. (NPAFC Doc. 277).

Orsi, J.A., A.G. Celewycz, D. G. Mortensen, and K. A. Herndon. 1987. Sampling juvenile Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) by small trolling gear in the northern and central regions of southeast Alaska, 1985. NOAA Technical Memorandum NMFS F/NWC-115.

Sandercock, F.K. 1991. Life history of coho salmon. Pages 395-445 *in*: C. Groot and L. Margolis, eds. Pacific salmon life histories. UBC Press, Vancouver, BC.

Slaney, T.L., K.D. Hyatt, T.G. Northcote, and R.J. Fielden. Status of anadromous salmon and trout in British Columbia and Yukon. Fisheries 21(10): 20-35.

Thedinga, J.F., M.L. Murphy, S.W. Johnson, J.M. Lorenz, and K.V. Koski. 1994. Determination of salmonid smolt yield with rotary-screw traps in the Situk River, Alaska, to predict effects of glacial flooding. N. Am. J. Fish. Manage. 14:837-851.

Walters, C.J., R. Hilborn, R.M. Peterman, and M. Staley. 1978. A model for examining early ocean limitation of Pacific salmon production. Journal of the Fisheries Research Board of Canada 35, 1303-1315.

Wertheimer, A.C. Status of Alaska salmon. 1997. Pages 179-197 *in*: D.J. Stouder, P.A. Bisson, and R.J. Naiman, eds. Pacific salmon and their ecosystems: status and future options.

SPECIES: Coho Salmon *(Oncorhynchus kisutch)*

Stage -EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic/ Riverine Features	Other
Eggs/Larvae	150 days at optimum temperature	NA	Fall/winter	WC, LK	Intra-gravel	G	Streambed	DO < 2 mg/l lethal, optimum >8 mg/l; Temperature 0-17˚C; optimum 4.4-13.3˚C; substrate 2-10 cm with <15 percent fines (<3.3 mm), optimum <5 percent fines
Juveniles, Fresh water (fry to smolt)	1 to 5 years, most (>90 percent) 1 to 2 years	invertebrates and fish	Entire year	WC, LK	Entire column	N/A	Pools, woody debris, currents for migration	DO lethal at <3 mg/l, optimum at saturation; Temperature 0-26˚C; optimum 12-14˚C.
Juveniles, Estuarine	1 to 6 months	Invertebrates and fish	Rearing - summer, Migration - spring	EST	Mid-water and surface, P, N	N/A	Pools, glides, etc.	
Juveniles, Marine	up to 4 months	fish and invertebrates	June - September	BCH, ICS, MCS, BA, IP	P, N	N/A	UP, CL	Temperature <15˚C; Depth <10 m
Immature/ Maturing Adults, Marine	12 to 14 months	Fish (e.g., herring, sand lance)		BCH, ICS, MCS, OCS, USP, LSP, BSN, BAY, IP	P, N	N/A	U	Temperature range 1-26˚C; optimum 12-14˚C
Adults, Fresh water	up to 2 months	little or none	migration - fall; spawning - fall, winter	WC, LK	Deep parts of streams and lakes	Alluvial bottom types	Deep pools, Pool-riffle transition	Temperature range 1-26˚C; optimum 12-14˚C

Appendix F
Essential Fish Habitat Assessment Reports

Prepared by

National Marine Fisheries Service

April 2005

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Appendix F.1 **Essential Fish Habitat Assessment Report for the Groundfish Resources of the Gulf of Alaska Region**

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Appendix F.4 **Essential Fish Habitat Assessment Report for Scallop Resources of the Gulf of Alaska, Bering Sea, and Aleutian Islands Regions**

Appendix F.5 **Essential Fish Habitat Assessment Report for the Salmon Fisheries in the EEZ off the Coast of Alaska**

ACRONYMS AND ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
AFA	1999 American Fisheries Act
AI	Aleutian Islands
BAY	nearshore bays
BCH	beach
BS	Bering Sea
BSAI	Bering Sea/Aleutian Islands
BSN	basin
C	coral
CB	cobble
CL	carapace length
CL	thermocline or pycnocline
cm	centimeters
Council	North Pacific Fishery Management Council
CTC	Chinook Technical Committee
CW	carapace width
D	demersal
CO	dissolved oxygen
E	edges
EBS	Eastern Bering Sea
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	evolutionarily significant units
F	fronts
fm	fathoms
FMP	Fishery Management Plan
G	gravel
G	gyres
GIS	geographic information system
GOA	Gulf of Alaska
ICS	inner continental shelf
IP	island passes
K	kelp
km^2	kilometer
LSP	lower slope
m	meter
M	mud
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MCS	middle continental shelf
ML	mantle length
mm	millimeters
MS	muddy sand
mt	metric ton
N/A	not applicable
N	neustonic
NOAA	National Oceanic and Atmospheric Administration

OCS	outer continental shelf
P	pelagic
ppt	parts per thousand
PSC	Pacific Salmon Commission
R	rock
S	sand
SAV	subaquatic vegetation
SD/SP	semi-demersal or semi-pelagic
SM	sandy mud
TAC	total allowable catch
U	unknown
UP	upwelling
USP	upper slope

Appendix G
Non-fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures

Prepared by

National Marine Fisheries Service

April 2005

This appendix to the Alaska Essential Fish Habitat Environmental Impact Statement was adapted from a document developed jointly by the National Marine Fisheries Service Alaska Region, Northwest Region, and Southwest Region, and it was revised to apply specifically to Alaska. The following people contributed to this document (listed in alphabetical order): Lt. Mark Boland, Mark Carls, Eric Chavez, Bryant Chesney, Brian Cluer, Tracy Collier, Natalie Consentino-Manning, Joe Dillion, Bob Donnelly, Jeanne Hanson, Mark Helvey, Ron A. Heintz, Bob Hoffman, Thom Hooper, DeAnee Kirkpatrick, K. Koski, Brian Lance, Stacey Li, Marc Liverman, Matt Longenbaugh, Jon Mann, Leah Mahan, Ben Meyer, Adam Moles, Nancy Munn, Loren Peltz, Erika Phillips, Ken Phippen, Stanley Rice, Maggie Sommer, John Stadler, Dan Tonnes, and Susan Walker.

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ACRONYMS AND ABBREVIATIONS

ADNR	Alaska Department of Natural Resources
AFS	American Fisheries Society
AMAP	Arctic Mapping and Assessment Program
ATTF	Alaska Timber Task Force
BOD	biochemical oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Council	North Pacific Fishery Management Council
CWA	Clean Water Act
CWP	Center for Watershed Protection
dB	decibel
DDT	dichloro-diphyl-trichloroetane
DDE	dichlorodyphenyl dichloroethylene
EA	environmental assessment
EBS	Bering Sea
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FL	fork length
GOA	Gulf of Alaska
Hg	mercury
hz	hertz
LTF	log transfer facilities
LWD	large woody debris
mm	millimeter
MMS	Minerals Management Service
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
nm	nautical mile
NMDMP	National Marine Debris Monitoring Program
NMFS	National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
OCS	outer coastal shelf
OWRRI	Oregon Water Resources Research Institute
PAH	polycyclic aromatic hydrocarbon

PCB	polychlorinated biphenyl
PFMC	Pacific Fishery Management Council
POP	persistent organic pollutant
SPL	sound pressure level
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
ZOD	zone of deposit

G.1 INTRODUCTION

G.1.1 Background on Essential Fish Habitat

In 1996, the U.S. Congress added new habitat conservation provisions to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), the federal law that governs U.S. marine fisheries management. The renamed Magnuson-Stevens Act mandated the identification of Essential Fish Habitat[1] (EFH) for federally managed species and consideration of measures to conserve and enhance the habitat necessary for these species to carry out their life cycles.

The Magnuson-Stevens Act requires federal agencies to consult with the National Marine Fisheries Service (NMFS) on all actions or proposed actions permitted, funded, or undertaken by the agency that may adversely affect[2] EFH. Federal agencies initiate consultation by preparing and submitting a written assessment of the effects of the proposed federal action on EFH to NMFS. If a federal action agency determines that an action will not adversely affect EFH, no consultation is required. To promote efficiency and avoid duplication, EFH consultation is usually integrated into existing environmental review procedures under other laws such as the National Environmental Policy Act, Endangered Species Act (ESA), or Fish and Wildlife Coordination Act.

The Magnuson-Stevens Act requires NMFS to recommend conservation measures to federal and state agencies regarding actions that would adversely affect EFH. These EFH conservation recommendations are advisory, not mandatory, and may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH. Within 30 days of receiving NMFS' conservation recommendations, federal action agencies must provide a detailed response in writing. The response must include measures proposed for avoiding, mitigating, or offsetting the impact of a proposed activity on EFH. State agencies are not required to respond to EFH conservation recommendations. If a federal action agency chooses not to adopt NMFS' conservation recommendations, it must provide an explanation. Examples of federal action agencies that permit or undertake activities that may trigger EFH consultation include, but are not limited to, the U.S. Army Corps of Engineers (USACE), Environmental Protection Agency (EPA), Federal Energy Regulatory Commission, and Department of the Navy. Fishery Management Councils (FMCs) may also choose to comment on proposed actions that may adversely affect EFH.

G.1.2 Significance of Essential Fish Habitat

The waters and substrate that comprise EFH designations under the jurisdiction of the FMCs are diverse and widely distributed. They are also closely interconnected with other aquatic and terrestrial environments.

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[1] EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include aquatic areas and their associated physical, chemical, and biological properties. Substrate includes sediment underlying the waters. "Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. "Spawning, breeding, feeding, or growth to maturity" covers all habitat types utilized by a species throughout its life cycle.

[2] An adverse effect is any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species, and their habitat, as well as other ecosystem components. Adverse effects may be site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.910[a]).

The following discussion addresses non-fishing activities that may adversely affect EFH. They are grouped into four different systems in which the activities usually occur: upland, river or riverine, estuary or estuarine, and coastal or marine. Riverine systems provide important habitat that serves multiple purposes for anadromous species such as salmon. These purposes include migration, feeding, spawning, nursery, and rearing functions. Protecting these functions is key to providing for a productive system and a healthy fishery. The riparian corridor is an important component of a river system. The term "riparian" refers to the land directly adjacent to a stream, lake, or estuary. A healthy riparian area has vegetation harboring prey items (e.g., insects), contributes necessary nutrients, provides large woody debris (LWD) that creates channel structure and cover for fish, and provides shade, which controls stream temperatures (Bilby and Ward 1991). When vegetation is removed from riparian areas, waters are heated, and LWD is less common. This results in less refuge for fish, fundamental changes in channel structure (e.g., loss of pool habitats), instability of streambanks, and alteration of nutrient and prey sources within the river system (Murphy 1995, Koski 1993, Koski 1992).

Estuaries are the bays and inlets influenced by both the ocean and rivers, and they serve as the transition zone between freshwater and saltwater (Botkin et al. 1995). Estuaries support a community of plants and animals that are adapted to the zone where freshwater and saltwater mix (Zedler et al. 1992). Estuarine habitats fulfill fish and wildlife needs for reproduction, feeding, refuge, and other physiological necessities (Simenstad et al. 1991, Good 1987, Phillips 1984). Estuaries often include eelgrass beds that protect young fish from predators, provide habitat for fish and wildlife, improve water quality, and control sediments (Johnson et al. 2003, Thayer et al. 1984, Hoss and Thayer 1993, Phillips 1984). In addition, mud flats, high salt marsh, and saltmarsh creeks also provide productive shallow-water habitat for epibenthic fishes and decapods (Sogard and Able 1991).

Coastal or marine habitats comprise a variety of broad habitat types for EFH-managed species, including sand bottoms, rocky reefs, and submarine canyons. When rock reefs support kelp stands, they become exceptionally productive. Relative to other habitats, including wetlands, shallow and deep sand bottoms, and rock bottom, giant kelp habitats are substantially more productive in the fish communities they support (Bond et al. 1999). The stands provide nurseries, feeding grounds, and/or shelter to a variety of groundfish species and their prey (Feder et al. 1974, Ebeling et al. 1980).

G.1.3 Non-fishing Impacts

The diversity, widespread distribution, and ecological linkages with other aquatic and terrestrial environments make the waters and substrates that comprise EFH susceptible to a wide array of human activities unrelated to fishing.

Non-fishing activities have the potential to adversely affect the quantity or quality of EFH in riverine, estuarine, and marine systems. Broad categories of such activities include, but are not limited to, mining, dredging, fill, impoundment, discharge, water diversions, thermal additions, actions that contribute to nonpoint source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. For each activity, known and potential adverse impacts to EFH are described in this document. The descriptions explain the mechanisms or processes that may cause the adverse effects and how these may affect habitat function.

Non-fishing activities discussed in this document are subject to a variety of regulations and restrictions designed to limit environmental impacts under federal, state, and local laws. For example, a description of laws and regulations pertaining to oil and gas exploration, development production and transportation can be found in such documents as the Northeast National Petroleum Reserve - Alaska Final Integrated Activity Plan/Environmental Impact Statement (Department of the Interior 1998), Cook Inlet Areawide

1999 Oil and Gas Lease Sale, final Finding of the Director (Alaska Department of Natural Resources 1999), and the Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199 (Minerals Management Service [MMS] 2003). Many current requirements help to avoid or minimize adverse effects to aquatic habitats, including EFH. The conservation recommendations contained in this document are rather general and may overlap with certain existing standards for specific development activities. Nevertheless, the recommendations highlight practices that can help to avoid and minimize adverse effects to EFH. During EFH consultations between NMFS and other agencies, NMFS strives to provide reasonable and scientifically based recommendations that account for restrictions imposed under various state and federal laws by agencies with appropriate regulatory jurisdiction. Listing all applicable environmental laws and management practices herein is beyond the scope of the document. Moreover, the coordination and consultation required by Section 305(b) of the Magnuson-Stevens Act do not supersede the regulations, rights, interests, or jurisdictions of other federal or state agencies. NMFS will not recommend that state or federal agencies take actions beyond their statutory authority, and NMFS' EFH conservation recommendations are not binding.

The conservation measures discussed in this document should be viewed as options to avoid, minimize, or compensate for adverse impacts and promote the conservation and enhancement of EFH. Ideally, non-water-dependent actions should not be located in EFH if such actions may have adverse impacts on EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. If there are no alternatives, the impacts of these actions should be minimized. Environmentally sound engineering and management practices should be employed for all actions that may adversely affect EFH. If avoidance or minimization is not practicable, or will not adequately protect EFH, compensatory mitigation (as defined for Section 404 of the Clean Water Act – the restoration, creation, enhancement, or in exceptional circumstances, preservation of wetlands and/or other aquatic resources for the purpose of compensating for unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved) should be considered to conserve and enhance EFH.

G.1.4 Purpose of the Document

Section 303(a)(7) of the Magnuson-Stevens Act requires FMPs to identify activities other than fishing that may adversely affect EFH and define actions to encourage the conservation and enhancement of EFH, including recommended options to avoid, minimize, or compensate for the adverse effects identified. During consultation, agencies strive to consider all potential non-fishing impacts to EFH so that the appropriate mix of recommendations can be made. Because impacts that may adversely affect EFH can be direct, indirect, and cumulative, the biologist must consider and analyze these interrelated impacts. Consequently, it is not unusual for particular impacts to be overlooked or discounted during a consultation. In addition to fulfilling the requirements for revising the FMPs, this document will be useful to NMFS biologists reviewing proposed projects as they consider potential impacts that may adversely affect EFH. The document should also be useful for federal action agencies undertaking EFH consultations, especially in preparing EFH assessments.

The conservation recommendations included with each activity present a series of site-specific measures the action agency can undertake to avoid, offset, or mitigate impacts to EFH. Not all of these suggested measures are necessarily applicable to any one project or activity that may adversely affect EFH. More specific or different measures based on the best and most current scientific information may be developed before or during EFH consultations and communicated to the appropriate agency. The conservation recommendations provided herein represent a short menu of actions that can contribute to the conservation, enhancement, and proper functioning of EFH.

G.1.5 Overall Approach and Comparison to Previous Analyses

The 1999 EFH Environmental Assessment (EA) limited the scope of the discussion of non-fishing threats to coastal activities with some references to possible offshore impacts from non-fishing activities. The EFH EA categorized the non-fishing impacts to EFH in Alaska by combining several types of activities that may or may not occur together and calling out specific activities that cause habitat alteration. For example, the EFH EA combined dredging, fill, and excavation, providing a unified narrative discussion and analysis of these activities as they relate to port construction and support activities. These activities often occur independently, and the possible impacts to EFH that may occur from one activity (e.g., dredging) differ from those that may associated with another (e.g., fill). In contrast, the EFH EA's discussion and analysis of possible adverse impacts from certain activities (e.g., mining) were limited to activities that occur in the marine environment without addressing the same activities in other areas with potential adverse effects on EFH (such as anadromous streams).

The format for discussion of non-fishing threats in the 1999 EFH EA summarized potential impacts from each activity and then provided an expanded discussion with general conservation recommendations for some of the activities. In addition, an attached worksheet provided a professional interpretative summary of the broad category of threats discussed in the Non-fishing Adverse Impacts section. Habitat conservation and enhancement recommendations were provided in tabular format, starting with a broad category of habitats (i.e., near shore habitat and waters [0 to 3 nautical miles (nm)], pelagic habitat and waters [3 to 12 nm], and offshore habitat and waters [more than12 nm]) with general recommendations as they relate to a particular area or habitat type and associated managed species.

Impacts to EFH can be direct, indirect, and cumulative. While it is necessary to distinguish between activities to identify possible adverse impacts, it is equally important to consider and analyze these activities as they interrelate within habitats. Appendix G to the EFH EIS, therefore, takes an ecosystem perspective and provides more detail and a different format than the non-fishing impacts section of the 1999 EFH EA.

This document is organized by activities that may potentially impact EFH occurring in four discrete ecosystems. The separation of these ecosystems is artificial, and many of the impacts and their related activities are not exclusive to one system. For instance, as recognized in the discussion of the 1999 EFH EA, activities such as sand and gravel mining occur in riverine, estuarine, and marine systems. Because activities are discussed in the section corresponding to the primary ecosystem where they occur, readers should use the Master Index at the end of the document to identify other systems where such activities may also take place. Also, certain activities (e.g., pile driving) have specific potential impacts to EFH and may be associated with other construction activities (e.g., dredging) that have their own potential impacts. Readers should use the Master Index to ensure that all activities for a given project are considered.

Similar to the Non-fishing Adverse Impacts section of the 1999 EFH EA, this document is not meant to provide an exhaustive review. This document is, however, a result of a collaborative effort among the NMFS Alaska Region, Northwest Region, and Southwest Region and the respective Fisheries Science Centers, which provided a broader range of expertise to reach consensus regarding potential impacts and the general conservation recommendations.

The format for presenting the information in this document provides an introductory description of each activity, identification of potential adverse impacts, and suggested general conservation measures that would help minimize and avoid adverse effects of non-fishing activities on EFH. Table 3.4-36 of the EIS identifies the categories from Appendix G and correlates them with possible changes in physical, chemical, and biological parameters, and Table 3.4-37 takes the same categories from Appendix G and broadly interprets whether the effects from the activities in Alaska have been positive, insignificant, negative, or unknown.

G.2 UPLAND ACTIVITIES

G.2.1 Nonpoint Source Pollution

The information in this section is adapted from EPA 1993.

Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, seepage, or hydrologic modification. Technically, the term nonpoint source means anything that does not meet the legal definition of point source in Section 502(14) of the Clean Water Act (CWA), which refers to discernable, confined, and discrete conveyance from which pollutants are or may be discharged. The major categories of nonpoint pollution are as follows:

- Agricultural runoff
- Urban runoff, including developed and developing areas (Section G.2.2)
- Silvicultural (forestry) runoff (Section G.2.1.1)
- Marinas and recreational boating
- Road construction
- Channel and streambank modifications, including channelization (Section G.4.7)
- Streambank and shoreline erosion

Nonpoint source pollution is usually lower in intensity than an acute point source event, but it may be more damaging to fish habitat in the long term. Nonpoint source pollution is often difficult to detect. It may affect sensitive life stages and processes, and the impacts may go unnoticed for a long time. When severe population impacts are finally noticed, they may not be tied to any one event; hence, it may be difficult to correct, clean up, or mediate.

G.2.1.1 Silviculture/Timber Harvest

Recent revisions of Alaska's federal and state timber harvest regulations and best management practices (BMPs) have resulted in increased protection of EFH on federal, state, and private timber lands (Tongass Land Management Plan, http://www.fs.fed.us/r10/tongass/management%20news/tlmp/tlmp.shtml; Chugach Land and Resources Management Plan, http://www.geographynetwork.com/chugach/; and the Alaska Forest Resources and Practices Act, AS 41.17 (Murphy and Koski 1991). The Tongass and Chugach forest management plans provide for multiple uses of national forest lands and are highly protective of EFH on lands designated for timber production and on less intensively managed lands. The FPRA and its regulations set riparian buffers and establish mandatory BMPs for timber harvesting, road construction, road maintenance, and reforestation to protect water quality on state and privately owned timber production lands. The FPRA is also the standard for compliance with federal Coastal Zone Management Act and Clean Water Act requirements in Alaska.

Current forest management practices, when fully implemented and effective, avoid or minimize adverse effects to EFH that can result from the harvest and cultivation of timber and other forestry products. However, timber harvest can have both short- and long-term impacts throughout many coastal watersheds and estuaries if management practices are not fully implemented or effective. Past timber harvest in Alaska was not conducted under the current protective standards, and some effects from past harvesting continue to affect EFH.

In general, timber harvest can have a variety of effects such as removing the dominant vegetation; converting mature and old-growth upland and riparian forests to tree stands or forests of early seral stage; reducing permeability of soils and increasing the area of impervious surfaces; increasing sedimentation from surface runoff and mass wasting processes; altering hydrologic regimes; and impairing fish passage through inadequate design, construction, and/or maintenance of stream crossings (Northcote and Hartman 2004). As noted above, effects on EFH can be avoided or minimized by adhering to modern forestry practices.

If appropriate environmental standards are not followed, forest conditions after harvest may result in altered or impaired instream habitat structure and watershed function. Timber harvest may result in inadequate or excessive surface and stream flows, increased streambank and streambed erosion, loss of complex instream habitats, sedimentation of riparian habitat, and increased surface runoff with associated contaminants (e.g., herbicides, fertilizers, and fine sediments). Hydrologic characteristics (e.g., water temperature), annual hydrograph change, and greater variation in stream discharge can be associated with timber harvest. Alterations in the supply of LWD and sediment can have negative effects on the formation and persistence of instream habitat features. Excess debris in the form of small pieces of wood and silt can cover benthic habitat and reduce dissolved oxygen levels.

G.2.1.1.1 Potential Adverse Impacts

There are many complex and important interactions, in both small and large watersheds, between fish and forests (Northcote and Hartman, 2004). Five major categories of activities can adversely affect EFH: 1) construction of logging roads, 2) creation of fish migration barriers, 3) removal of streamside vegetation, 4) hydrologic changes and sedimentation and 5) disturbance associated with log transfer facilities (LTFs) (Section G.4.9). Potential impacts to EFH have been greatly reduced by the adoption of BMPs designed to protect fish habitat.

Improperly engineered, constructed, or maintained logging roads can destabilize slopes and increase erosion and sedimentation (Section G.2.3). Two major types of erosion occur: mass wasting and surface erosion. Mass movement of soils, commonly referred to as landslides or debris slides, can occur with timber harvest and road building on high-hazard soils and unstable slopes. Both the frequency and size of debris slides can be increased when logging roads are built on, or timber is harvested from, these unstable land forms. Increased erosion can occur, and some sediment deposition can reach downslope waterways. Erosion from roadways is most severe when construction practices do not include properly located, sized, and installed culverts, proper ditching, and ditch blocker water bars (Furniss et al. 1991). Under current federal and state BMPs, hazardous slopes must be avoided or site specific hazard management plans must be developed.

Stream crossings (bridges and culverts) on forest roads can be inadequately designed, installed, and maintained, and they frequently result in full or partial barriers to both upstream and downsteam fish migration. For example, between 13 and 17 percent of the culverts installed since 1997 on the Tongass National Forest do not meet fish passage standards, although most failures are for the upstream migration of juveniles during high-flow events (Tongass Best Management Practices Implementation Monitoring Report, 2003). Perched and undersized culverts can accelerate stream flows so that these structures become velocity barriers for migrating fish. However, perched culverts are prohibited under current BMPs and all culverts are now subject to sizing requirements designed to allow passage of fish and significant flood events.

Blocked culverts result from undersized designs or inadequate maintenance to remove debris. Blocked culverts can result in displacement of the stream from the downstream channel to the roadway or roadside ditch, resulting in dewatering of the downstream channel and increased erosion of the roadway. Under modern BMPs, however, culverts must be properly sized and maintained.

Culverts and bridges deteriorate structurally over time. Failure to replace or remove them at the end of their useful life may cause partial or total fish passage blockage. Current BMPs require removal of culverts upon road closure unless other measures are warranted. Caution should be used when removing culverts. Channel incision can often occur downstream of a culvert and generally moves upstream. An existing culvert can act as a grade control, halting the upstream progression of a headcut and causing further channel regrade (Castro 2003). The unchecked upstream progression of a headcut can cause further damage to EFH. Additional information on culverts is available in the August 2001 Alaska Department of Fish and Game and Alaska Department of Transportation and Public Facilities Memorandum of Agreement for the Design, Permitting, and Construction of Culverts for Fish Passage, http://www.sf.adg.state.ak.us/SARR/fishpassage/pdfs/dot_adfg_fishpass080301.pdf.

Removing streamside vegetation increases the amount of solar radiation reaching the stream and can result in warmer water temperatures, especially in small, shallow streams of low velocity. In southeast Alaska, Meehan et al. (1969) found that maximum temperature in logged streams without riparian buffers exceeded that of unlogged streams by up to 2.3°C, but did not reach lethal temperatures. In cold climates, the removal of riparian vegetation can result in lower water temperatures during winter, increasing the formation of ice and damaging and delaying the development of incubating fish eggs and alevins. Current BMPs require retention of riparian buffers for shade, which should limit changes in water temperature and dissolved oxygen (Shult and McGreer 2001).

By removing vegetation, timber harvest reduces transpiration losses from the landscape and decreases the absorptive capability of the groundcover. These changes can result in increased surface runoff during periods of high precipitation and decreased base flows during dry periods (Heifetz et al. 1996, Myren and Ellis 1984). Reduced soil strength can result in destabilized slopes and increased sediment and debris input to streams (Swanston 1974). Sediment deposition in streams can reduce benthic community production (Culp and Davies 1983), cause mortality of incubating salmon eggs and alevins (Koski 1981), and reduce the amount of habitat available for juvenile salmon (Heifetz et al. 1996). Cumulative sedimentation from logging activities can significantly reduce the egg-to-fry survival of coho and chum salmon (Cederholm and Reid 1987). Reductions in the supply of LWD also result when old-growth forests are removed, with resulting loss of habitat complexity that is critically important for successful salmonid spawning and rearing (Bisson et al. 1988, Murphy and Koski 1989). Current riparian buffer standards and BMPs are being implemented in most instances (Tongass National Forest Draft Annual Monitoring Report 2003) and long-term effectiveness studies are being conducted to determine if timber harvest has any effect on habitat condition (Martin and Grotefelt, 2001; Martin and Shelly 2004).

G.2.1.1.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. For timber operations near streams with EFH, adhere to modern forest management practices and BMPs, including the maintenance of vegetated buffers to reduce sedimentation and supply LWD. For the Alaska region, see the following links: Fish: Forest-Wide Standards and Guides:
   - http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF
   - http://www.or.blm.gov/ForestPlan/newsandga.pdf
   - http://www.dnr.state.ak.us/forestry/pdfs/forpracregs.pdf.

2. Avoid timber operations to the extent practicable in wetlands contiguous with anadromous fish streams. See the following links: Wetlands: Forest-Wide Standards and Guides:
    - http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF
    - http://www.dnr.state.ak.us/forestry/pdfs/forpracregs.pdf.
3. For timber operations near estuaries or beaches, maintain vegetated buffers as needed to protect EFH. See the following links: Beach and Estuary Fringe: Forest-Wide Standards and Guides:
    - http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF
    - http://www.fs.fed.us/r10/chugach/forest_plan/forest_plan_web.pdf.
4. Maintain riparian buffers along all streams to the extent practicable. In Alaska, buffer width is site-specific and dependent on use by anadromous and resident fish and stream process type. Stream process groups are described in the following link:
    - http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_D.PDF

    Standards and guidelines for riparian buffers for Alaska are described in the following links. Riparian Forest-Wide Standards and Guides:
    - http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF
    - http://www.fs.fed.us/r10/chugach/forest_plan/forest_plan_web.pdf FPRA

    Riparian buffer regulations can be found at:
    - http://www.dnr.state.ak.us/forestry/pdfs/fprachrt.pdf.
5. Incorporate watershed analysis into timber and silviculture projects whenever possible or practicable. Particular attention should be given to the cumulative effects of past, present, and future timber sales within the watershed. See the following link on watershed analysis:
    - http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_J.PDF.
6. For forest roads, see Section G.2.3, Road Building and Maintenance. Also see the following links: Transportation: forest-wide standards and guides:
    - http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

    Soils and water: forest-wide standards and guides:
    - http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF
    - http://www.fs.fed.us/r10/chugach/forest_plan/forest_plan_web.pdf
    - http://www.dnr.state.ak.us/forestry/pdfs/forpracregs.pdf.

G.2.1.2 Pesticide Application (includes insecticides, herbicides, fungicides)

Pesticides are substances intended to prevent, destroy, control, repel, or mitigate any pest. They include the following: insecticides, herbicides, fungicides, rodenticides, repellents, bactericides, sanitizers, disinfectants, and growth regulators. More than 800 different pesticides are currently registered for use in the U.S. Legal mandates covering pesticides are the CWA and the Federal Insecticide, Fungicide, and Rodenticide Act. Water quality criteria for the protection of aquatic life have only been developed for a few of the currently used chemicals (EPA, Office of Pesticide Programs). In Alaska, the pesticide control program is administered by the Alaska Department of Environmental Conservation's (ADEC's) Division of Environmental Health (http://www.state.ak.us/dec/eh/pest/index.htm). Collectively, these substances are designed to repel, kill, or regulate the growth of undesirable biological organisms. This diverse group includes fungicides, herbicides, insecticides, nematicides, molluscicides, rodenticides, fumigants, disinfectants, repellents, wood preservatives, and antifoulants. The most common pesticides are insecticides, herbicides, and fungicides. These are used for pest control on forested lands, agricultural crops, tree farms and nurseries, highways and utility rights of way, parks and golf courses, and residences. Pesticides can enter the aquatic environment as single chemicals or as complex mixtures. Direct applications, surface runoff, spray drift, agricultural return flows, and groundwater intrusions are all examples of transport processes that deliver pesticides to aquatic ecosystems.

Pesticides are frequently detected in freshwater and estuarine systems that provide EFH. Nationwide, the most comprehensive environmental monitoring efforts have been conducted by the U.S. Geological

Survey (USGS) as part of the National Water Quality Assessment Program. A variety of human activities, such as fire suppression on forested lands, forest site preparation, noxious weed control, right-of-way maintenance (roads, railroads, power lines, etc.), algae control in lakes and irrigation canals, various agricultural practices, riparian habitat restoration, and urban and residential pest control result in contamination from these substances. The term “pesticide” is a collective description of hundreds of chemicals with different sources, different fates in the aquatic environment, and different toxic effects on fish and other aquatic organisms. Despite these variations, all current use pesticides are (1) specifically designed to kill, repel, or regulate the growth of biological organisms, and (2) intentionally released into the environment. Habitat alteration from pesticides is different from more conventional water quality parameters, such as temperature, suspended solids, or dissolved oxygen, because, unlike temperature or dissolved oxygen, the presence of pesticides can be difficult to detect due to limitations in proven methodologies. This monitoring may also be expensive. As analytical methodologies have improved in recent years, however, the number of pesticides documented in fish and their habitats has increased.

G.2.1.2.1 Potential Adverse Impacts

There are three basic ways that pesticides can adversely affect EFH. These are (1) a direct toxicological impact on the health or performance of exposed fish, (2) an indirect impairment of the productivity of aquatic ecosystems, and (3) a loss of aquatic vegetation that provides physical shelter for fish.

Fish kills are rare when pesticides are used according to their labels. For fish, most effects from pesticide exposures are sublethal. Sublethal effects are a concern if they impair the physiological or behavioral performance of individual animals in ways that will decrease their growth or survival, alter migratory behavior, or reduce reproductive success. In addition to early development and growth, key physiological systems affected include the endocrine, immune, nervous, and reproductive systems. Many pesticides have been shown to impair one or more of these physiological processes in fish (Moore and Waring 2001). In general, however, the sublethal impacts of pesticides on fish health are poorly understood. Accordingly, this is a focus of recent and ongoing National Oceanic and Atmospheric Administration (NOAA) research (Scholz et al. 2000, Van Dolah et al. 1997).

The effects of pesticides on ecosystem structure and function can be key factors in determining the cascading impacts of those chemicals on fish and other aquatic organisms at higher trophic levels (Preston 2002). This includes impacts on primary producers (Hoagland et al. 1996) and aquatic microorganisms (DeLorenzo et al. 2001), as well as on macroinvertebrates that are prey species for fish. For example, many pesticides are specifically designed to kill insects. Not surprisingly, these chemicals are relatively toxic to insects and crustaceans that inhabit river systems and estuaries. Overall, pesticides will have an adverse impact on fish habitat if they reduce the productivity of aquatic ecosystems. Finally, some herbicides are toxic to aquatic plants that provide shelter for various fish species. A loss of aquatic vegetation could damage nursery habitat or other sensitive habitats, such as eelgrass beds and emergent marshes.

G.2.1.2.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Incorporate integrated pest management and BMPs as part of the authorization or permitting process to ensure the reduction of pesticide contamination in EFH (Scott et al. 1999).
2. Carefully review labels and ensure that application is consistent. Follow local, supplemental instructions such as state-use bulletins where they are available.

3. Avoid the use of pesticides in and near EFH. ADEC has established a pesticide-free area of 35 feet (10.67 meters) from any surface or marine water body and a protective area in which pesticides will not be applied that would extend beyond the pesticide-free area to ensure that no pesticides enter the pesticide-free area. Protective areas will be different for each project. ADEC considers region, terrain, weather, droplet size, pesticide labeling directions, and other conditions to decide how far the protective area must extend to ensure that no pesticides end up in the pesticide-free area.
4. Refrain from aerial spraying of pesticides on windy days.

G.2.2 Urban/Suburban Development

The information in this section is adapted from NMFS 1998, a, b.

Urban development is most likely the greatest non-fishing threat to EFH. Urban growth and development in the U.S. continue to expand in coastal areas at a rate approximately four times greater than in other areas. Urban and suburban development and the corresponding infrastructure result in four broad categories of impacts to aquatic ecosystems: hydrological, physical, water quality, and biological indicators (Center for Watershed Protection [CWP] 2003). Runoff from impervious surfaces is the most widespread source of pollution into the nation's waterways (EPA 1995). When a watershed's impervious cover exceeds 10 percent, impacts to stream quality can be expected (CWP 2003).

G.2.2.1 Potential Adverse Impacts

Development activities within watersheds and in coastal marine areas often impact the EFH of managed species on both long- and short-term scales. The CWP made a comprehensive review of the impacts associated with impervious cover and urban development and found a negative relationship between watershed development and about 26 stream quality indicators (CWP 2003). Many of the impacts listed here are discussed in greater detail in other sections of this document. The primary impacts include (1) the loss of riparian and shoreline habitat and vegetation and (2) runoff. Upland and shoreline vegetation removal can increase stream water temperatures, reduce supplies of LWD, and reduce sources of prey and nutrients to the water system. An increase in impervious surfaces, such as the addition of new roads (see Section G.2.3), roofs, bridges, and parking facilities, results in a decreased infiltration to groundwater and increased runoff volumes. This also has the potential to adversely affect water quality and water quantity/timing in downstream water bodies (i.e., estuaries and coastal waters).

Salmonids and other anadromous fish appear to be particularly impacted by the amount of impervious cover in a watershed (CWP 2003). In a study in the Pacific Northwest, sensitive coho salmon were seldom found in watersheds above 10 or 15 percent impervious cover (Luchetti and Feurstenburg 1993). Key stressors in urban streams, such as higher peak flows and reduction in habitat complexity (e.g., fewer pools, LWD, and hiding places), as well as changes in water quality, are believed to change salmon species composition, favoring cutthroat trout populations over the natural coho populations (Horner et al. 1999 and May et al. 1997). In the mid-Atlantic region, native trout are temperature-sensitive and are seldom present in watersheds where impervious cover exceeds 15 percent (Schueler 1994).

The loss of riparian and shoreline habitat and vegetation can increase water temperatures and remove sources of cover. Such impacts can alter the structure of benthic and fish communities, resulting in a reduction in diversity and abundance of EFH species. Shoreline stabilization projects (Section G.4.7) that alter reflective wave energy can impede or accelerate natural movements of shoreline substrates, thereby affecting intertidal and sub-tidal habitats. Channelization of rivers causes loss of floodplain connectivity and simplification of habitat. The resulting sediment runoff can also restrict tidal flows and elevations, resulting in losses of important fauna and flora (e.g., submerged aquatic vegetation).

Due to the intermittent nature of rainfall and runoff, the large variety of pollutant source types, and the variable nature of source loadings, urban runoff is difficult to control (Safavi 1996). The National Water Quality Inventory (EPA 2002) reports that runoff from urban areas is the leading source of impairment to surveyed estuaries and the third largest source of impairment to surveyed lakes. Such runoff includes construction sediments, oil from autos, bacteria from failing septic systems, road salts, and heavy metals. Urban areas have an insidious pollution potential that one-time events such as oil spills do not. Pollutant increases result in gradual declines in habitat quality.

Storm drains are often built to move water quickly away from roads, resulting in increased water input to streams. The greater volume and velocity erode streambanks, increasing sediment loads and often changing temperatures. In a simulation model comparing an urban watershed with a forested watershed, Corbett et al. (1997) demonstrated that urban runoff volume and sediment yield were 5.5 times greater than forest runoff.

Among contaminants that can enter watersheds, polycyclic aromatic hydrocarbons (PAHs) are among the most toxic to aquatic life and can persist for decades (Short et al. 2003). Waterborne PAH levels are often significantly higher in urbanized than non-urbanized watersheds (Fulton et al. 1993). Petroleum-based contaminants contain PAHs, which when released into the environment through spill, combustion and atmospheric deposition can cause acute toxicity to managed species and their prey, as some PAHs are known carcinogens and mutagens (Neff 1985).

Failing septic systems are an outgrowth of urban development. EPA estimates that 10 to 25 percent of all individual septic systems are failing at any one time, introducing excrement, detergents, chlorine and other chemicals into the environment. Even treated wastewater from urban areas can alter the physiology of intertidal organisms (Moles, A. and N. Hale 2003). Sewage discharge is a major source of coastal pollution, contributing 41, 16, 41, and 6 percent of the total pollutant load for nutrients, bacteria, oils, and toxic metals, respectively (Kennish 1998). Nutrients such as phosphorus concentrations, in particular, are indicative of urban stormwater runoff (Holler 1990). Sewage wastes may also contain significant amounts of organic matter that exert a biochemical oxygen demand (Kennish 1998). Organic contamination contained within urban runoff can also cause immuno suppression (Arkoosh et al. 2001, NMFS Draft 1998).

G.2.2.2 Recommended Conservation Measures

The recommended conservation measures for urban/suburban development are provided below. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH. For additional measures, see Section G.2.3.2, Recommended Conservation Measures.

1. Implement BMPs (EPA 1993) for sediment control during construction and maintenance operations. These can include avoiding ground-disturbing activities during the wet season; minimizing exposure time of disturbed lands; using erosion prevention and sediment control methods; minimizing the spatial extent of vegetation disturbance; maintaining buffers of vegetation around wetlands, streams, and drainage ways; and avoiding building activities in areas with steep slopes and areas prone to mass wasting events with highly erodible soils. Use methods such as sediment ponds, sediment traps, bioswales, or other facilities designed to slow water runoff and trap sediment and nutrients.
2. Avoid using hard engineering structures for shoreline stabilization and channelization when possible. Use bioengineering approaches (i.e., applying vegetation approaches with principles of geomorphology, ecology, and hydrology) to protect shorelines and riverbanks. Naturally stable shorelines and river banks should not be altered (Section G.4.7).

3. Encourage comprehensive planning for watershed protection to avoid filling and building in floodplain areas affecting EFH. Development sites should be planned to minimize clearing and grading, cut-and-fill, and new impervious surfaces.
4. Where feasible, remove impervious surfaces such as abandoned parking lots and buildings from riparian and shoreline areas, and reestablish wetlands and native vegetation.
5. Protect and restore vegetated buffer zones of appropriate width along all streams, lakes, and wetlands that include or influence EFH.
6. Manage stormwater to duplicate the natural hydrologic cycle, maintaining natural infiltration and runoff rates to the maximum extent practicable.
7. Where in-stream flows are insufficient to maintain water quality and quantity needed for EFH, establish conservation guidelines for water use permits and encourage the purchase or lease of water rights and the use of water to conserve or augment instream flows in accordance with state and federal water laws.
8. Encourage municipalities to use the best available technologies in upgrading their wastewater systems to avoid combined sewer overflow problems and chlorinated sewage discharges into rivers, estuaries, and the ocean.
9. Design and install proper on-site disposal systems. Locate them away from open waters, wetlands, and floodplains.

G.2.3 Road Building and Maintenance

The building and maintenance of roads can affect aquatic habitats by increasing rates of natural processes such as debris slides or landslides and sedimentation, introducing exotic species, degrading water quality, and introducing chemical contamination (e.g., petroleum-based contaminants; Section G.2.2). Paved and dirt roads introduce an impervious or semipervious surface into the landscape. This surface intercepts rain and creates runoff, carrying soil, sand and other sediments, and oil-based materials quickly downslope. If roads are built near streams, wetlands, or other sensitive areas, they may experience increased sedimentation that occurs from maintenance and use, as well as during storm and snowmelt events. Even carefully designed and constructed roads can become sources of sediment and pollutants if they are not properly maintained.

G.2.3.1 Potential Adverse Impacts

The effects of roads on aquatic habitat can be profound. They include (1) increased deposition of fine sediments, (2) changes in water temperature, (3) elimination or introduction of migration barriers such as culverts, (4) changes in streamflow, (5) introduction of non-native plant species, and (6) changes in channel configuration (see Section G.2.1.1 and the standards referenced).

Poorly surfaced roads can substantially increase surface erosion. The rate of erosion is primarily a function of storm intensity, surfacing material, road slope, and traffic levels. This surface erosion results in an increase in fine sediment deposition (Cederholm and Reid 1987, Bilby et al. 1989, MacDonald et al. 2001, Ziegler et al. 2001). Increased fine-sediment deposition in stream gravels has been linked to decreased fry emergence and juvenile densities, loss of winter carrying capacity, and increased predation of fishes. Increased fines can reduce benthic production or alter the composition of the benthic community. For example, embryo-to-emergent fry survival of incubating salmonids is negatively affected by increases in fine sediments in spawning gravels (Chapman 1988, Everest et al. 1987, Koski 1981, Scrivener and Brownlee 1989, Weaver and Fraley 1993, Young et al. 1991).

Roads built adjacent to streams can result in changes in water temperature and increased sunlight reaching the stream if riparian vegetation is removed and/or altered in composition. Beschta et al. (1987) and Hicks et al. (1991) document some of the negative effects of road construction on fish habitat, including elevation of stream temperatures beyond the range of preferred rearing where vegetation has been removed, inhibition of upstream migrations, increased disease susceptibility, reduced metabolic efficiency, and shifts in species assemblages.

Roads can also degrade aquatic habitat through improperly placed culverts at road-stream crossings that reduce or eliminate fish passage (Belford and Gould 1989, Clancy and Reichmuth 1990, Evans and Johnston 1980, Furniss et al. 1991). In a large river basin in Washington, 13 percent of the historical coho habitat was lost due to improper culvert design and placement (Beechie et al. 1994). Road crossings also affect benthic communities of stream invertebrates. Roads have a negative effect on the biotic integrity of both terrestrial and aquatic ecosystems (Trombulak and Frissell 2000). Studies indicate that populations of non-insect invertebrates tend to increase the farther away they are from a road (Luce and Crowe 2001).

Roads may be the first point of entry into a virgin landscape for non-native grass species that are seeded along road cuts or introduced from seeds transported by tires and shoes. Roads can serve as corridors for such species, allowing plants to move further into the landscape (Greenberg et al. 1997, Lonsdale and Lane 1994). Some non-native plants may be able to move away from the roadside and into aquatic sites of suitable habitat, where they may out-compete native species and have significant biological and ecological effects on the structure and function of the ecosystem.

Roads have three primary effects on hydrologic processes. First, they intercept rainfall directly on the road surface, in road cutbanks, and as subsurface water moving down the hillslope. Second, they concentrate flow, either on the road surfaces or in adjacent ditches or channels. Last, they divert or reroute water from flowpaths that would otherwise be taken if the road were not present (Furniss et al. 1991).

Road drainage and transport of water and debris, especially during heavy rains and snow melt periods, are primary reasons why roads fail, often with major structural, ecological, economic, or other social consequences. The effects of roads on peak streamflow depend on the size of the watershed and the density of roads. Two of the effects are (1) changes in flood flows (Wemple et al. 1996), mainly in smaller basins and for smaller floods (Beschta et al. 2000), and (2) increases in channel erosion and mass wasting (Montgomery 1994, Madej 2001, Wemple et al. 2001). For example, capture and rerouting of water can dewater one small stream and cause major channel adjustments in the stream receiving the additional water. In large watersheds with low road density, properly located and maintained roads may constitute a small proportion of the land surface and have relatively insignificant effects on peak flow.

Roads can lead to increased rates of natural processes such as debris or landslides and sedimentation when slopes are destabilized and surface erosion and soil mass movement increases. Erosion is most severe when poor construction practices are allowed, combined with inadequate attention to proper road drainage and maintenance practices. Mass movement risks increase when roads are constructed on high-hazard soils and overly steep slopes. In steep areas prone to landslides, rates of mass soil movements affected by roads include shallow debris slides, deep-seated slumps and earthflows, and debris flows. Accelerated erosion rates from roads because of debris slides range from 30 to 300 times the natural rate in forested areas, but vary with terrain in the Pacific Northwest (Sidle et al. 1985). The magnitude of road-related mass erosion varies by climate, geology, road age, construction practices, and storm history. Road-related mass failures can result from various causes, including improper placement and construction of road fills and stream crossings; inadequate culvert sizes to pass water, sediment, and wood during floods; poor road siting; modification of surface or subsurface drainage by the road surface or prism; and diversion of water into unstable parts of the landscape (Burroughs et al. 1976, Clayton 1983, Hammond et al. 1988, Furniss et al. 1991, Larsen and Parks 1997).

G.2.3.2 Recommended Conservation Measures

The following conservation measures for road building and maintenance should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid locating roads near fish-bearing streams. Roads should be sited to avoid sensitive areas such as streams, wetlands, and steep slopes.
2. Incorporate appropriate erosion control and stabilization measures into road construction plans to reduce erosion potential.
3. Build bridges when possible. If culverts are to be used, they should be sized, constructed, and maintained to match the gradient and width of the stream, so as to accommodate design flood flows, and they should be large enough to provide for migratory passage of adult and juvenile fishes. If appropriate, consider using the culvert guidelines contained in the Alaska Department of Fish and Game and the Alaska Department of Transportation and Public Facilities Fish Pass Memorandum of Agreement, August, 2001 (http://www.sf.adg.state.ak.us/SARR/fishpassage/pdfs/dot_adfg_fishpass080301.pdf).
4. Locate stream crossings in stable stream reaches.
5. Design bridge abutments to minimize disturbances to streambanks and place abutments outside of the floodplain whenever possible.
6. To the extent practicable, avoid road construction across alluvial floodplains, mass wastage areas, or braided stream bottom lands unless site-specific protection can be implemented to ensure protection of soils, water, and associated resources.
7. Avoid side-casting of road construction and maintenance materials on native surfaces and into streams.
8. To the extent practicable, use native vegetation in stabilization plantings.
9. Ensure that maintenance operations avoid adverse affects to EFH.

G.3 RIVERINE ACTIVITIES

G.3.1 Mining

Mining and mineral extraction activities take many forms, such as commercial dredging and recreational suction dredging, placer, area surface removal, and contour operations (Section G.5.6). Activities include gravel mining (NMFS 2004), exploration, site preparation, mining, milling, waste management, decommissioning or reclamation, and mine abandonment (American Fisheries Society [AFS] 2000). Mining and its associated activities have the potential to cause environmental impacts from exploration through post-closure. These impacts may include adverse effects to EFH. The operation of metal, coal, rock quarries, and gravel pit mining has caused varying degrees of environmental damage in urban, suburban, and rural areas. Some of the most severe damage, however, occurs in remote areas, where some of the most productive fish habitat is often located (Sengupta 1993). In Alaska, existing regulations, promulgated and enforced by other federal and state agencies, have been designed to control and manage these changes to the landscape to avoid and minimize impacts. These regulations are regularly updated as new technologies are developed to improve mineral extraction, reclaim mined lands, and limit environmental impacts. However, while environmental regulations may avoid, limit, control, or offset many of these potential impacts, mining will, to some degree, always alter landscapes and environmental resources (National Research Council [NRC] 1999).

G.3.1.1 Mineral Mining

G.3.1.1.1 Potential Adverse Impacts

Potential impacts from mining include (1) adverse modification of hydrologic conditions so as to cause erosion of desirable habitats, (2) removal of substrates that serve as habitat for fish and invertebrates, (3) conversion of habitats,(4) release of harmful or toxic materials, and (5) creation of harmful turbidity levels.

The effects of mineral mining on EFH depend on the type, extent, and location of the activities. Minerals are extracted using several methods. Surface mining involves suction dredging, hydraulic mining, panning, sluicing, strip mining, and open-pit mining (including heap leach mining). Underground mining uses tunnels or shafts to extract minerals by physical or chemical means. Surface mining probably has a greater potential to affect aquatic ecosystems, though specific effects will depend on the extraction and processing methods and the degree of disturbance (Spence et al. 1996). Surface mining has the potential to eliminate vegetation, permanently alter topography, permanently and drastically alter soil and subsurface geological structure, and disrupt surface and subsurface hydrologic regimes (AFS 2000). While mining may not be as geographically pervasive as other sediment-producing activities, surface mining typically increases sediment delivery much more per unit of disturbed area than other activities because of the level of disruption of soils, topography, and vegetation. (Nelson et al. 1991).

Mining and placement of spoils in riparian areas can cause the loss of riparian vegetation and changes in heat exchange, leading to higher summer temperatures and lower winter stream temperatures (Spence et al. 1996). Bank instability can also lead to altered width-to-depth ratios, which further influence temperature (Spence et al. 1996). Mining efforts can also bury productive habitats near mine sites.

Mining operations can release harmful or toxic materials and their byproducts, either in association with actual mining, or in connection with machinery and materials used for mining. Mining can also introduce levels of heavy metals and arsenic that are naturally found within the streambed sediments. Tailings and discharge waters from settling ponds can result in loss of EFH and life stages of managed species. The impact degrades water quality, and levels can become high enough to prove lethal (North Pacific Fishery Management Council [Council] 1999).

Commercial operations may also involve road building (Section G.2.3), tailings disposal (Section G.4.2), and leaching of extraction chemicals, all of which may create serious impacts to EFH. Cyanide, sulfuric acid, arsenic, mercury, heavy metals, and reagents associated with such development are a threat to EFH. Improper or in-water disposal of tailings may be toxic to managed species or their prey downstream. Upland disposal of tailings in unstable or landslide prone areas can cause large quantities of toxic compounds to be released into streams or to contaminate groundwater (Council 1999). Indirectly, the sodium cyanide solution used in heap leach mining is contained in settling ponds from which groundwater and surface waters may become contaminated (Nelson et al. 1991).

Water pollution by heavy metals and acid is often associated with mineral mining operations, as ores rich in sulfides are commonly mined for gold, silver, copper, iron, zinc, and lead. When stormwater comes in contact with sulfide ores, sulfuric acid is commonly produced (West et al. 1995). Abandoned pit mines can also cause severe water pollution problems.

Recreational gold mining with such equipment as pans, motorized or nonmotorized sluice boxes, concentrators, rockerboxes, and dredges can adversely affect EFH on a local level. Commercial mining is likely to involve activities at a larger scale with much disturbance and movement of the channel involved (Oregon Water Resources Research Institute [OWRRI] 1995).

G.3.1.1.2 Recommended Conservation Measures

The following measures are adapted from recommendations in Spence et al. (1996), NMFS (2004), and Washington Department of Fish and Wildlife (1998). They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid mineral mining in waters, riparian areas, and floodplains containing EFH.
2. Schedule necessary in-water activities when the fewest species/least vulnerable life stages of federally managed species will be present.
3. Use an integrated environmental assessment, management, and monitoring package in accordance with state and federal law and regulations. Allow for adaptive operations to minimize adverse effects on EFH.
4. Minimize spillage of dirt, fuel, oil, toxic materials, and other contaminants into EFH. Prepare a spill prevention plan if appropriate.
5. Treat wastewater (acid neutralization, sulfide precipitation, reverse osmosis, electrochemical, or biological treatments) and recycle on site to minimize discharge to streams. Test wastewater before discharge for compliance with federal and state clean water standards.
6. Minimize opportunities for sediments to enter or affect EFH. Use methods such as contouring, mulching, and construction of settling ponds to control sediment transport. Monitor turbidity during operations, and cease operations if turbidity exceeds predetermined threshold levels. Use methods such as turbidity/sediment curtains to limit the spread of suspended sediments and minimize the area affected.
7. If possible, reclaim, rather than bury, mine waste that contains heavy metals, acid materials, or other toxic compounds if leachate can enter EFH through groundwater.
8. Restore natural contours and plant native vegetation on site after use to restore habitat function to the extent practicable. Monitor the site for an appropriate time to evaluate performance and implement corrective measures if necessary.
9. Minimize the aerial extent of ground disturbance (e.g., through phasing of operations), and stabilize disturbed lands to reduce erosion.

G.3.1.2 Sand and Gravel Mining

G.3.1.2.1 Potential Adverse Impacts

Sand and gravel mining is extensive and occurs by several methods. These include wet-pit mining (i.e., removal of material from below the water table), dry-pit mining on beaches, exposed bars, and ephemeral streambeds, and subtidal mining. Sand and gravel mining in riverine, estuarine, and coastal environments can create EFH impacts, including (1) turbidity plumes and resuspension effects, (2) removal of spawning habitat, and (3) alteration of channel morphology.

Mechanical disturbance of EFH spawning habitat by mining equipment can also lead to high mortality rates in early life stages. One result is the creation of turbidity plumes (Section G.4.1), which can move spawning habitat several kilometers downstream. Sand and gravel mining in riverine, estuarine, and coastal environments can also suspend materials at the sites (Section G.5).

Sedimentation may be a delayed effect because gravel removal typically occurs at low flow when the stream has the least capacity to transport fine sediments out of the system. Another delayed sedimentation effect results when freshets inundate extraction areas that are less stable than they were before the activity occurred. In addition, for species such as salmon, gravel operations can also interfere with migration past the site if they create physical or thermal changes, either at or downstream from the work site (OWRRI 1995).

Additionally, extraction of sand and gravel in riverine ecosystems can directly eliminate the amount of gravel available for spawning if the extraction rate exceeds the deposition rate of new gravel in the system. Gravel excavation also reduces the local supply of gravel to downstream habitats. The extent of suitable spawning habitat may be reduced where degradation reduces gravel depth or exposes bedrock (Spence et al. 1996).

Mining can also alter channel morphology by making the stream channel wider and shallower. Consequently, the suitability of stream reaches as rearing EFH may be decreased, especially during summer low-flow periods when deeper waters are important for survival. Similarly, a reduction in pool frequency may adversely affect migrating adults that require holding pools (Spence et al. 1996). Changes in the frequency and extent of bedload movement and increased erosion and turbidity can also remove spawning substrates, scour redds (resulting in a direct loss of eggs and young), or reduce their quality by deposition of increased amounts of fine sediments. Other effects that may result from sand and gravel mining include increased temperatures (from reduction in summer base flows and decreases in riparian vegetation), decreased nutrients (from loss of floodplain connection and riparian vegetation), and decreased food production (loss of invertebrates) (Spence et al. 1996).

Examples of using gravel removal to improve habitat and water quality are limited and isolated (OWRRI 1995). Deep pools created by material removal in streams appear to attract migrating adult salmon for holding. These concentrations of fish may result in high losses as a result of increased predation or recreational fishing pressure.

G.3.1.2.2 Recommended Conservation Measures

Individual gravel extraction operations should be judged in the context of their spatial, temporal, and cumulative impacts. Potential impacts to habitat should be viewed from a watershed management perspective. The following recommended conservation measures for sand and gravel mining are adapted from NMFS (2004) and OWRRI (1995). They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid sand/gravel mining in waters containing EFH. Many factors influence site selection for a gravel or sand mining site. Because of the need to incorporate technical, economic, and environmental factors, siting decisions should be considered on a case-by-case basis (U.S. Fish and Wildlife Service 1980).
2. Identify upland or off-channel (where the channel will not be captured) gravel extraction sites as alternatives to gravel mining in or adjacent to EFH, if possible.
3. Design, manage, and monitor sand and gravel mining operations to minimize potential direct and indirect impacts to EFH, if operations in EFH cannot be avoided. This includes, but is not limited to, migratory corridors, foraging and spawning areas, stream/river banks, intertidal areas, etc.
4. Minimize the areal extent and depth of extraction.
5. Include restoration, mitigation, and monitoring plans, as appropriate in sand/gravel extraction plans.

G.3.2 Organic and Inorganic Debris

Natural occurring flotsam, such as LWD and macrophyte wrack (i.e., kelp), plays an important role in aquatic ecosystems, including EFH. LWD and wrack promote habitat complexity and provide structure to various aquatic and shoreline habitats.

The natural deposition of LWD creates habitat complexity by altering local hydrologic conditions, nutrient availability, sediment deposition, turbidity, and other structural habitat conditions. In riverine systems, the physical structure of woody debris provides cover for managed species, creates habitats and microhabitats (e.g., pools, riffles, undercut banks, and side channels), retains gravels, and helps maintain underlying channel structure (Abbe and Montgomery 1996, Montgomery et al. 1995, Ralph et al. 1994, Spence et al. 1996). Woody debris also plays similar role in salt marsh habitats (Maser and Sedell 1994). In benthic ocean habitats, LWD enriches local nutrient availability as deep-sea wood borers convert the wood to fecal matter, providing terrestrial-based carbon to the ocean food chain (Maser and Sedell 1994). When deposited on coastal shorelines, macrophyte wrack creates microhabitats and provides a food source for aquatic and terrestrial organisms such as isopods and amphipods, which play an important role in marine food webs.

Conversely, inorganic flotsam and jetsam debris can negatively impact EFH. Inorganic marine debris is a problem along much of the coastal U.S., where it litters shorelines, fouls estuaries, entangles fish and wildlife, and creates hazards in the open ocean. Marine debris consists of a wide variety of man-made materials, including general litter, plastics, hazardous wastes, and discarded or lost fishing gear. The debris enters waterbodies indirectly through rivers and storm drains, as well as directly via ocean dumping and accidental release. Although laws and regulatory programs exist to prevent or control the problem, marine debris continues to affect aquatic resources.

G.3.2.1 Organic Debris Removal

Natural occurring flotsam, such as LWD and macrophyte wrack (i.e., kelp), is sometimes intentionally removed from streams, estuaries, and coastal shores. This debris is removed for a variety of reasons, including dam operations, aesthetic concerns, and commercial and recreational uses. However, the presence of organic debris is important for maintaining aquatic habitat structure and function. Removal can alter the ecological conditions of riverine, estuarine, and coastal ecosystems and habitats.

G.3.2.1.1 Potential Adverse Impacts

The removal of organic debris from natural systems can reduce habitat function, adversely impacting habitat quality. For example, in parts of the Pacific Northwest, reduction in LWD inputs to estuaries has reduced the number of spatially complex and diverse channel systems that provide productive salmon habitat (NRC 1996). Reductions in woody debris inputs to estuaries may also affect the ecological balance of estuarine systems by altering rates and patterns of nutrient transport, sediment deposition, and availability of in-water cover for larval and juvenile fish. In rivers and streams of the Pacific Northwest, the historic practice of removing LWD to improve navigability and facilitate log transport has altered channel morphology and reduced habitat complexity, thereby negatively affecting habitat quality for spawning and rearing salmonids (Koski 1992, Sedell and Luchessa 1982).

Beach grooming and wrack removal can substantially alter the macrofaunal community structure of exposed sand beaches (Dugan et al. 2000). It has been found that species richness, abundance, and biomass of macrofauna associated with beach wrack (e.g., sand crabs, isopods, amphipods, and polychaetes) are higher on ungroomed beaches than on those that are groomed (Dugan et al. 2000). The input and maintenance of wrack can strongly influence the structure of macrofauna communities, including the abundance of sand crabs (*Emerita analoga*) (Dugan et al. 2000), an important prey species for some managed species of fish.

G.3.2.1.2 Recommended Conservation Measures

The recommended conservation measures for organic debris include the following. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Leave LWD whenever possible, removing it only when it presents a threat to life or property. Otherwise, reposition, rather than remove, LWD.
2. Encourage appropriate federal, state, and local agencies to prohibit or minimize commercial removal of LWD from rivers, estuaries, and beaches.
3. Encourage appropriate federal, state, and local agencies to aid in the downstream movement of LWD around dams, culverts, and bridges wherever possible, rather than removing it from the system.
4. Educate landowners and recreationalists about the benefits of maintaining LWD.
5. Localize beach grooming practices, and minimize them whenever possible.

G.3.2.2 Inorganic Debris

Congress has passed numerous laws intended to prevent the disposal of marine debris in U.S. ocean waters. These include the Marine Protection, Research, and Sanctuaries Act, Titles I and II (also known as the Ocean Dumping Act), The Federal Water Pollution Control Act (CWA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The International Convention for the Prevention of Pollution from Ships, commonly known as the MARPOL Annex V (33 CFR 151), is intended to protect the marine environment from various types of garbage by preventing ocean dumping if the ship is less than 25 nm from shore. Dumping of unground food waste and other garbage is prohibited within 12 nm from shore, and ground non-plastic or food waste may not be dumped within 3 nm of shore. The Ocean Dumping Act implements the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) for the U.S. Section 311 of the Federal Water Pollution Control Act makes it unlawful for any person to discharge any pollutant into the waters of the U.S. except as authorized by law. CERCLA stipulates that releases of hazardous substances in reportable quantities must be reported, and the release must be removed by the responsible party. Regulations implementing these acts are intended to control marine debris from ocean sources, including galley waste and other trash from ships, recreational boaters and fishermen, and offshore oil and gas exploration and facilities.

Nationally, land-based sources of marine debris account for about 80 percent of the marine debris on beaches and in U.S. waters. Debris from these sources can originate from combined sewer overflows and storm drains, stormwater runoff, landfills, solid waste disposal, poorly maintained garbage bins, floating structures, and general littering of beaches, rivers, and open waters. Typical debris from these land-based sources includes raw or partially treated sewage, litter, hazardous materials, and discarded trash. Legislation and programs that address these land-based sources of pollution include the BEACH Act, the National Marine Debris Monitoring Program (NMDMP), the Shore Protection Act of 1989, and the CWA. The BEACH Act authorizes EPA to fund state, territorial, Tribal, and local government programs that test and monitor coastal recreational waters near public access sites for microbial contaminants and to assess and monitor floatable debris. The NMDMP is a 5-year study designed to provide statistically valid estimates of marine debris affecting the entire U.S. coastline and to determine the main sources of the debris. The Shore Protection Act contains provisions to ensure that municipal and commercial solid wastes are not deposited in coastal waters during vessel transport from source to the waste receiving station.

G.3.2.2.2 Potential Adverse Impacts

Land and ocean based marine debris is a very diverse problem, and adverse effects to EFH are likewise varied. Floating or suspended trash can directly affect fish that consume or are entangled in it. Toxic substances in plastics can kill or impair fish and invertebrates that use habitat polluted by these materials. The chemicals leach from plastics, persist in the environment, and can bioaccumulate through the food web.

Once floatable debris settles to the bottom of estuaries, coastal, and open ocean areas it may continue to cause environmental problems. Plastics and other materials with a large surface area can cover and suffocate immobile animals and plants, creating large spaces devoid of life. Currents can carry suspended debris to underwater reef habitats where the debris can become snagged, damaging these sensitive habitats. The typical floatable debris from combined sewer overflows includes street litter, sewage containing viral and bacterial pathogens, pharmaceutical by-products from human excretion, and pet wastes. It may contain condoms, tampons, and contaminated hypodermic syringes, all of which can pose physical and biological threats to EFH. Pathogens can also contaminate shellfish beds and reefs.

G.3.2.2.3 Recommended Conservation Measures

The recommended conservation measures for minimizing inorganic debris include the following. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Encourage proper trash disposal in coastal and ocean settings.
2. Advocate and participate in coastal cleanup activities.
3. Encourage enforcement of regulations addressing marine debris pollution and proper disposal.
4. Provide resources and technical guidance for development of studies and solutions addressing the problem of marine debris.
5. Provide resources to the public explaining the impact of marine debris and giving guidance on how to reduce or eliminate the problem.

G.3.3 Dam Operation

Dams are constructed and operated to provide sources for hydropower, water storage, and flood control. Their operation, however, can affect water quality and quantity in riverine systems.

G.3.3.1 Potential Adverse Impacts

The effects of dam construction and operation on EFH can include (1) migratory impediments, (2) water flow and current pattern shifts, (3) thermal impacts, and (4) limits on sediment and woody debris transport.

Dam construction and operation impede anadromous fish migration in streams and rivers or make fish passage impossible. Unless proper fish passage devices are in place, dams can either prevent access to productive upstream spawning habitat or can alter downstream juvenile movements. The passage of salmon through turbines, sluiceways, bypass systems, and fish ladders also affects the quality of EFH (Pacific Fishery Management Council [PFMC] 1999).

Dam operations also reduce downstream water velocities and change current patterns (PFMC 1999). These modifications can increase migration times (Raymond 1979). Water-level fluctuations, altered seasonal and daily flow regimes, reduced water velocities, and discharge volumes can affect the migratory behavior of juvenile salmonids and reduce the availability of shelter and foraging habitat (PFMC 1999).

Dams can affect the thermal regimes of streams by raising water temperatures. Changes in water temperature can affect the development and smoltification of salmonids (PFMC 1999) and adult migration (Spence et al. 1996).

Dams also limit or alter natural sediment and LWD transport processes by impeding the high flows needed to scour fine sediments and move woody debris downstream (PFMC 1999). Curtailing these resources will affect the availability of spawning gravels and change channel morphology (Spence et al. 1996).

G.3.3.2 Recommended Conservation Measures

The information in this section is adapted from PFMC 1999. The recommended conservation measures for dam operation include the following. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Operate facilities to create flow conditions that provide for passage, water quality, proper timing of life history stages, and properly functioning channel conditions to avoid strandings and redd dewatering.
2. Develop water and energy conservation guidelines for integration into dam operation plans and into regional and watershed-based water resource plans.
3. Provide mitigation (including monitoring and evaluation) for nonavoidable adverse effects on EFH.

G.3.4 Commercial and Domestic Water Use

Commercial and domestic water use demands to support the needs of homes, farms, and industries require a constant supply of water. Freshwater is diverted directly from lakes, streams, and rivers by means of pumping facilities, or is stored in impoundments. Because human populations are expected to continue increasing in Alaska, it is reasonable to assume that water uses, including water impoundments and diversion, will similarly increase (Gregory and Bisson 1997).

G.3.4.1 Potential Adverse Impacts

The information in this section is adapted from NMFS 1998, a, b.

The withdrawal of water can affect EFH by (1) altering natural flows and the process associated with flow rates, (2) affecting shoreline riparian habitats, (3) affecting prey bases, (4) affecting water quality, and (5) entrapping fishes. Water diversions can involve either withdrawals (reducing flow) or discharges (increasing flow). Water withdrawal will alter natural flow and stream velocity and channel depth and width. It can also change sediment and nutrient transport characteristics (Christie et al. 1993, Fajen and Layzer 1993), increase deposition of sediments, reduce depth, and accentuate diel temperature patterns (Zale et al. 1993). Loss of vegetation along streambanks and coastlines due to fluctuating water levels can decrease the availability of fish cover and reduce stability (Christie et al. 1993). Changes in the quantity and timing of stream flow alters the velocity of streams, which, in turn, affects the composition and abundance of both insect and fish populations (Spence et al. 1996). Returning irrigation water to a stream, lake, or estuary can substantially alter and degrade habitat (NRC 1989). Problems associated with return flows include increased water temperature, increased salinity, introduction of pathogens, decreased dissolved oxygen, increased toxic contaminants from pesticides and fertilizers, and increased sedimentation (Northwest Power Planning Council 1986). Diversions can also physically divert or entrap EFH-managed species (Section G.5.3).

G.3.4.2 Recommended Conservation Measures

The recommended conservation measures for commercial and domestic water use include the following. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Design projects to create flow conditions that provide for adequate passage, water quality, proper timing of life history stages, and properly functioning channels to avoid juvenile stranding and redd dewatering, as well as to maintain and restore proper channel, floodplain, riparian, and estuarine conditions.
2. Establish adequate instream flow conditions for anadromous fish.
3. Screen water diversions on fish-bearing streams, as needed.
4. Incorporate juvenile and adult fish passage facilities on all water diversion projects (e.g., fish bypass systems).
5. Where practicable, ensure that mitigation is provided for nonavoidable impacts.

G.4 ESTUARINE ACTIVITIES

G.4.1 Dredging

Dredging navigable waters creates a continuous impact primarily affecting benthic and water-column habitats in the course of constructing and operating marinas, harbors, and ports. Routine dredging (i.e., the excavation of soft-bottom substrates) is used to create deepwater navigable channels or to maintain existing channels that periodically fill with sediments. In addition, port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size (Section G.4.3). Elimination or degradation of aquatic and upland habitats is commonplace because port expansion almost always affects open water, submerged bottoms, and, possibly, riparian zones.

G.4.1.1 Potential Adverse Impacts

The environmental effects of dredging on EFH can include (1) direct removal/burial of organisms; (2) turbidity/siltation effects, including light attenuation from turbidity; (3) contaminant release and uptake, including nutrients, metals, and organics; (4) release of oxygen consuming substances; (5) entrainment; (6) noise disturbances; and (6) alteration to hydrodynamic regimes and physical habitat.

Many EFH species forage on infaunal and bottom-dwelling organisms. Dredging may adversely affect these prey species at the site by directly removing or burying immobile invertebrates such as polychaete worms, crustacean, and other EFH prey types (Newell et al. 1998, Van der Veer et al. 1985). Similarly, the dredging activity may also force mobile animals such as fish to migrate out of the project area. Recolonization studies suggest that recovery may not be quite as straightforward. Physical factors, including particle size distribution, currents, and compaction/stabilization processes following deposition reportedly can regulate recovery after dredging events. Rates of recovery listed in the literature range from several months for estuarine muds to up to 2 to 3 years for sands and gravels. Recolonization can also take up to 1 to 3 years in areas of strong current, but up to 5 to 10 years in areas of low current. Thus, forage resources for benthic feeders may be substantially reduced.

The use of certain types of dredging equipment can result in greatly elevated levels of fine-grained mineral particles or suspended sediment concentration, usually smaller than silt, and organic particles in the water column. The associated turbidity plumes of suspended particulates may reduce light penetration and lower the rate of photosynthesis for subaquatic vegetation (Dennison 1987) and the primary productivity of an aquatic area if suspended for extended periods of times (Cloern 1987). If suspended sediments loads remain high, fish may suffer reduced feeding ability (Benfield and Minello 1996) and be prone to fish gill injury (Nightingale and Simenstad 2001a).

Sensitive habitats such as submerged aquatic vegetation beds, which provide food and shelter, may also be damaged. Eelgrass beds are critical to nearshore food web dynamics (Wyllie-Echeverria and Phillips 1994, Murphy et al. 2000). Studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993, Hoss and Thayer 1993). This primary production, combined with other nutrients, provide high rates of secondary production in the form of fish (Herke and Rogers 1993, Good 1987, Sogard and Able 1991).

The contents of the suspended material may react with the dissolved oxygen in the water and result in short-term oxygen depletion to aquatic resources (Nightingale and Simenstad 2001a). Dredging can also disturb aquatic habitats by resuspending bottom sediments and, thereby, recirculate toxic metals (e.g., lead, zinc, mercury, cadmium, copper etc.), hydrocarbons (e.g., polyaromatics), hydrophobic organics (e.g., dioxins), pesticides, pathogens, and nutrients into the water column (EPA 2000). Toxic metals and organics, pathogens, and viruses, absorbed or adsorbed to fine-grained particulates in the material, may become biologically available to organisms either in the water column or through food chain processes.

Direct uptake of fish species by hydraulic dredging at the proposed borrow site is also an issue. Definitive information in the literature shows that elicit avoidance responses to the suction dredge entrainment occurs for both benthic and water column oriented species (Larson and Moehl 1990, McGraw and Armstrong 1990).

Dredging, as well as equipment such as pipelines used in the process (Section G.4.10), may damage or destroy spawning, nursery, and other sensitive habitats such as emergent marshes and subaquatic vegetation, including eelgrass beds and kelp beds. Dredging may also modify current patterns and water circulation of the habitat by changing the direction or velocity of water flow, water circulation, or dimensions of the waterbody traditionally used by fish for food, shelter, or reproductive purposes.

G.4.1.2 Recommended Conservation Measures

The recommended conservation measures for dredging include the following. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Avoid new dredging to the maximum extent practicable.
2. Where possible, minimize dredging by using natural and existing channels.
3. Site activities that would likely require dredging (such as placement of piers, docks, marinas, etc.) in deep-water areas or design such structures to alleviate the need for maintenance dredging.
4. Incorporate adequate control measures by using BMPs to minimize turbidity and dispersal of dredged material in areas where the dredging equipment would cause such effects.
5. For new dredging projects, undertake multi-season, pre-, and post-dredging biological surveys to assess the cumulative impacts to EFH and allow for implementation of adaptive management techniques.

6. Provide appropriate compensation for significant impacts (short-term, long-term, and cumulative) to benthic environments resulting from dredging.
7. Perform dredging at times when impacts to federally managed species or their prey are least likely. Avoid dredging in areas with submerged aquatic vegetation.
8. Reference all dredging latitude-longitude coordinates at the site so that information can be incorporated into a geographical information system format. Inclusion of aerial photos may be useful to identify precise locations for long-term evaluation.
9. Test sediments for contaminants as per EPA and USACE requirements.
10. Identify excess sedimentation in the watershed that prompts excessive maintenance dredging activities, and implement appropriate management actions, if possible, to ensure that actions are taken to curtail those causes.
11. Ensure that bankward slopes of the dredged area are slanted to acceptable side slopes (e.g., 3:1) to prevent sloughing.
12. Avoid placing pipelines and accessory equipment used in conjunction with dredging operations to the maximum extent possible close to kelp beds, eelgrass beds, estuarine/salt marshes, and other high value habitat areas.

G.4.2 Material Disposal/Fill Material

The discharge of dredged materials subsequent to dredging operations or the use of fill material in aquatic habitats can result in sediments (e.g., dirt, sand, mud) covering or smothering existing submerged substrates, loss of habitat function, and adverse effects on benthic communities.

G.4.2.1 Disposal of Dredged Material

G.4.2.1.1 Potential Adverse Impacts

The disposal of dredged material can adversely affect EFH by (1) altering or destroying benthic communities, (2) altering adjacent habitats, and (3) creating turbidity plumes and introducing contaminants and/or nutrients.

Disposing dredged materials result in varying degrees of change in the physical, chemical, and biological characteristics of the substrate. Discharges may adversely affect infaunal and bottom-dwelling organisms at the site by smothering immobile organisms (e.g., prey invertebrate species) or forcing mobile animals (e.g., benthic-oriented fish species) to migrate from the area. Infaunal invertebrate plants and animals present prior to a discharge are unlikely to recolonize if the composition of the discharged material is drastically different.

Erosion, slumping, or lateral displacement of surrounding bottom of such deposits can also adversely affect substrate outside the perimeter of the disposal site by changing or destroying benthic habitat. The bulk and composition of the discharged material and the location, method, and timing of discharges may all influence the degree of impact on the substrate.

The discharge of material can result in greatly elevated levels of fine-grained mineral particles, usually smaller than silt, and organic particles in the water column (i.e., turbidity plumes). These suspended particulates may reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area if suspended for long intervals. Aquatic vegetation such as eelgrass beds and kelp beds may also be affected. Managed fish species may suffer reduced feeding ability, leading to limited growth and lowered resistance to disease if high levels of suspended particulates persist. The contents of the suspended material may react with the dissolved oxygen in the water and result in oxygen depletion. Toxic metals and organics, pathogens, and viruses absorbed into or adsorbed to fine-grained particulates in the material may become biologically available to organisms either in the water column or through food chain processes.

The discharge of dredged or fill material can change the chemistry and the physical characteristics of the receiving water at the disposal site by introducing chemical constituents in suspended or dissolved form. Reduced clarity and excessive contaminants can reduce, change, or eliminate the suitability of water bodies for populations of groundfish, other fish species, and their prey. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as polychaetes or algae to the detriment of other types.

G.4.2.1.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Study all options for disposal of dredged materials, including upland disposal sites, and select disposal sites that minimize adverse effects to EFH.
2. Where long-term maintenance dredging is anticipated, acquire and maintain disposal sites for the entire project life.
3. Encourage beneficial uses of dredged materials. Consider using dredging material for beach replenishment and construction where appropriate. When dredging material is placed in open water, consider the possibilities for enhancing marine fishery resources.
4. State and federal agencies should identify the direct and indirect impacts open-water disposal permits for dredged material may have on EFH during proposed project reviews. Determine benthic productivity by sampling prior to any discharge of fill material. Develop the sampling design with input from state and federal natural resource agencies.
5. Minimize the areal extent of any disposal site in EFH, or avoid the site entirely. Mitigate all non-avoidable adverse impacts as appropriate.

G.4.2.2 Fill Material

G.4.2.2.1 Potential Adverse Impacts

Adverse impacts to EFH from the introduction of fill material include (1) loss of habitat function and (2) changes in hydrologic patterns.

Aquatic habitats sustain remarkably high levels of productivity and support various life stages of fish species and their prey. Many times, these habitats are used for multiple purposes, including habitat necessary for spawning, breeding, feeding, or growth to maturity. The introduction of fill material eliminates those functions and permanently removes the habitat from production.

The discharge of dredged or fill material can modify current patterns and water circulation by obstructing flow, changing the direction or velocity of water flow and circulation, or otherwise changing the dimensions of a water body. As a result, adverse changes can occur in the location, structure, and dynamics of aquatic communities; shoreline and substrate erosion and deposition rates; the deposition of suspended particulates; the rate and extent of mixing of dissolved and suspended components of the water body; and water stratification (NMFS 1998, b).

G.4.2.2.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH:

1. Federal, state, and local resource management and permitting agencies should address the cumulative impacts of past and current fill operations on EFH and consider them in the permitting process for individual projects.
2. Minimize the areal extent of any fill in EFH, or avoid it entirely. Mitigate all non-avoidable adverse impacts as appropriate.
3. Consider alternatives to the placement of fill into areas that support EFH. Identify and characterize EFH habitat functions/services in the project areas, so that appropriate mitigation can be determined if necessary.

G.4.3 Vessel Operations/Transportation/Navigation

The growth in Alaska coastal communities is putting demands on port districts to increase infrastructure capacity to accommodate additional vessel operations for cargo handling activities and marine transportation. Port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size (Council 1999). In addition, increasing boat sales have put more pressure on improving and building new commercial fishing and small boat harbors.

G.4.3.1 Potential Adverse Impacts

The expansion of port facilities, vessel/ferry operations, and recreational marinas can bring additional impacts to EFH, especially by filling productive shallow water habitats. There is considerable evidence that docks and piers block sunlight penetration, alter water flow, introduce chemicals, and restrict access and navigation (Section G.4.6). The increase in hard surfaces close to the marine environment increases nonpoint surface discharges (Section G.2.2), adds debris sources, and reduces buffers between land use and the aquatic ecosystem. These include direct, indirect, and cumulative impacts on shallow subtidal, deep subtidal, eelgrass beds, mudflats, sand shoals, rock reefs, and salt marsh habitats. Such impacts would be site-specific. Some activities affecting these habitats, including new channel deepening and maintenance dredging (Section G.4.1), disposal of dredged material (Section G.4.2), reduced water quality from resuspension of contaminated sediments, ballast water discharge (Section G.4.4), and shading from overwater structures (Section G.4.6), are addressed in other sections. Additional impacts include vessel groundings, modification of water circulation (breakwaters, channels, and fill), vessel wake generation, pier lighting, anchor and prop scour, discharge of contaminants and debris, and changing natural patterns of fish movement.

Potential adverse impacts to EFH can occur during both the construction and operation phases. An increase in the number and size of vessels can generate more wave and surge effects on shorelines. These vessel-wakes, or wash events, can affect shorelines depending on the wake wave energy, the water depth, and the type of shoreline. Vessel wakes can cause a significant increase in shoreline erosion, affect wetland habitat, and increase water turbidity. Vessel prop wash can also damage aquatic vegetation and disturb sediments, which may increase turbidity and suspend contaminants (Klein 1997, Warrington 1999).

Impacts can also occur from anchor scour. Mooring buoys, when anchored in shallow nearshore waters, can drag the anchor chain across the bottom, destroying submerged vegetation and creating a circular scour hole (Walker et al. 1989, *in* Shafer 2002).

Vessel discharges, engine operations, bottom paint sloughing, boat washdowns, painting, and other vessel maintenance activities can deliver debris, nutrients, and contaminants to waterways and may degrade water quality and contaminate sediments.

Inadequate flushing of marinas also results in water quality problems (USACE 1993, Klein 1997). Poor flushing in marinas can increase temperature and raise phytoplankton populations with nocturnal dissolved oxygen level declines, resulting in organism hypoxia and pollutant inputs (Cardwell et al. 1980). An exchange of at least 30 percent of the water in the marina during a tidal change should minimize temperature increases and dissolved oxygen problems (Cardwell et al. 1980).

G.4.3.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Locate marinas in areas of low biological abundance and diversity; if possible, for example, avoid the disturbance of eelgrass or other submerged aquatic vegetation including macroalgae, mudflats, and wetlands as part of the project design. In situations where such impacts are unavoidable, consider mitigation as appropriate. Other dredging-related conservation measures are provided in Section G.4.1.
2. If practicable, excavate uplands to create marina basins rather than converting intertidal or shallow subtidal areas to deeper subtidal areas for basin creation.
3. Leave riparian buffers in place to help maintain water quality and nutrient input.
4. Should mitigation be required, include a monitoring plan to gauge the success of mitigation efforts.
5. Include low-wake vessel technology, appropriate routes, and BMPs for wave attenuation structures as part of the design and permit process. Vessels should be operated at sufficiently low speeds to reduce wake energy, and no-wake zones should be designated near sensitive habitats.
6. Incorporate BMPs to prevent or minimize contamination from ship bilge waters, antifouling paints, shipboard accidents, shipyard work, maintenance dredging and disposal, and nonpoint source contaminants from upland facilities related to vessel operations and navigation.
7. Locate mooring buoys in water deep enough to avoid grounding and to minimize the effects of prop wash. Use subsurface floats or other methods to prevent contact of the anchor line with the substrate.
8. Use catchment basins for collecting and storing surface runoff from upland repair facilities. Include parking lots and other impervious surfaces as components of the site development plan to remove contaminants prior to delivery to any receiving waters.
9. Locate facilities in areas with enough water velocity to maintain water quality levels within acceptable ranges.
10. Locate marinas where they do not interfere with drift sectors determining the structure and function of adjacent habitats.
11. To facilitate the movement of fish around breakwaters, provide a shallow shelf or “fish bench” on the outside of the breakwater.
12. Harbor facilities should be designed to include practical measures for reducing, containing, and cleaning up petroleum spills.
13. Use appropriate timing windows for construction and dredging activities to avoid potential impacts on EFH.

G.4.4 Introduction of Exotic Species

Introductions of exotic species into estuarine, riverine, and marine habitats have been well documented (Rosecchi et al. 1993, Kohler and Courtenay 1986, Spence et al. 1996) and can be intentional (e.g., for the purpose of stock or pest control) or unintentional (e.g., fouling organisms). Exotic fish, shellfish, pathogens, and plants can enter the environment from industrial shipping (e.g., as ballast), recreational boating, aquaculture (Section G.4.10), biotechnology, and aquariums. The transportation of nonindigenous organisms to new environments can have many severe impacts on habitat (Omori et al. 1994).

G.4.4.1 Potential Adverse Impacts

Long-term impacts from the introduction of nonindigenous and reared species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal disease. Overall, exotic species introductions create five types of negative effects: (1) habitat alteration, (2) trophic alteration, (3) gene pool alteration, (4) spatial alteration, and (5) introduction of diseases. Habitat alteration includes the excessive colonization of exotic species (e.g., *Spartina* grasses), which precludes the growth of endemic organisms (e.g., eelgrass). The introduction of exotic species may alter community structure by predation on native species or by population explosions of the introduced species. For example, this has occurred in freshwater lakes on Alaska's Kenai Peninsula, where introduced northern pike have depleted local salmonid populations through rampant juvenile predation. Spatial alteration occurs when territorial introduced species compete with and displace native species. Although hybridization is rare, it may occur between native and introduced species and can result in gene pool deterioration.

Non-native plants and algae can degrade coastal and marine habitats by changing natural habitat qualities. Introduced organisms increase competition with indigenous species, or they may forage on indigenous species, which can reduce fish and shellfish populations. Long-term impacts from the introduction of nonindigenous species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal diseases. The introduction of exotic organisms also threatens native biodiversity and could lead to changes in relative abundance of species and individuals that are of ecological and economic importance.

The introduction of bacteria, viruses, and parasites is another severe threat to EFH as it may reduce habitat quality. New pathogens or higher concentrations of disease can be spread throughout the environment, resulting in deleterious habitat conditions.

Relatively few exotic, invasive species have been documented in Alaska. It is believed that this is due to a combination of factors, including geographic isolation, harsh climate conditions and cold temperatures, fewer concentrated, highly disturbed habitat areas, and the state's stringent plant and animal transportation laws (Fay 2002).

Alaska waters are, however, vulnerable to exotic species invasion. "Potential introduction pathways include fish farms, the intentional movement of game or bait fish from one aquatic system to another, the movement of large ships and ballast water from the United States West Coast and Asia, fishing vessels docking at Alaska's busy commercial fishing ports, construction equipment, trade of live seafood, aquaculture, and contaminated sport angler gear brought to Alaska's world-renowned fishing sites" (Fay 2002).

G.4.4.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Uphold fish and game regulations of the Alaska Board of Fisheries (AS 16.05.251) and Board of Game (AS 16.05.255), which prohibit and regulate the live capture, possession, transport, or release of native or exotic fish or their eggs.
2. Adhere to regulations and use best management practices outlined in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002).
3. Encourage vessels to perform a ballast water exchange in marine waters (in accordance with the U.S. Coast Guard's voluntary regulations) to minimize the possibility of introducing exotic estuarine species into similar habitats. Ballast water taken on in marine waters will contain fewer organisms, and these will be less likely to become invasive in estuarine conditions than species transported from other estuaries.
4. Discourage vessels that have not performed a ballast water exchange from discharging their ballast water into estuarine receiving waters.
5. Require vessels brought from other areas over land via trailer to clean any surfaces that may harbor non-native plant or animal species (propellers, hulls, anchors, fenders, etc.). Bilges should be emptied and cleaned thoroughly by using hot water or a mild bleach solution. These activities should be performed in an upland area to prevent introduction of non-native species during the cleaning process.
6. Treat effluent from public aquaria displays and laboratories and educational institutes using exotic species before discharge to prevent the introduction of viable animals, plants, reproductive material, pathogens, or parasites into the environment.
7. Prevent introduction of non-native plant species into aquatic and riparian ecosystems by avoiding use of non-native seed mixes or invasive, non-native landscaping materials near waterways and shorelines.
8. Encourage proper disposal of seaweeds and other plant materials used for packing purposes when shipping fish or other animals. These materials may harbor invasive species and pathogens and should be treated accordingly.

G.4.5 Pile Installation and Removal

Pilings are an integral component of many overwater and in-water structures. They provide support for the decking of piers and docks, function as fenders and dolphins to protect structures, support navigation markers, and help in the construction of breakwaters and bulkheads. Materials used in pilings include steel, concrete, wood (both treated and untreated), plastic, or a combination thereof. Piles are usually driven into the substrate by using either impact hammers or vibratory hammers. Impact hammers consist of a heavy weight that is repeatedly dropped onto the top of the pile, driving it into the substrate. Vibratory hammers use a combination of a stationary, heavy weight and vibration, in the plane perpendicular to the long axis of the pile, to force the pile into the substrate. The type of hammer used depends on a variety of factors, including pile material and substrate type. Impact hammers can be used to drive all types of piles, while vibratory hammers are generally most efficient at driving piles with a cutting edge (e.g., hollow steel pipe) and are less efficient at driving displacement piles (those without a cutting edge that must displace the substrate). Displacement piles include solid concrete, wood, and closed-end steel pipe. While impact hammers are able to drive piles into most substrates (including hardpan, glacial till, etc.), vibratory hammers are limited to softer, unconsolidated substrates (e.g., sand, mud, and gravel). Because vibratory hammers do not use force to drive the piles, the bearing capacity is not known, and the piles must often be proofed with an impact hammer. This involves striking the pile a number of times with the impact hammer to ensure that it meets the designed bearing capacity. Under certain circumstances, piles may be driven using a combination of vibratory and impact hammers. The vibratory hammer makes positioning and plumbing of the pile easier; therefore, it is often used to drive the pile through the soft, overlying material. Once the pile stops penetrating the sediment, the impact hammer is used to finish driving the pile to final depth. An additional advantage of this method is that the vibratory hammer can be used to extract and reposition the pile, while the impact hammer cannot.

Overwater structures usually must meet seismic stability criteria, requiring that the supporting piles are attached to, or driven into, the underlying hard material. This requirement often means that at least some impact driving is necessary. Piles that do not have to be seismically stable, including temporary piles, fender piles, and some dolphin piles, may be driven with a vibratory hammer, providing the type of pile and sediments are appropriate.

Piles can be removed using a variety of methods, including vibratory hammer, direct pull, clam shell grab, or cutting/breaking the pile below the mudline. Vibratory hammers can be used to remove all types of pile, including wood, concrete, and steel. Old brittle piles may, however, break under the vibrations; this may necessitate using another method. The direct pull method involves placing a choker around the pile and pulling upward with a crane or other equipment. Broken stubs in soft substrates can be removed with a clam shell and crane, although suitable conditions rarely exist in Alaska. In this method, the clam shell grips the pile near the mudline and pulls it out. More commonly, piles may be cut or broken below the mudline, leaving the buried section in place.

G.4.5.1 Pile Driving

G.4.5.1.1 Potential Adverse Impacts

Pile driving can generate intense underwater sound pressure waves that may adversely affect EFH. These pressure waves have been shown to injure and kill fish (CalTrans 2001, Longmuir and Lively 2001, Stotz and Colby 2001, Stadler, pers. obs. 2002). Injuries associated directly with pile driving are poorly studied, but include rupture of the swimbladder and internal hemorrhaging (CalTrans 2001; Abbott and Bing-Sawyer 2002; Stadler, pers. obs. 2002). Sound pressure levels (SPLs) 100 decibels (dB) above the threshold for hearing are thought to be sufficient to damage the auditory system in many fishes (Hastings 2002).

The type and intensity of the sounds produced during pile driving depend on a variety of factors, including, but not limited to, the type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer. SPLs are positively correlated with the size of the pile, as more energy is required to drive larger piles. Wood and concrete piles appear to produce lower sound pressures than hollow-steel piles of a similar size, although it is unclear if the sounds produced by wood or concrete piles are harmful to fishes. Hollow-steel piles as small as 14 inches (35.5 centimeters) in diameter have been shown to produce SPLs that can injure fish (Reyff 2003). Firmer substrates require more energy to drive piles and produce more intense sound pressures. Sound attenuates more rapidly with distance from the source in shallow water than it does in deep water (Rogers and Cox 1988).

Driving large hollow-steel piles with impact hammers produces intense, sharp spikes of sound that can easily reach levels injurious to fish. Vibratory hammers, on the other hand, produce sounds of lower intensity, with a rapid repetition rate. A key difference between the sounds produced by impact hammers and those produced by vibratory hammers is the responses they evoke in fish. When exposed to sounds that are similar to those of a vibratory hammer, fish consistently displayed an avoidance response (Enger et al. 1993, Dolat 1997, Knudsen et al. 1997, Sand et al. 2000), and they did not habituate to the sound, even after repeated exposure (Dolat 1997, Knudsen et al. 1997). Fishes may respond to the first few strikes of an impact hammer with a startle response. After these initial strikes, the startle response wanes, and the fishes may remain within the field of a potentially harmful sound (Dolat 1997, NMFS 2001). The differential responses to these sounds are due to the differences in the duration and frequency of the sounds. When compared to impact hammers, the sounds produced by vibratory hammers are of longer duration (minutes versus milliseconds) and have more energy in the lower frequencies (15 to 26 hertz [hz] versus 100 to 800 hz) (Würsig, et al. 2000, Carlson et al. 2001). Studies have shown that fish respond to particle acceleration of 0.01 meter per second squared (m/s^2) at infrasound frequencies, that the response to infrasound is limited to the nearfield (less than 1 wavelength), and that the fish must be exposed to the sound for several seconds (Enger et al. 1993, Knudsen et al. 1994, Sand et al. 2000). Impact hammers, however, produce such short spikes of sound with little energy in the infrasound range, that fish fail to respond to the particle motion (Carlson et al. 2001). Thus, impact hammers may be more harmful than vibratory hammers because they produce more intense pressure waves and because the sounds produced do not elicit an avoidance response in fishes, which exposes them to those harmful pressures for longer periods.

The degree to which an individual fish exposed to sound will be affected depends on a number of variables, including (1) species of fish, (2) fish size, (3) presence of a swimbladder, (4) physical condition of the fish, (5) peak sound pressure and frequency, (6) shape of the sound wave (rise time), (7) depth of the water around the pile, (8) depth of the fish in the water column, (9) amount of air in the water, (10) size and number of waves on the water surface, (11) bottom substrate composition and texture, (12) effectiveness of bubble curtain sound/pressure attenuation technology, (13) tidal currents, and (14) presence of predators.

Depending on these factors, effects on fish can range from changes in behavior to immediate mortality. There are little data on the SPL required to injure fish. Short-term exposure to peak SPLs above 190 dB (re:1 µPa) is thought to impose physical harm on fish (Hastings 2002). However, 155 dB (re:1 µPa) may be sufficient to stun small fish temporarily (personal communication, J. Miner, Gunderboom, Inc., Anchorage, Alaska, 2002). Stunned fish, while perhaps not physically injured, are more susceptible to predation. Small fish are more prone to injury by intense sound than are larger fish of the same species (Yelverton et al. 1975). For example, a number of surfperches (*Cymatogaster aggregata* and *Embiotoca lateralis*) were killed during impact pile driving (Stadler, pers. obs. 2002). Most of the dead fish were the smaller *C. aggregata* and similar sized specimens of *E. lateralis*, even though many larger *E. lateralis* were in the same area. Dissections revealed that the swimbladder of the smallest fish (80 millimeter [mm] forklength [FL]) was completely destroyed, while that of the largest individual (170 mm FL) was nearly intact, indicating a size-dependent effect. The SPLs that killed these fish are unknown. Of the reported fish kills associated with pile driving, all have occurred during use of an impact hammer on hollow-steel piles (Longmuir and Lively 2001, NMFS 2001, Stotz and Colby 2001, NMFS 2003).

Systems successfully designed to reduce the adverse effects of underwater SPLs on fish have included the use of air bubbles. Both confined (i.e., metal or fabric sleeve) and unconfined air bubble systems have been shown to attenuate underwater sound pressures up to 28 dB (Würsig et al. 2000, Longmuir and Lively 2001, Christopherson and Wilson 2002, Reyff and Donovan 2003). When using an unconfined air bubble system in areas of strong currents, it is critical that the pile be fully contained within the bubble curtain. To accomplish this when designing the system, adequate air flow and ring spacing, both vertically and in terms of distance from the pile, are factors that should be considered.

G.4.5.1.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Install hollow-steel piles with an impact hammer at a time of year when larval and juvenile stages of fish species with designated EFH are not present. If the first measure is not possible, then the following measures regarding pile driving should be incorporated when practicable to minimize adverse effects:
2. Drive piles during low tide when they are located in intertidal and shallow subtidal areas.

3. Use a vibratory hammer when driving hollow-steel piles. When impact hammers are required due to seismic stability or substrate type, drive the pile as deep as possible with a vibratory hammer before using the impact hammer.
4. Implement measures to attenuate the sound should SPLs exceed the 180 dB (re:1 µPa) threshold. If sound pressure levels are anticipated to exceed acceptable limits, implement appropriate mitigation measures when practicable. Methods to reduce the sound pressure levels include, but are not limited to, the following:
   a) Surround the pile with an air bubble curtain system or air-filled coffer dam.
   b) Because the sound produced has a direct relationship to the force used to drive the pile, use a smaller hammer to reduce the sound pressures.
   c) Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers; reducing the impact force will reduce the intensity of the resulting sound.
5. Drive piles when the current is reduced (i.e., centered around slack current) in areas of strong current to minimize the number of fish exposed to adverse levels of underwater sound.

G.4.5.2 Pile Removal

G.4.5.2.1 Potential Adverse Impacts

The primary adverse effect of removing piles is the suspension of sediments, which may result in harmful levels of turbidity and release of contaminants contained in those sediments (Section G.4.1). Vibratory pile removal tends to cause the sediments to slough off at the mudline, resulting in relatively low levels of suspended sediments and contaminants. Vibratory removal of piles is gaining popularity because it can be used on all types of piles, providing that they are structurally sound. Breaking or cutting the pile below the mudline may suspend only small amounts of sediment, providing that the stub is left in place, and little digging is required to access the pile. Direct pull or use of a clamshell to remove broken piles may, however, suspend large amounts of sediment and contaminants. When the piling is pulled from the substrate using these two methods, sediments clinging to the piling will slough off as it is raised through the water column, producing a potentially harmful plume of turbidity and/or contaminants. The use of a clamshell may suspend additional sediment if it penetrates the substrate while grabbing the piling.

While there is a potential to adversely affect EFH during the removal of piles, many of the piles removed are old creosote-treated timber piles. In some cases, the long-term benefits to EFH obtained by removing a chronic source of contamination may outweigh the temporary adverse effects of turbidity.

G.4.5.2.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Remove piles completely rather than cutting or breaking them off, if they are structurally sound.
2. Minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
   a) When practicable, remove piles with a vibratory hammer, rather than using the direct pull or clamshell method.
   b) Remove the pile slowly to allow sediment to slough off at, or near, the mudline.
   c) The operator should first hit or vibrate the pile to break the bond between the sediment and the pile to minimize the potential for the pile to break, as well as to reduce the amount of sediment sloughing off the pile during removal.

    d) Encircle the pile, or piles, with a silt curtain that extends from the surface of the water to the substrate.
3. Complete each pass of the clamshell to minimize suspension of sediment if pile stubs are removed with a clamshell.
4. Place piles on a barge equipped with a basin to contain all attached sediment and runoff water after removal. Creosote-treated timber piles should be disposed of properly to prevent reuse in the marine environment, and all debris, including attached contaminated sediments, should be disposed of in an approved upland facility.
5. Using a pile driver, drive broken/cut stubs far enough below the mudline to prevent release of contaminants into the water column as an alternative to their removal.

G.4.6 Overwater Structures

Overwater structures include commercial and residential piers and docks, floating breakwaters, barges, rafts, booms, and mooring buoys. These structures typically are located in intertidal areas out to about 49 feet (15 meters) below the area exposed by the mean lower low tide (i.e., the shallow subtidal zone). Light, wave energy, substrate type, depth, and water quality are the primary factors controlling the plant and animal assemblages found at a particular site. Overwater structures and associated activities can alter these factors and interfere with key ecological functions such as spawning, rearing, and refugia. Site-specific factors (e.g., water clarity, current, depth, etc.) and the type and use of a given overwater structure determine the occurrence and magnitude of these impacts.

G.4.6.1 Potential Adverse Impacts

Overwater structures and associated developments may adversely affect EFH in a variety of ways, primarily by changes in ambient light conditions, alteration of the wave and current energy regime, and activities associated with the use and operation of the facilities (Nightingale and Simenstad 2001b).

Overwater structures can create shade, which reduces the light levels below the structure. The size, shape, and intensity of the shadow cast by a particular structure depends upon its height, width, construction materials, and orientation. High and narrow piers and docks produce narrower, more diffuse shadows than do low and wide structures. Increasing the numbers of pilings used to support a given pier enhances the shade pilings cast on the under-pier environment. In addition, less light is reflected underneath structures built with light-absorbing materials (e.g., wood) than under structures built with light-reflecting materials (e.g., concrete or steel). Structures that are oriented north-south produce a shadow that moves across the bottom throughout the day, resulting in a smaller area of permanent shade than those that are oriented east-west.

The shadow cast by an overwater structure affects both the plant and animal communities below the structure. Distributions of plants, invertebrates, and fishes appear severely limited in under-dock environments when compared to adjacent, unshaded, vegetated habitats. Light is the most important factor affecting aquatic plants. Under-pier light levels can fall below threshold amounts for the photosynthesis of diatoms, benthic algae, eelgrass, and associated epiphytes and other autotrophs. These photosynthesizers are an essential part of nearshore habitat and the estuarine and nearshore foodwebs that support many species of marine and estuarine fishes. Eelgrass and other macrophytes can be reduced or eliminated, even through partial shading of the substrate, and have little chance to recover.

Fishes rely on visual cues for spatial orientation, prey capture, schooling, predator avoidance, and migration. The reduced-light conditions found under an overwater structure may limit the ability of fishes, especially juveniles and larvae, to perform these essential activities. Shading from overwater structures may also reduce prey organism abundance and the complexity of the habitat by reducing aquatic vegetation and phytoplankton abundance (Kahler et al. 2000, Haas et al. 2002). Glasby (1999) found that epibiotic assemblages on pier pilings at marinas subject to shading were markedly different than in surrounding areas. Other studies have shown shaded epibenthos to be reduced relative to that in open areas. These factors are thought to be responsible for the observed reductions in juvenile fish populations found under piers and the reduced growth and survival of fishes held in cages under piers, when compared to open habitats (Able et al. 1998, Duffy-Anderson and Able 1999).

The shadow cast by an overwater structure may increase predation on managed species of fish by creating a light/dark interface that allows ambush predators to remain in a darkened area (barely visible to prey) and watch for prey to swim by against a bright background (high visibility) (Helfman 1981). Prey species moving around the structure are unable to see predators in the dark area under the structure and are more susceptible to predation. Furthermore, the reduced vegetation (i.e., eelgrass) densities associated with overwater structures decrease the available refugia from predators.

Wave energy and water transport alterations from overwater structures can impact the nearshore detrital foodweb by altering the size, distribution, and abundance of substrate and detrital materials. Disruption of longshore transport can alter substrate composition and present potential barriers to the natural processes that build spits and beaches and provide substrates required for plant propagation, fish and shellfish settlement and rearing, and forage fish spawning.

Pilings can alter adjacent substrates with increased shell deposition from piling communities and changes to substrate bathymetry (Section G.4.5). Changes in substrate type can alter the nature of the flora and fauna native to a given site. In the case of pilings, native dominant communities typically associated with sand, gravel, mud, and eelgrass substrates are replaced by communities associated with shell hash substrates.

Treated wood used for pilings and docks releases contaminants into saltwater environs. PAHs are commonly released from creosote-treated wood. PAHs can cause a variety of deleterious effects (cancer, reproductive anomalies, immune dysfunction, and growth and development impairment) to exposed fish (Johnson et al. 1999, Johnson 2000, Stehr et al. 2000). Wood also is commonly treated with other chemicals such as ammoniacal copper zinc arsenate and chromated copper arsenate (Poston 2001). These preservatives are known to leach into marine waters for a relatively short time after installation, but the rate of leaching varies considerably, depending on many factors. Concrete and steel, on the other hand, are relatively inert and do not leach contaminants into the water.

Construction and maintenance of overwater structures often involve driving pilings (Section G.4.5) and dredging navigation channels (Section G.4.1). Both activities may also adversely affect EFH.

While the effect of some individual overwater structures on EFH may be minimal, the overall impact may be substantial when considered cumulatively. The additive effects of these structures increase the overall magnitude of impact and reduce the ability of EFH to support native plant and animal communities.

G.4.6.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Use upland boat storage whenever possible to minimize need for overwater structures.
2. Locate overwater structures in deep enough waters to avoid intertidal and shade impacts, minimize or preclude dredging, minimize groundings, and avoid displacement of submerged aquatic vegetation, as determined by a preconstruction survey.

3. Design piers, docks, and floats to be multiuse facilities to reduce the overall number of such structures and to limit impacted nearshore habitat.
4. Incorporate measures that increase the ambient light transmission under piers and docks. These measures include, but are not limited to, the following:
    a) Maximize the height of the structure, and minimize the width of the structure to decrease the shade footprint and using grated decking material.
    b) Use reflective materials (e.g., concrete or steel instead of materials that absorb light such as wood) on the underside of the dock to reflect ambient light.
    c) Use the fewest number of pilings necessary to support the structures to allow light into under-pier areas and minimize impacts to the substrate.
    d) Align piers, docks, and floats in a north-south orientation to allow the arc of the sun to cross perpendicular to the structure and to reduce the duration of light limitation.
5. Use floating rather than fixed breakwaters whenever possible, and remove them during periods of low dock use. Encourage seasonal use of docks and off-season haul-out.
6. Locate floats in deep water to avoid light limitation and grounding impacts to the intertidal or shallow subtidal zone.
7. Maintain at least 1 foot (0.30 meter) of water between the substrate and the bottom of the float at extreme low tide.
8. Conduct in-water work when managed species and prey species are least likely to be impacted.
9. To the extent practicable, avoid the use of treated wood timbers or pilings. If practicable, use alternative materials such as untreated wood, concrete, or steel.
10. Mitigate for unavoidable impacts to benthic habitats. Mitigation should be adequate, monitored, and adaptively managed.

G.4.7 Flood Control/Shoreline Protection

Protecting riverine and estuarine communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. The use of dikes and berms can also have long-term adverse effects on tidal marsh and estuarine habitats. Tidal marshes are highly variable, but typically have freshwater vegetation at the landward side, saltwater vegetation at the seaward side, and gradients of species inbetween that are in equilibrium with the prevailing climatic, hydrographic, geological, and biological features of the coast. These systems normally drain through highly dendritic tidal creeks that empty into the bay or estuary. Freshwater entering along the upper edges of the marsh drains across the surface and enters the tidal creeks. Structures placed for coastal shoreline protection include, but are not limited to, concrete or wood seawalls, rip-rap revetments (sloping piles of rock placed against the toe of the dune or bluff in danger of erosion from wave action), dynamic cobble revetments (natural cobble placed on an eroding beach to dissipate wave energy and prevent sand loss), vegetative plantings, and sandbags.

G.4.7.1 Potential Adverse Impacts

Dikes, levees, ditches, or other water controls at the upper end of a tidal marsh can cut off all tributaries feeding the marsh, preventing freshwater flushing and annual flushing, annual renewal of sediments and nutrients, and the formation of new marshes. Water controls within the marsh proper intercept and carry away freshwater drainage, block freshwater from flowing across seaward portions of the marsh, increase the speed of runoff of freshwater to the bay or estuary, lower the water table, permit saltwater intrusion into the marsh proper, and create migration barriers for aquatic species. In deeper channels where reducing conditions prevail, large quantities of hydrogen sulfide are produced. These quantities are toxic to marsh grasses and other aquatic life. Acid conditions of these channels can also result in release of heavy metals from the sediments.

Long-term effects on the tidal marsh include land subsidence (sometimes even submergence), soil compaction, conversion to terrestrial vegetation, greatly reduced invertebrate populations, and general loss of productive wetland characteristics. Loss of these low-salinity environments reduces estuarine fertility, restricts suitable habitat for aquatic species, and creates abnormally high salinity during drought years. Low-salinity environments form a barrier that prevents the entrance of many marine species, including competitors, predators, parasites, and pathogens.

Armoring of shorelines to prevent erosion and to maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of numerous species (Williams and Thom 2001). Hydraulic effects on the shoreline include increased energy seaward of the armoring, reflected wave energy, dry beach narrowing, substrate coarsening, beach steepening, changes in sediment storage capacity, loss of organic debris, and downdrift sediment starvation (Williams and Thom 2001). Installation of breakwaters and jetties can result in community changes from burial or removal of resident biota, changes in cover and preferred prey species, and predator attraction (Williams and Thom 2001). As with armoring, breakwaters and jetties modify hydrology and nearshore sediment transport, as well as movement of larval forms of many species (Williams and Thom 2001).

G.4.7.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Minimize the loss of riparian habitats as much as possible.
2 Do not undertake diking and draining of tidal marshlands and estuaries.
3. Wherever possible, use soft approaches (such as beach nourishment, vegetative plantings, and placement of LWD) to shoreline modifications.
4. Include efforts to preserve and enhance EFH by providing new gravel for spawning areas, removing barriers to natural fish passage, and using weirs, grade control structures, and low-flow channels to provide the proper depth and velocity for fish.
5. Construct a low-flow channel to facilitate fish passage and help maintain water temperature in reaches where water velocities require armoring of the riverbed.
6. Offset unavoidable impacts to in-stream fish habitat by providing rootwads, deflector logs, boulders, and rock weirs and by planting shaded riverine aquatic cover vegetation.
7. Use an adaptive management plan with ecological indicators to oversee monitoring and to ensure that mitigation objectives are met. Take corrective action as needed.

G.4.8 Log Transfer Facilities/In-water Log Storage

Rivers, estuaries, and bays were historically the primary ways to transport and store logs in the Pacific Northwest. Log storage within the bays and estuaries remains an issue in several Pacific Northwest bays. Using estuaries and bays and nearby uplands for storage of logs is common in Alaska, with most LTFs found in Southeast Alaska and a few located in Prince William Sound.

G.4.8.1 Potential Adverse Impacts

Log handling and storage in the estuary and intertidal zones of rivers can result in modification of benthic habitat and water quality degradation within the area of bark deposition (Levings and Northcote 2004). A log transfer facility (LTF) is a facility that is wholly or partly constructed in waters of the U.S. and that is used to transfer commercially harvested logs to or from a vessel or log raft, including the formation of a log raft (EPA 2000). LTFs may include a crane, A-frame structure, conveyor, or a slide or ramp to move logs into the water. Logs can also be placed in the water at the site by helicopters and barges. The physical adverse impacts from these structures are similar in many ways to those of floating docks and other over-water structures (Section G.4.6).

EFH may also be physically impacted by activities associated with LTFs. Bark and wood debris may accumulate as a result of the abrasion of log surfaces from transfer equipment and impact EFH. After the logs have entered the water, they usually are bundled into rafts and hooked to a tug for shipment. In the process, bark and other wood debris can pile up on the ocean floor. The piles can smother clams, mussels, some seaweed, kelp, and grasses, with the bark sometimes remaining for decades. Accumulation of bark debris in shallow and deep-water environments has resulted in locally decreased epifaunal macrobenthos richness and abundance (Kirkpatrick et al. 1998, Jackson 1986).

Log storage may also result in a release of soluble organic compounds within the bark pile. Log bark may affect groundfish habitat by significantly increasing oxygen demand within the area of accumulation (Pacific Northwest Pollution Control Council 1971). High oxygen demand can lead to an anaerobic zone within the bark pile where toxic sulfide compounds are generated, particularly in brackish and marine waters. Reduced oxygen levels, anaerobic conditions, and the presence of toxic sulfide compounds can result in reduced localized habitat value for groundfish species and their forage base. In addition, soils at onshore facilities where logs are decked can become contaminated with gasoline, diesel fuel, solvents, etc., from trucks and heavy equipment. These contaminants could leach into nearshore EFH.

The physical, chemical, and biological impacts of LTF operations can be substantially reduced by adherence to appropriate siting and operational constraints. In 1985, the Alaska Timber Task Force (ATTF) developed guidelines to “delineate the physical requirements necessary to construct a log transfer and associated facilities, and in context with requirements of applicable law and regulations, methods to avoid or control potential impacts from these facilities on water quality, aquatic and other resources.” Since 1985, the ATTF guidelines have been applied to new LTFs through the requirements of National Pollutant Discharge Elimination System (NPDES) permits and other state and federal programs (EPA 1996). Adherence to the ATTF operational and siting guidelines and BMPs in the NPDES General Permit will reduce (1) the amount of bark and wood debris that enters the marine and coastal environment, (2) the potential for displacement or harm to aquatic species, and (3) the accumulation of bark and wood debris on the ocean floor. The following conservation measures reflect those guidelines.

G.4.8.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Restrict or eliminate storage and handling of logs from waters where state and federal water quality standards cannot be met at all times outside of the authorized zone of deposition.
2. Minimize potential impacts of log storage by employing effective bark and wood debris control, collection, and disposal methods at log dumps, raft building areas, and mill-side handling zones; avoiding free-fall dumping of logs; using easy let-down devices for placing logs in the water; and bundling logs before water storage (bundles should not be broken except on land and at millside).
3. Do not store logs in the water if they will ground at any time or shade sensitive aquatic vegetation such as eelgrass.
4. Avoid siting log-storage areas and LTFs in sensitive habitat and areas important for specified species, as required by the ATTF guidelines.
5. Site log storage areas and LTFs in areas with good currents and tidal exchanges.
6. Use land-based storage sites where possible, with the goal of eliminating in-water storage of logs.

7. Also see the following link for LTF guidelines: http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_G.PDF.

G.4.9 Utility Line/Cables/Pipeline Installation

With the continued development of coastal regions comes greater demand for the installation of cables, utility lines for power and other services, and pipelines for water, sewage, etc. The installation of pipelines, utility lines, and cables can have direct and indirect impacts on the offshore, nearshore, estuarine, wetland, beach, and rocky shore coastal zone habitats. Many of the primary and direct impacts occur during the construction phase of installation, such as ground disturbance in the clearing of the right-of-way, access roads, and equipment staging areas. Indirect impacts can include increased turbidity, saltwater intrusion, accelerated erosion, and introduction of urban and industrial pollutants.

G.4.9.1 Potential Adverse Impacts

Adverse effects on EFH from the installation of pipelines, utility lines, and cables can occur through (1) destruction of organisms and habitat, (2) turbidity impacts, (3) resuspension of contaminants, and (4) changes in hydrology.

Destruction of organisms and habitats can occur in pipeline or cable right of way. This destruction can lead to long-term or permanent damage depending on the degree and type of habitat disturbance and the mitigation measures employed. Shallow-water environments, rocky reefs, nearshore and offshore rises, salt and freshwater marshes (wetlands), and estuaries are more likely to be adversely impacted than open-water habitats. This is due to their higher sustained biomass and lower water volumes, which decrease their ability to dilute and disperse suspended sediments (Gowen 1978).

Because vegetated coastal wetlands provide forage for and protection of commercially important invertebrates and fish, marsh degradation due to plant mortality, soil erosion, or submergence will eventually decrease productivity. Vegetation loss and reduced soil elevation within pipeline construction corridors should be expected with the continued use of current double-ditching techniques (Polasek 1997).

Increased water turbidity from higher than normal sediment loading can result in decreased primary production. Depending on the time of year of the construction, adverse impacts can occur, such as during highly productive spring phytoplankton blooms or times when organisms are already under stressed conditions. Changes in turbidity can temporarily alter phytoplankton communities. Depending upon the severity of the turbidity, these changes in water clarity can affect the EFH habitat functions of species higher in the food chain.

Another impact is resuspension of contaminants such as heavy metals and pesticides from the sediment, which can have lethal effects (Gowen 1978). Spills of petroleum products, solvents, and other construction-related material can also adversely affect habitat.

Pipeline canals have the potential to change the hydrology of coastal areas by (1) facilitating rapid drainage of interior marshes during low tides or low precipitation, (2) reducing or interrupting freshwater inflow and associated littoral sediments, and (3) allowing saltwater to move farther inland during periods of high tides (Chabreck 1972). Saltwater intrusion into freshwater marshes often causes loss of salt-intolerant emergent and submerged aquatic plants (Chabreck 1972, Pezeshki 1987), erosion, and net loss of soil organic matter (Craig et al. 1979).

G.4.9.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Align crossings along the least environmentally damaging route. Avoid sensitive habitats such as hard-bottom (e.g., rocky reefs), cold-water corals, submerged aquatic vegetation, oyster reefs, emergent marsh, and mud flats. If impacts remain after all appropriate and practicable avoidance and minimization has been achieved, consider compensatory mitigation.
2. Use horizontal directional drilling where cables or pipelines would cross anadromous fish streams, salt marsh, vegetated inter-tidal zones, or steep erodible bluff areas adjacent to the inter-tidal zone to avoid surface disturbances.
3. Avoid construction of permanent access channels since they disrupt natural drainage patterns and destroy wetlands through excavation, filling, and bank erosion.
4. Store and contain excavated material on uplands. If storage in wetlands or waters cannot be avoided, use alternate stockpiles to allow continuation of sheet flow. Store stockpiled materials on construction cloth rather than bare marsh surfaces, sea grasses, or reefs.
5. Backfill excavated wetlands with either the same or comparable material capable of supporting similar wetland vegetation. Restore original marsh elevations. Stockpile topsoil and organic surface material such as root mats separately, and return it to the surface of the restored site. Use adequate material so that the proper preproject elevation is attained following settling and compaction of the material. If excavated materials are insufficient to accomplish this, use similar particle-size material to restore the trench to the required elevation. After backfilling, implement erosion protection measures where needed.
6. Use existing rights-of-way whenever possible to lessen overall encroachment and disturbance of wetlands.
7. Bury pipelines and submerged cables where possible. Unburied pipelines, or pipelines buried in areas where scouring or wave activity eventually exposes them, run a much greater risk of damage leading to leaks or spills.
8. Remove inactive pipelines and submerged cables unless they are located in sensitive areas (e.g., marsh, reefs, sea grass, etc.) or in areas that present no safety hazard. If allowed to remain in place, ensure that pipelines are properly pigged, purged, filled with seawater, and capped before abandonment in place.
9. Use silt curtains or other type barriers to reduce turbidity and sedimentation whenever possible near the project site.
10. Limit access for equipment to the immediate project area. Tracked vehicles are preferred over wheeled vehicles. Consider using mats and boards to avoid sensitive areas. Caution equipment operators to avoid sensitive areas. Clearly mark sensitive areas to ensure that equipment operators do not traverse them.
11. Limit construction equipment to the minimum size necessary to complete the work. Use shallow-draft equipment to minimize effects and to eliminate the necessity for temporary access channels. Minimize the size of the pipeline trench proper. Use the push-ditch method, in which the trench is immediately backfilled. This reduces the impact duration, and it should, therefore, be used when possible.
12. Conduct construction during the time of year when it will have the least impact on sensitive habitats and species.
13. Suspend transmission lines beneath existing bridges or conduct directional boring under streams to reduce the environmental impact. If transmission lines span streams, site towers at least 200 feet from streams.

14. For activities on the Continental Shelf, shunt drill cuttings through a conduit and either discharge the cuttings near the sea floor, or transport them ashore.
15. For activities on the Continental Shelf, to the extent practicable, locate drilling and production structures, including pipelines, at least 1 mile (1.6 kilometers) from the base of a hard-bottom habitat.
16. For activities on the Continental Shelf, to avoid and minimize adverse impacts to managed species, implement the following to the extent practicable:
    a) Bury pipelines at least 3 feet (0.9 meter) beneath the sea floor, whenever possible. Particular considerations (i.e., currents, ice scour) may require deeper burial or weighting to maintain adequate cover. Buried pipeline and cables should be examined periodically for maintenance of adequate earthen cover.
    b) Where burial is not possible, such as in hard-bottomed areas, attach pipelines and cables to substrate to minimize conflicts with fishing gear. Wherever possible, mark the route by using lighted buoys and/or lighted ranges on platforms to reduce the risk of damage to fishing gear and the pipelines.
    c) Locate alignments along routes that will minimize damage to marine and estuarine habitat. Avoid laying cable over high-relief bottom habitat and across live bottom habitats such as coral and sponge. If coral or sponge habitats are encountered, NMFS is interested in position and description information.
    d) Where user conflicts are likely, consult and coordinate with fishing stakeholder groups during the route-planning process to minimize conflict.

G.4.10 Commercial Utilization of Habitat

Productive embayments are often used for commercial culturing and harvesting operations. These locations provide protected waters which serve as sites for oyster and mussel culturing. These operations may occur in areas of productive eelgrass beds. In 1988, Alaska passed the Alaska Aquatic Farming Act which is designed to encourage establishment and growth of an aquatic farming industry in the state. The Act establishes four criteria for issuance of an aquatic farm permit, including the requirement that the farm may not significantly affect fisheries, wildlife, or other habitats in an adverse manner. Aquatic farm permits are issued by the Alaska Department of Natural Resources.

G.4.10.1 Potential Adverse Impacts

Adverse impacts to EFH by operations that directly or indirectly use habitat include (1) discharge of organic waste, (2) shading and direct impacts to the seafloor, (3) risk of introducing undesirable species, and (4) impacts on estuarine food webs.

Intensive shellfish mariculture can result in the buildup of organic solid waste in the vicinity of the farm in higher concentrations than would occur naturally. The buildup of organic materials on the sea floor can impact the composition and diversity of the bottom-dwelling community (e.g., prey organisms for fish). Growth of submerged aquatic vegetation, which can provide shelter and nursery habitat for a number of fish species and their prey, can be inhibited by shading effects or, in extreme cases, can be smothered by organic debris. Disruption of eelgrass habitat by management activities (e.g., dumping of shell with spawn on eelgrass beds, damage to eelgrass due to subsequent water or wind shear against the sharp oyster shells, repeated mechanical raking or trampling, and impacts from predator exclusion netting) is also of concern, though few studies have documented impacts. Hydraulic dredges used to harvest oysters in coastal bays with eelgrass habitat can cause long-term adverse impacts to eelgrass beds by reducing or eliminating the beds (Phillips 1984).

The rearing of non-native, ecologically undesirable species may pose a risk of escape or accidental release into areas where they would adversely affect the ecological balance. Escape or other release into the environment can result in competition with native, wild species for food, mates, and spawning sites, which, if followed by successful interbreeding with wild stocks, can result in genetic dilution.

Concern has also been expressed about extensive shellfish culture in estuaries and its impact on estuarine food webs. Oysters are efficient filter feeders and can change the trophic structure by removal of the microalgae and zooplankton that are also the food source for salmon prey species. The extent of this effect, if any, is unknown, especially in light of the fact that native oysters were once present in large quantities and coexisted with other species. Furthermore, because bivalves remove suspended sediments and phytoplankton from the water column, mariculture may actually improve water quality in eutrophic areas and can assist in recycling nutrients from water column to the sediment (Emmett 2002).

Kelp is harvested for several reasons, which include directly obtaining its byproducts and as a substrate in the Pacific herring fishery. Harvesting can have a variety of possible impacts on the habitat functions provided by kelp canopies. For example, kelp provides refuge to prey resources used by some fish species. The kelp canopy also serves as habitat for canopy-dwelling invertebrates and can enhance fish recruitment and abundance. Removal of the canopy may affect some species by potentially displacing young-of-the-year or juvenile rockfishes, for example (Miller and Geibel 1973).

G.4.10.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Site mariculture operations away from exisiting kelp or eelgrass beds. If mariculture operations are to be located adjacent to existing kelp or eelgrass beds, monitor these beds on an annual basis and resite the mariculture facility if monitoring reveals adverse effects.
2. Do not enclose or impound tidally influenced wetlands for mariculture. Take into account the size of the facility, migratory patterns, competing uses, hydrographic conditions, and upstream uses when siting facilities.
3. Undertake a thorough scientific review and risk assessment before any non-native species are introduced.
4. Encourage development of harvesting methods to minimize impacts on plant communities and the loss of food and/or habitat to fish populations during harvesting operations.
5. Provide appropriate mitigation for the unavoidable, extensive, or permanent loss of plant communities.

G.5 COASTAL/MARINE ACTIVITIES

G.5.1 Point-source Discharges

Point-source discharges from municipal sewage treatment facilities or storm water discharges are controlled through EPA's regulations under the CWA and by state water regulations. The primary concerns associated with municipal point-source discharges involve treatment levels needed to attain acceptable nutrient inputs and overloading of treatment systems due to rapid development of the coastal zone. Storm drains are contaminated from communities using settling and storage ponds, street runoff, harbor activities, and honey buckets. Annually, wastewater facilities introduce large volumes of untreated excrement and chlorine through sewage outfall lines, as well as releasing treated freshwater into the nation's waters. This can significantly alter pH levels of marine waters (Council 1999).

G.5.1.1 Potential Adverse Impacts

There are many potential impacts from point-source discharge, but point-source discharges and resulting altered water quality in aquatic environments do not necessarily result in adverse impacts, either to marine resources or EFH. Because most point-source discharges are regulated by the state or EPA, effects to receiving waters are generally considered on a case-by-case basis. Point-source discharges can adversely affect EFH by (1) reducing habitat functions necessary for growth to maturity, (2) modifying community structure, (3) bioaccumulation, and (4) modifying habitat.

At certain concentrations, point-source discharges can alter the following properties of ecosystems and associated communities: diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity, and species richness and evenness. Pollution effects may be related to changes in water flow, pH, hardness, dissolved oxygen, and other parameters that affect individuals, populations, and communities. Sewage, fertilizers, and de-icing chemicals (e.g., glycols, urea) are examples of common urban pollutants that decompose with high biological or chemical oxygen demand (Council 1999).

Point-source discharges, at certain concentrations, can alter the following characteristics of finfish, shellfish, and related organisms: growth, visual acuity, swimming speed, equilibrium, feeding rate, response time to stimuli, predation rate, photosynthetic rate, spawning seasons, migration routes, and resistance to disease and parasites. Additionally, zones of low dissolved oxygen resulting from their decomposition can retard growth of salmon eggs, larvae, and juveniles and may delay or block smolt and adult migration. Sewage and fertilizers also introduce nutrients that drive algal and bacterial blooms into urban drainages. Such blooms may smother incubating salmon or produce toxins as they grow and die. Thermal effluents from industrial sites and removal of riparian vegetation from streambanks can degrade salmon habitat by allowing solar warming of water. Heavy metals, petroleum hydrocarbons, chlorinated hydrocarbons, and other chemical wastes can be toxic to salmonids and their food, and they can inhibit salmon movement and habitat use in streams (Council 1999).

Elevated salinity levels from desalination plants also have to be considered. While studies have shown that elevated salinity levels may not produce toxic effects (Bay and Greenstein 1994), peripheral effects of pollution may include forcing rearing fish into areas of high predation. Conversely, an influx of treated freshwater from municipal wastewater plants may force rearing fish into habitat with less than optimal salinity for growth (Council 1999).

Point discharges may affect the growth, survival, and condition of managed species and prey species if high levels of contaminants (e.g., chlorinated hydrocarbons, trace metals, PAHs, pesticides, and herbicides) are discharged. If contaminants are present, they may be absorbed across the gills or concentrated through bioaccumulation as contaminated prey is consumed (Raco-Rands 1996). Many heavy metals and persistent organic compounds such as pesticides and polychlorinated biphenyls tend to adhere to solid particles discharged from outfalls. As the particles are deposited, these compounds or their degradation products (which may be equally or more toxic than the parent compounds) can enter the foodchain by bioaccumulating in benthic organisms at much higher concentrations than in the surrounding waters (Stein et al. 1995). Due to burrowing, diffusion, and other upward transport mechanisms that move buried contaminants to the surface layers and eventually to the water column, pelagic and nektonic biota may also be exposed to contaminated sediments through mobilization into the water column.

Discharge sites may also modify habitat by creating adverse impacts to sensitive areas such as freshwater shorelines and wetlands, emergent marshes, sea grasses, and kelp beds if located improperly. Extreme discharge velocities of effluent may also cause scouring at the discharge point, as well as entraining particulates and thereby creating turbidity plumes. These turbidity plumes of suspended particulates can reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area while elevated turbidity persists. The contents of the suspended material can react with the dissolved oxygen in the water and result in oxygen depletion, or smother submerged aquatic vegetation sites including eelgrass beds and kelp beds. Accumulation of outfall sediments may also alter the composition and abundance of infaunal or epibenthic invertebrate communities (Ferraro et al. 1991). Pollutants, either suspended in the water column (e.g., nitrogen, contaminants, fine sediments) or settled on the bottom, can affect habitat. Many benthic organisms are quite sensitive to grain size, and accumulation of sediments can also submerge food organisms (Section G.4.2.2).

G.5.1.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Locate discharge points in coastal waters well away from shellfish beds, sea grass beds, coral reefs, and other similar fragile and productive habitats.
2. Reduce potentially high velocities by diffusing effluent to acceptable velocities.
3. Determine benthic productivity by sampling before any construction activity related to installation of new or modified facilities. Develop outfall design (e.g., modeling concentrations within the predicted plume or likely extent of deposition along a productive nearshore) with input from appropriate resource and Tribal agencies.
4. Provide for mitigation when degradation or loss of habitat occurs from placement and operation of the outfall structure and pipeline.
5. Institute source-control programs that effectively reduce noxious materials to avoid introducing these materials into the waste stream.
6. Ensure compliance with pollutant discharges regulated through discharge permits which set effluent discharge limitations and/or specify operation procedures, performance standards, or BMPs. These efforts rely on the implementation of BMPs to control polluted runoff (EPA 1993).
7. Treat discharges to the maximum extent practicable, including implementation of up-to-date methodologies for reducing discharges of biocides (e.g., chlorine) and other toxic substances.
8. Use land-treatment and upland disposal/storage techniques where possible. Limit the use of vegetated wetlands as natural filters and pollutant assimilators for large-scale discharges to those instances where other less damaging alternatives are not available, and the overall environmental and ecological suitability of such actions has been demonstrated.
9. Avoid siting pipelines and treatment facilities in wetlands and streams. Since pipelines and treatment facilities are not water-dependent with regard to positioning, it is not essential that they be placed in wetlands or other fragile coastal habitats. Avoiding placement of pipelines within streambeds and wetlands will also reduce inadvertent infiltration into conveyance systems and retain natural hydrology of local streams and wetlands.

G.5.2 Fish Processing Waste—Shoreside and Vessel Operation

Seafood processing facilities are either shore-based facilities discharging through stationary outfalls or mobile vessels engaged in the processing of fresh or frozen seafood (Science Applications International Corporation 2001). Discharge of fish waste from shoreside and vessel processing has occurred in marine waters since the 1800s (Council 1999). With the exception of fresh market fish, some form of processing involving butchering, evisceration, precooking, or cooking is necessary to bring the catch to market. Precooking or blanching facilitates the removal of skin, bone, shell, gills, and other materials. Depending on the species, the cleaning operation may be manual, mechanical, or a combination of both (EPA 1974). Seafood processing facilities generally consist of mechanisms to offload the harvest from fishing boats; tanks to hold the seafood until the processing lines are ready to accept them; processing lines, process water, and waste collection systems; treatment and discharge facilities; processed seafood storage areas; and necessary support facilities such as electrical generators, boilers, retorts, water desalinators, offices, and living quarters. In addition, marinas that cater to patrons who fish a large amount can produce an equally large quantity of fish waste at the marina from fish cleaning.

G.5.2.1 Potential Adverse Impacts

Generally, seafood processing wastes consist of biodegradable materials that contain high concentrations of soluble organic material. Seafood processing operations have the potential to adversely affect EFH through (1) direct and/or nonpoint source discharge, (2) particle suspension, and (3) increased turbidity and surface plumes.

Seafood processing operations have the potential to adversely affect EFH through the direct and/or nonpoint source discharge of nutrients, chemicals, fish byproducts, and “stickwater” (water and entrained organics originating from the draining or pressing of steam-cooked fish products). EPA investigations show that impacts affecting water quality are direct functions of the receiving waters. In areas with strong currents and high tidal ranges, waste materials disperse rapidly. In areas of quieter waters, waste materials can accumulate and result in shell banks, sludge piles, dissolved oxygen depressions, and associated aesthetic problems (Stewart and Tangarone 1977). If adequate disposal facilities are not available at marinas that generate a large amount of fish waste, there is a potential for disposal of fish waste in areas without enough flushing to prevent decomposition and the resulting dissolved oxygen depression (EPA 1993).

Processors discharging fish waste are required to have EPA-issued NPDES permits. Various water quality standards, including those for BOD, total suspended solids, fecal coliform bacteria, oil and grease, pH, and temperature, are all considerations in the issuance of such permits. Although fish waste, including heads, viscera, and bones, is biodegradable, fish parts that are ground to fine particles may remain suspended for some time, thereby overburdening habitats from particle suspension (Council 1999). Such pollutants have the potential to adversely impact EFH. The wide differences in habitats, types of processors, and seafood processing methods define those impacts and can also prevent the effective use of technology-based effluent limits.

In Alaska, seafood processors are allowed to deposit fish parts in a zone of deposit (ZOD) (EPA 2001). This can alter benthic habitat, reduce locally associated invertebrate populations, and lower dissolved oxygen levels in overlying waters. Impacts from accumulated processing wastes are not limited to the area covered by the ZOD. Severe anoxic and reducing conditions occur adjacent to effluent piles (EPA 1979). Examples of localized damage to benthic environment include several acres of bottomdriven anoxic by piles of decomposing waste up to 26 feet (7.9 meters) deep. Juvenile and adult stages of flatfish are drawn to these areas for food sources. One effect of this attraction may lead to increased predation on juvenile fish species by other flatfishes, diving seabirds, and marine mammals drawn to the food source (Council 1999). However, due to the difficulty in monitoring these areas, impacts to species can go undetected.

Scum and foam from seafood waste deposits can also occur on the water surface and/or increase turbidity. Increased turbidity decreases light penetration into the water column, reducing primary production. Reduced primary production decreases the amount of food available for consumption by higher trophic level organisms. In addition, stickwater takes the form of a fine gel or slime that can concentrate on surface waters and move onshore to cover intertidal areas.

G.5.2.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the maximum extent practicable, base effluent limitations on site-specific water quality concerns.
2. To the maximum extent practicable, avoid the practice of discharging untreated solid and liquid waste directly into the environment. Encourage the use of secondary or wastewater treatment systems where possible.
3. Do not allow designation of new ZODs. Explore options to eliminate or reduce ZODs at existing facilities.
4. Control stickwater by physical or chemical methods.
5. Promote sound fish waste management through a combination of fish-cleaning restrictions, public education, and proper disposal of fish waste.
6. Encourage the alternative use of fish processing wastes (e.g., fertilizer for agriculture and animal feed).
7. Explore options for additional research. Some improvements in waste processing have occurred, but the technology-based effluent guidelines have not changed in 20 years.
8. Locate new plants outside rearing and nursery habitat. Monitor both biological and chemical changes to the site.

G.5.3 Water Intake Structures/Discharge Plumes

The withdrawal of riverine, estuarine, and marine waters by water intake structures is a common aquatic activity. Water may be withdrawn and used, for example, to cool power-generating stations and create temporary ice roads and ice ponds. In the case of power plants, the subsequent discharge of heated and/or chemically treated discharge water can also occur.

G.5.3.1 Potential Adverse Impacts

Water intake structures and effluent discharges can interfere with or disrupt EFH functions in the source or receiving waters by (1) entrainment, (2) impingement, (3) discharge, (4) operation and maintenance, and (5) construction-related impacts.

Entrainment is the withdrawal of aquatic organisms along with the cooling water into the cooling system. These organisms are usually the egg and larval stages of managed species and their prey. Entrainment can subject these life stages to adverse conditions resulting from the effects of increased heat, antifouling chemicals, physical abrasion, rapid pressure changes, and other detrimental effects. Consequently, diverting water without adequate screening prevents that portion of EFH from providing important habitat functions necessary for the early life stages of managed living marine resources and their prey. Long-term water withdrawal may adversely affect fish and shellfish populations by adding another source of mortality to the early life stage, which often determines recruitment and year-class strength (Travnichek et al. 1993).

Impingement occurs when organisms that are too large to pass through in-plant screening devices become stuck against the screening device or remain in the forebay sections of the system until they are removed by other means (Grimes 1975, Hanson et al. 1977, Helvey and Dorn 1987, Helvey 1985, Langford et al. 1978, Moazzam and Rizvi 1980). The organisms cannot escape due to the water flow that either pushes them against the screen or prevents them from exiting the intake tunnel. Similar to entrainment, the withdrawal of water can trap particular species, especially when visual acuity is reduced (Helvey 1985).

This condition reduces the ability of the source waters to provide normal EFH functions necessary for subadult and adult life stages of managed living marine resources and their prey.

Thermal effluents in inshore habitat can cause severe problems by directly altering the benthic community or killing marine organisms, especially larval fish. Temperature influences biochemical processes of the environment and the behavior (e.g., migration) and physiology (e.g., metabolism) of marine organisms (Blaxter 1969). Further, the proper functioning of sensitive areas may be affected by the action of intakes as selective predators, resulting in cascading negative consequences as observed by the overexploitation of local fish populations in coral-reef fish communities (Carr et al. 2002).

Other impacts to aquatic habitats can result from construction-related activities (e.g., dewatering, dredging, etc.) (Section G.4.1), as well as routine operation and maintenance activities. A broad range of impacts associated with these activities depend on the specific design and needs of the system. For example, dredging activities can cause turbidity, degraded water quality, noise, and substrate alterations. Many of these impacts can be reduced or eliminated through the use of various techniques, procedures, or technologies, but some may not be fully eliminated except by eliminating the activity itself.

Power plants may use once-through cooling biocides, such as sodium hypochlorite and sodium bisulfate, periodically to clean the intake and discharge structures. Chlorine is extremely toxic to aquatic life.

G.5.3.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Locate facilities that rely on surface waters for cooling in areas other than estuaries, inlets, heads of submarine canyons, rock reefs, or small coastal embayments where managed species or their prey concentrate. Locate discharge points in areas with low concentrations of living marine resources. Incorporate cooling towers at discharge points to control temperature, and use enough safeguards to ensure against release of blow-down pollutants into the aquatic environment in concentrations that reduce the quality of EFH.
2. Design intake structures to minimize entrainment or impingement. Use velocity caps that produce horizontal intake/discharge currents and ensure that intake velocities across the intake screen do not exceed 0.5 foot (0.15 meter) per second.
3. Design power plant cooling structures to meet the best technology available requirements as developed pursuant to Section 316(b) of the CWA. Use alternative cooling strategies, such as closed cooling systems (e.g., dry cooling), to completely avoid entrainment or impingement impacts in all industries that require cooling water. When alternative cooling strategies are not feasible, other BTAs may include, but are not limited to, fish diversion or avoidance systems, fish return systems that convey organisms away from the intake, mechanical screen systems that prevent organisms from entering the intake system, and habitat restoration measures.
4. Regulate discharge temperatures (both heated and cooled effluent) so they do not appreciably alter the temperature to an extent that could cause a change in species assemblages and ecosystem function in the receiving waters. Implement strategies to diffuse the heated effluent.
5. Avoid the use of biocides (e.g., chlorine) to prevent fouling where possible. Implement the least damaging antifouling alternatives.
6. Mitigate for impacts related to power plants and other industries requiring cooling water. Ensure that mitigation compensates for the net loss of EFH habitat functions from placement and operation of the intake and discharge structures. Provide mitigation for the loss of habitat from placement of the intake structure and delivery pipeline, the loss of fish larvae and eggs that may be entrained by large

intake systems, and the degradation or loss of habitat from placement of the outfall structure and pipeline, as well as the treated water plume.
7. Treat all discharge water from outfall structures to meet state water quality standards at the terminus of the pipe. Ensure that pipes extend a substantial distance offshore and are buried deep enough not to affect shoreline processes. Set buildings and associated structures far enough back from the shoreline to preclude the need for bank armoring.

G.5.4 Oil/Gas Exploration/Development/Production

Offshore exploration, development, and production of natural gas and oil reserves have been, and continue to be, an important aspect of the U.S. economy. As demand for energy resources grows, the debate over trying to balance the development of oil and gas resources and the protection of the environment will also continue. Projections indicate that U.S. demand for oil will increase by 1.3 percent per year between 1995 and 2020. Gas consumption is projected to increase by an average of 1.6 percent during the same time frame (Waisley 1998). Much of the 1.9 billion acres within the offshore jurisdiction of the U.S. remains unexplored (Oil and Gas Technologies for the Arctic and Deepwater 1985). Some of the older oil and gas platforms in operation will probably reach the end of their productive life in the near future, and decommissioning them is also an issue.

G.5.4.1 Potential Adverse Impacts

Offshore oil and gas operations can be classified into exploration, development, and production activities (which includes transportation). These activities occur at different depths in a variety of habitats. These areas are subject to an assortment of physical, chemical, and biological disturbances, including the following (Council 1999, Helvey 2002):

- Noise from seismic surveys, vessel traffic, and construction of drilling platforms or islands
- Physical alterations to habitat from the construction, presence, and eventual decommissioning and removal of facilities such as islands or platforms, storage and production facilities, and pipelines to onshore common carrier pipelines, storage facilities, or refineries
- Waste discharges, including well drilling fluids, produced waters, surface runoff and deck drainage, domestic waste waters generated from the offshore facility, solid waste from wells (drilling muds and cuttings), and other trash and debris from human activities associated with the facility
- Oil spills
- Platform storage and pipeline decommissioning

Not all of the potential disturbances in this list apply to every type of activity.

Noise generates sound pressure that may disrupt or damage marine life. Oil and gas activities may generate noise from drilling activities, construction, production facility operations, seismic exploration, and supply vessel and barge movements. Research suggests that the noise from seismic surveys associated with oil exploration may cause fish to move away from the acoustic pulse and display an alarm response (McCauley et. al. 2000). This affects both fish distribution and catch rates (Engas et. al 1996). However, while there are few disagreements that noise from seismic surveys affects the behavior of fish, there are differences of opinion regarding the magnitude of those effects (McCauley et. al 2003, Gausland 2003, Wardle 2001).

Activities such as vessel anchoring, platform or artificial island construction, pipeline laying (Section G.4.9), dredging, and pipeline burial can change bottom habitat by altering substrates used for feeding or shelter. Disturbances to the associated epifaunal communities, which may provide feeding or predator escape habitat, may also result. Benthic organisms, especially prey species, may recolonize disturbed areas, but this may not occur if the substrate composition is drastically changed or if facilities are left in place after production ends. Dredging, trenching, and pipelaying generate spoils that may be disposed of on land or in the marine environment where sedimentation may smother benthic habitat and organisms. Most activities associated with oil and gas operations are, however, conducted under permits and regulations that require companies to minimize impacts or to avoid construction or other disturbances in sensitive marine habitats (Section G.4.2.2).

EPA and the state of Alaska issue permits for discharge of drilling muds and cuttings to ensure the activities meet Alaska water quality standards. Potentially, the discharge of muds and cuttings from exploratory and construction activities may, change the sea floor and suspend fine-grained mineral particles in the water column. This may affect feeding, nursery, and shelter habitat for various life stages of managed species. Drilling muds and cuttings may adversely affect bottom-dwelling organisms at the site by covering immobile forms or forcing mobile forms to migrate. Suspended particulates may reduce light penetration and lower the rate of photosynthesis and the primary productivity of the aquatic area, especially if suspended for long intervals. High levels of suspended particulates may reduce feeding ability for groundfish and other fish species, leading to limited growth. The contents of the suspended material may react with the dissolved oxygen in the water and result in oxygen depletion. In addition, the discharge of oil drilling muds can change the chemical and physical characteristics of benthic sediments at the disposal site by introducing toxic chemical constituents. Changes in water clarity and the addition of contaminants may reduce or eliminate the suitability of water bodies as habitat for fish species and their prey (NMFS 1998, a, b).

Federal and state laws and regulations require numerous oil spill prevention and cleanup response measures. The industry takes the initiative to prevent oil spills and uses the most current BMPs and state-of-the-art technology in oil spill prevention and response. Spills from oil and gas development remain, a potential source of contamination to the marine environment. Offshore oil and gas development, in any given geographic area, may result in some amount of oil entering the environment. Most spills are small, although large spills sometimes occur. Many factors determine the degree of damage from a spill, including the type of oil, size and duration of the spill, its geographic location, and the season. Oil is toxic to all marine organisms at high concentrations, but certain species are more sensitive than others. In general, the early life stages (eggs and larvae) are most sensitive, juveniles are less sensitive, and adults are least sensitive (Rice et al. 2000).

Both large and small quantities of oil can affect habitats and living marine resources. In addition, oil spills may interrupt commercial or subsistence fishing activities. Accidental discharge of oil can occur during almost any stage of exploration, development, or production on the outer continental shelf (OCS) or in nearshore coastal areas. Sources include equipment malfunction, ship collisions, pipeline breaks, other human error, or severe storms. Support activities associated with product recovery and transportation may also contribute to oil spills. In addition to crude oil, chemical, diesel, and other contaminant spills, accidental discharge can also occur (Council 1999).

Chronic small oil spills are a potential problem because residual oil can build up in sediments and affect living marine resources. Low levels of petroleum components (e.g., PAHs) from such chronic pollution may accumulate in fish tissues and cause lethal and sublethal effects, particularly during embryonic development. Low-level chronic exposure alters embryonic development in fish, resulting in reductions in growth and subsequent marine survival (Carls et al. 1999, Heintz et al. 1999, 2000).

A major oil spill (e.g., 50,000 barrels) can produce a surface slick covering several hundred square kilometers. If the oil spill moves toward land, habitats and species could be affected by oil reaching the near-shore environment. Immediately after a large spill, aromatic hydrocarbons would be toxic to some organisms. Waters beneath and surrounding the surface slick would be oil-contaminated. Physical and biological forces act to reduce oil concentrations with depth and distance (Council 1999); generally the lighter-fraction aromatic hydrocarbons evaporate rapidly, particularly during high winds and wave activity. Heavier oil fractions may settle through the water column. Suspended sediment can adsorb and carry oil to the seabed. Hydrocarbons may be solubilized by wave action, which may enhance adsorption to sediments. The sediments then sink to the seabed, contaminating benthic sediments.

Carls et al. (2003) demonstrated that tides and the resultant hydraulic gradients move groundwater containing soluble and slightly soluble contaminants (such as oil) from beaches surrounding streams into the hyporheic zone (the region beneath and next to streams where surface and groundwater mix) where pink salmon eggs incubate. Oil reaching nearshore areas will affect productive nursery grounds or areas containing high densities of fish eggs and larvae. An oil spill near an especially important habitat (e.g., a gyre where fish or invertebrate larvae are concentrated) could cause a disproportionately high loss of a population of marine organisms. Other aquatic biota at risk would be eggs, larvae, and planktonic organisms in the upper seawater column. Because they are small, they absorb contaminants quickly. They are also at risk because they cannot actively avoid exposure. Their proximity to the seasurface may make them vulnerable to photo-enhanced toxicity effects, which can multiply the toxicity of hydrocarbons (Barron et al. 2003). Population reductions due to delayed and indirect effects of PAH in tidal sediments postponed recovery among some species for more than a decade following the *Exxon Valdez* oil spill (Peterson et al. 2003).

Habitats that are susceptible to damage from oil spills include not just the low-energy coastal bays and estuaries where oil may accumulate, but also high-energy cobble environments where wave action drives oil into sediments. Many of the beaches in Prince William Sound with the highest persistence of oil following the *Exxon Valdez* oil spill were high-energy environments containing large cobbles overlain with boulders. These beaches were pounded by storm waves that drove the oil into and well below the surface (Michel and Hayes 1999). Oil that mixes into bottom sediments may persist for years. Subsurface oil was still detected in beach sediments of Prince William Sound 12 years after the *Exxon Valdez* oil spill, much of it unweathered and more prevalent in the lower intertidal biotic zone than at higher tidal elevations (Short et al. 2002, 2004). The unknown impact of an oil-related event near and within ice is an added concern. Should oil become trapped in ice, it could affect habitat for months or years after the initial event. It could also move into a different region (Council 1999).

Oil and gas platforms may consist of a lattice-work of pilings, beams, and pipes that support diverse fish and invertebrate populations and are considered de facto artificial reefs (Love and Westphal 1990, Love et al. 1994, Love et al. 1999, Helvey 2002). Because decommissioning includes plugging and abandoning all wells and removing the platforms and associated structures from the ocean, impacts to EFH are possible during removal. The demolition phase may generate underwater sound pressure waves (Section G.4.5.2), impacting on marine organisms. Taking out these midwater structures may remove habitat for invertebrates and fish that associate with them. In some areas of the U.S., offshore oil and gas platforms are left in place after decommissioning, thereby providing permanent habitat for some organisms.

The potential disturbances and associated adverse impacts on the marine environment have been reduced through operating procedures required by regulatory agencies and, in many cases, self-imposed by facilities operators. Most of the activities associated with oil and gas operations are conducted under permits and regulations that require companies to minimize impacts or avoid construction in sensitive marine habitats. For example, the discharge of muds and cuttings is subject to EPA environmental standards, effluent limitations, and related requirements. New technological advances in operating procedures also reduce the potential for impacts.

G.5.4.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH:

1. As part of pre-project planning, identify all species of concern regulated under federal or state fishery management plans that inhabit, spawn, or migrate through areas slated for exploration, development, or production. Pay particular attention to critical life stages, and develop options that avoid and minimize adverse effects from any associated activities. Modify the project design, timing, or location and use adaptive management.
2. Avoid the discharge of produced waters into marine waters and estuaries. Reinject produced waters into the oil formation whenever possible.
3. Avoid discharge of muds and cuttings into the marine and estuarine environment. Use methods to grind and reinject such wastes down an approved injection well or use onshore disposal wherever possible. When not possible, provide for a monitoring plan to ensure that the discharge meets EPA effluent limitations and related requirements.
4. To the extent practicable, avoid the placement of fill to support construction of causeways or structures in the nearshore marine environment.
5. As required by federal and state regulatory agencies, encourage the use of geographic response strategies that identify EFH and environmentally sensitive areas. Identify appropriate cleanup methods and response equipment.
6. To the extent practicable, use methods to transport oil and gas that limit the need for handling in environmentally sensitive areas, including EFH.
7. Ensure that appropriate safeguards have been considered before drilling the first development well into the targeted hydrocarbon formations whenever critical life history stages of federally managed species are present.
8. Ensure that appropriate safeguards have been considered before drilling exploration wells into untested formations whenever critical life stages of federally managed species are present. If possible, avoid such work entirely during those time frames.
9. Oil and gas transportation and production facilities should be designed, constructed, and operated in accordance with applicable regulatory and engineering standards.
10. Evaluate impacts to EFH during the decommissioning phase of oil and gas facilities, including possible impacts during the demolition phase. Minimize such impacts to the extent practicable.

G.5.5 Habitat Restoration/Enhancement

Habitat loss and degradation are major, long-term threats to the sustainability of fishery resources (NMFS 2002). Viable coastal and estuarine habitats are important to maintaining healthy fish stocks. Good water quality and quantity, appropriate substrate, ample food sources, and substantial hiding places are needed to sustain fisheries. Restoration and/or enhancement of coastal and riverine habitat that supports managed fisheries and their prey will assist in sustaining and rebuilding fisheries stocks and recovering certain threatened or endangered species by increasing or improving ecological structure and functions. Habitat restoration/enhancement may include, but is not limited to, improvement of coastal wetland tidal exchange or reestablishment of historic hydrology, dam or berm removal, fish passage barrier removal/ modification, road-related sediment source reduction, natural or artificial reef/substrate/habitat creation, establishment or repair of riparian buffer zones, improvement of freshwater habitats that support anadromous fishes, planting of native coastal wetland and submerged aquatic vegetation, creation of oyster reefs, and improvements to feeding, shade or refuge, spawning, and rearing areas that are essential to fisheries.

G.5.5.1 Potential Adverse Impacts

The implementation of restoration/enhancement activities may have localized and temporary adverse impacts on EFH. Possible impacts can include (1) localized nonpoint source pollution such as influx of sediment or nutrients, (2) interference with spawning and migration periods, (3) temporary or permanent removal feeding opportunities, and (4) indirect effects from actual construction portions of the activity.

Unless proper precautions are taken, upland-related restoration projects can contribute to nonpoint source pollution. Such concerns should be addressed as part of the planning process (Section G.2.1). Particular in-water projects may interfere with spawning periods or impede migratory corridors and should be addressed accordingly. Projects may also have an affect on the feeding behavior of managed species. For instance, if dredging is involved, benthic food resources may be affected (Section G.4.1). Impacts can occur from individuals conducting the restoration, especially at staging areas; as part of accessing the restoration site; or due to the actual restoration techniques employed. Particular water quality impacts can derive from individuals conducting the restoration, excessive foot traffic, diving techniques, equipment handling, boat anchoring, and planting techniques.

Habitat restoration activities that include the removal of invasive species may cause minor disturbances of native species. For example, netting and trapping of invasive fish species may result in unwanted bycatch of native fish and other aquatic species. Fish passage restoration and other hydrologic restoration activities, such as the removal of culverts or other in-stream structures, installation of fishways, or other in-water activities will require temporary rerouting of flows around the project area. This could temporarily disturb on-site or adjacent habitats by altering hydrologic conditions and flows during project implementation.

Artificial reefs are sometimes used for habitat enhancement, but can have negative effects. Impacts of artificial reefs on EFH may include loss of habitat upon which the reef material is placed or the use of inappropriate, damaging materials for construction. Usually, reef materials are set upon flat sand bottoms or "biological deserts," which end up burying or smothering bottom-dwelling organisms at the site or even preventing mobile forms (e.g., benthic-oriented fish species) from using the area as habitat. Some materials may be inappropriate for the marine environment (e.g., automobile tires or compressed incinerator ash) and can serve as sources of toxic releases or physical damage to existing habitat when breaking free of their anchoring systems (Collins et al. 1994).

G.5.5.2 Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Use BMPs to minimize and avoid potential impacts to EFH during restoration activities. BMPs should include, but are not limited to, the following:
   a) Use turbidity curtains, haybales, and erosion mats to protect the water column.
   b) Plan staging areas in advance, and keep them to a minimum size.
   c) Establish buffer areas around sensitive resources; flag and avoid rare plants, archeological sites, etc.

   d) Remove invasive plant and animal species from the proposed action area before starting work. Plant only native plant species. Identify and implement measures to ensure native vegetation or revegetation success (Section G.4.4).
   e) Establish temporary access pathways before restoration activities to minimize adverse impacts from project implementation.
2. Avoid restoration work during critical life stages for fish such as spawning, nursery, and migration. Determine these periods before project implementation to reduce or avoid any potential impacts.
3. Provide adequate training and education for volunteers and project contractors to ensure minimal impact to the restoration site. Train volunteers in the use of low-impact techniques for planting, equipment handling, and any other activities associated with the restoration.
4. Conduct monitoring before, during, and after project implementation to ensure compliance with project design and restoration criteria. If immediate post-construction monitoring reveals that unavoidable impacts to EFH have occurred, ensure that appropriate coordination with NMFS occurs to determine appropriate response measures, possibly including mitigation.
5. To the extent practicable, mitigate any unavoidable damage to EFH within a reasonable time after the impacts occur.
6. Remove and, if necessary, restore any temporary access pathways and staging areas used in the restoration effort.
7. Determine benthic productivity by sampling before any construction activity in the case of subtidal enhancement (e.g., artificial reefs). Avoid areas of high productivity to the maximum extent possible. Develop a sampling design with input from state and federal resource agencies. Before construction, evaluate of the impact resulting from the change in habitat (sand bottom to rocky reef, etc.). During post-construction monitoring, examine the effectiveness of the structures for increasing habitat productivity.

G.5.6 Marine Mining

Mining activity, which is also described in Sections G.3.1.1 and G.3.1.2, can lead to the direct loss of EFH for certain species. Offshore mining, such as the extraction of gravel and gold in the Bering Sea (EBS) and the mining gravel of gravel from beaches, can increase turbidity of water. Thus, the resuspension of organic materials could affect less motile organisms (i.e., eggs and recently hatched larvae) in the area. Benthic habitats could be damaged or destroyed by these actions. Mining large quantities of beach gravel may significantly affect the removal, transport, and deposition of sand and gravel along the shore, both at the mining site and down-current (Council 1999). Neither the future extent of this activity nor the effects of such mortality on the abundance of marine species is known.

G.5.6.1 Potential Adverse Impacts

Mining practices that can affect EFH include physical impacts from intertidal dredging and chemical impacts from the use of additives such as flocculates (Council 1999). Impacts may include the removal of substrates that serve as habitat for fish and invertebrates; habitat creation or conversion in less productive or uninhabitable sites, such as anoxic holes or silt bottom; burial of productive habitats, such as in near-shore disposal sites (as in beach nourishment); release of harmful or toxic materials either in association with actual mining, or in connection with machinery and materials used for mining; creation of harmful turbidity levels; and adverse modification of hydrologic conditions so as to cause erosion of desirable habitats. Submarine disposal of mine tailings can also alter the behavior of marine organisms. Submarine mine tailings may not provide suitable habitat for some benthic organisms. In laboratory experiments, benthic dwelling flatfishes (Johnson et al. 1998a) and crabs (Johnson et al. 1998b) strongly avoided mine tailings.

During beach gravel mining, water turbidity increases and the resuspension of organic materials can affect less motile organisms (i.e., eggs and recently hatched larvae) in the area. Benthic habitats can be damaged or destroyed by these actions. Changes in bathymetry and bottom type may also alter population and migrations patterns (Hurme and Pullen 1988).

G.5.6.2 Recommended Conservation Measures

The following recommended conservation measures for marine mining should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid mining in waters containing sensitive marine benthic habitat including EFH (e.g., spawning, migrating, and feeding sites).
2. Minimize the areal extent and depth of extraction to reduce recolonization times.
3. Monitor turbidity during operations, and cease operations if turbidity exceeds predetermined threshold levels. Use sediment or turbidity curtains to limit the spread of suspended sediments and minimize the area affected.
4. Monitor individual mining operations to avoid and minimize cumulative impacts. For instance, three mining operations in an intertidal area could impact EFH, whereas one may not. Disturbance of previously contaminated mining areas may cause additional loss of EFH.
5. Use seasonal restrictions, as appropriate, to avoid and minimize impacts to EFH during critical life history stages of managed species (e.g., migration and spawning).

G.5.7 Persistent Organic Pollutants

The single biggest pollution threat to marine waters in Alaska is the deposition of persistent pollutants from remote sources. North Pacific and Alaska marine waters are perceived as pristine because most of Alaska’s 6,640 miles (10,686 kilometers) of coastline are devoid of point-source pollution, unlike much of North America. Effluents from pulp mills, marinas and boat harbors, municipal outfalls, and other industrial activities are generally considered to be the primary sources of contamination in Alaska waters, so most efforts at monitoring and mitigation have been focused on the local level. The only major regional pollution event was the *Exxon Valdez* oil spill in 1989, a contaminant threat that has abated considerably over the last 14 years. However, there is an increasing body of evidence suggesting that the greatest contaminant threat in Alaska comes from atmospheric and marine transport of contaminants from areas quite distant from Alaska.

The geography of Alaska makes it particularly vulnerable to contaminants volatilized from Asia. During winter, the Aleutian low pressure cell steers air from Southeast Asia into the EBS and northern Gulf of Alaska (GOA), bringing precipitation along the way. When this air meets the mountains along Alaska’s southern coast, more precipitation occurs, bringing entrained contaminants from the atmosphere into the marine ecosystem or coastal/interior ecosystems. Thus, pesticides applied to crops in Southeast Asia can be volatilized into the air, bound to suspended particulates, transported in the atmosphere to Alaska, and deposited in snow or rain directly into marine ecosystems or indirectly from freshwater flow to nearshore waters. Revolatilization of these compounds is inhibited by the cold temperatures associated with Alaska latitudes, resulting in a net accumulation of these compounds in northern habitats. This same distillation process also transfers volatilized contaminants from the atmosphere to the Pacific at lower latitudes, and ocean currents also deliver the contaminants to Alaska. Concentrations will be very low, but there will extensive geographical marine or land areas to act as cold deposit zones.

G.5.7.1 Potential Adverse Impacts

The effect of these transport mechanisms has been the appearance of persistent organic contaminants in northern latitudes, despite the absence of local sources. A good demonstration of global transport into northern latitudes is the presence of dichloro-diphyl-trichloroethanes (DDTs) in the blubber of ring seals in the western Canadian Arctic (Addison and Smith 1996). DDT and its congeners were first observed in these seals during the early 1970s. The persistence DDTs in these seals through the 1990s, despite North American bans on DDT use in the1970s, is evidence of continued deposition of DDT from countries still using this pesticide.

The existence of organic contaminants in biological tissues means these contaminants are being transported within the food webs in Alaska fish habitats. For example, Ewald et al. (1998) found detectable levels of polychlorinated biphenyls (PCBs), DDTs, and other pesticides in the tissues of adult sockeye salmon returning to the Copper River. These fish apparently concentrated these contaminants in their tissues during their migration in the northern GOA and delivered them to their spawning habitats in the interior of Alaska. Avian and mammalian predators of these fish would further distribute these contaminants.

Distribution of Contaminants in Marine Habitats

A large variety of contaminants can be found in Alaska's marine environment, including persistent organic pollutants (POPs) and heavy metals. POPs are characterized as those with half-lives over 2 months, bioaccumulation factors greater than 5,000, potential for long-range transport, and capable of toxic effects. Currently, 12 classes of compounds are considered POPs and are regulated by the Stockholm Convention on Persistent Organic Pollutants (Table 5.7-1). In addition to POPs, heavy metals present in Alaska habitats include mercury (Hg), cadmium, chromium, arsenic, lead, and silver. Contaminants found in Alaska marine mammals sampled between southeastern Alaska and the Aleutian and Pribilof Islands include PCBs, DDT, chlordanes, hexachlorocyclohexanes (HCHs), hexachlorobenzene, dieldrin, butyltins, arsenic, mercury, cadmium, and lead (Barron and Heintz in press). With over 100,000 chemicals on the market and an additional 1,000 to 2,000 new ones introduced annually, there are likely other toxic compounds in the environment whose concentrations are increasing. In addition, combustion and industrial processes result in the inadvertent production of unregulated chemicals (Arctic Monitoring and Assessment Programme [AMAP] 2002).

There have been few large-scale evaluations of the spatial or temporal patterns to contamination in Alaska's marine environment. Most effort at monitoring contaminant loads in Alaska waters has focused on Arctic habitats where there is evidence that PCBs and DDTs have declined over the last 25 years (AMAP 2002). Recently, Beckmen et al. (2001) reported on the concentrations of PCBs in sea lion scats collected from around the GOA. These data suggest that sea lion prey in the eastern Aleutian Islands have greater PCB loads than prey near Kodiak, Cook Inlet, and Prince William Sound. Prey from the latter three locations also have lower PCB loads than those from southeastern Alaska. Some of the relatively high values observed in the eastern Aleutians may reflect the addition of PCB point-source inputs at specific sites (Barron and Heintz in press), but it would seem unlikely that a few point sources could account for the general elevated state of PCB loads in the entire Aleutians.

Table 5.7-1. The Twelve Persistent Organic Pollutants Regulated by the POPs Treaty

	Common Name	Effect on Organisms
Pesticides	Dieldrin	Reproductive impairment; renal and liver damage
	Aldrin	Neurological damage; reproductive impairment
	Chlordane	Altered hormone function
	DDT/DDE	Neurological damage; hormonal disruption; reproductive impairment
	Endrin	Developmental abnormalities
	Heptachlor	Liver damage; hormonal changes
	Hexachlorobenzene	Reduced embryo weights in herring gulls
	Mirex	Kidney lesions in fish
	Toxaphene	"Broken-back" syndrome in fish
Polychlorinated biphenyls	PCBs	Poor reproductive success Impaired immune function
Industrial and Incineration Byproducts	Dioxins	Immune suppression; hormonal dysfunction; developmental impairment
	Furans	Developmental impairment; increased abortions

Source: World Federation of Public Health Associations 2000. Persistent organic pollutants and human health. Washington, DC.

Temporal studies provide little information because they are quite limited as to the number of locations evaluated and the samples collected. The mechanism, however, by which contaminants are delivered to the Alaska marine environment guarantees that the contaminants will be found in Alaska waters for as long as they are released (Wania and Mackay 1999). For example, the types of PCBs found in seals from sites near the Russian coast are consistent with those used in Russian electrical equipment (Muir and Norstrom 2000). Contributions of contaminants by marine transport will continue for some time. More water-soluble organic contaminants like HCHs are slower to accumulate in Arctic and subarctic food webs and appear to be increasing (Wania and Mackay 1999). Mercury appears to be higher in more recent samples (mid 1990s) than in the 1980s and 1970s, and rates of Hg accumulation also appear to be higher than they were 10 to 20 years ago (Muir et al. 1999). Polybrominated diphenyl ethers (PBDEs) also appear to be increasing in marine mammals (Ikonomou et al. 2002) and may surpass PCBs as the most prevalent persistent organic pollutants (POPs) in arctic habitats.

Factors Leading to Higher Contaminant Loads

The trophic structure of Alaska marine food webs, coupled with the tendency of contaminants to accumulate in Alaska habitats, causes apex predators to concentrate significant amounts of POPs in their tissues. Organisms occupying the top trophic levels in a food web bioaccumulate the highest concentrations of contaminants (Ruus et al. 2002). For example, the total PCB concentration in seal-eating killer whales sampled near Kenai Fjords National Monument was one to two orders of magnitude greater than fish-eating killer whales, indicating the significance of their trophic position (Ylitalo et al. 2001a). Further, seal-eating killer whale PCB loads were greater than the loads typically associated with belugas from the St. Lawrence River, while those of resident, fish-eating killer whales were consistent with loads observed in harbor seals in Puget Sound (Ylitalo et al. 2001a). The few data available on organisms at lower trophic levels in Alaska's marine habitats indicate these species experience relatively low contaminant loads (de Brito et al. 2002, Aono et al. 1997, Kawano et al. 1986). Thus, Alaska killer whales are likely accumulating loads of contaminants from remote sources that are consistent with those of marine mammals living near heavily contaminated urban areas as a result of their high trophic position. While this interpretation fails to account for differences in life stage, sex, or analytical method, it illustrates the need for more detailed information about this region.

This issue is particularly relevant when the contaminant loads experienced by Alaska natives subsisting on foods derived from marine habitats are considered. In one study, the total PCB concentration (not lipid adjusted) in serum collected from Aleutian males, ages 45 to 54, averaged 8.7 parts per billion (Alaska Division of Public Health 2003). By comparison, the concentrations in similarly aged males from around the Great Lakes who also consumed large amounts of fish (more than 52 meals per year) averaged 4.8 parts per billion (Hanrahan et al. 1999). Reference males in the latter study were demographically similar, ate less fish, and averaged 1.5 parts per billion. The relatively high level for the Alaska natives is likely the result of their trophic position relative to that of the Great Lakes fishers. Alaska natives with subsistence lifestyles who live in the Aleutians probably consume seals and fish, leading to a trophic position above that of Great Lakes fishers, who likely consume more grains and plant materials than Aleutian natives.

A second contributing factor to increased contaminant loads among apex predators in Alaska is their relatively long life. Contaminant loads increase with age in fish (Vuorinen et al. 2002), Steller sea lions (O'Hara 2001, Ylitalo et al. 2001b), and humans (Alaska Division of Public Health 2003). Female pinnipeds in the EBS and northern GOA typically begin reproducing at 5 years of age (Riedman 1990), allowing time for significant accumulation of contaminants, especially because pinnipeds eat relatively large (i.e., old) prey. For example, the pollock consumed by Steller sea lions average 1.3 feet (393 mm) and Atka mackerel 1.06 feet (323 mm) (Zeppelin et al. 2003). This translates to fish ages of approximately 3 to 5 years old. These sizes, however, were at the low end of the size distribution, indicating that sea lions can eat much older prey. Vuorinen et al. (2002) reported a sevenfold increase in POP loads of sprat between ages 2 and 10, demonstrating the increased potential for exposure associated with consuming older prey.

Significance of Contaminant Loads

It is not clear if the levels of contaminants in Alaska waters are causing deleterious effects to populations, because research in this area is still in its infancy. Relatively small and spotty contaminant surveys have established that POPs are present in Alaska waters, forage, and predators. No comprehensive geographical and temporal studies have been done to date to examine trends or sources of variation. The potential for the problem has been exposed; the extent and significance remain to be determined.

The potential for significant effects is most likely greatest among apex predators. Contamination is probably widespread among forage species at low levels, but apex predators are likely be the most affected as a result of their longevity, lipid storage, and the relatively high concentrations they bear. In mammals, it is most likely that lipophilic contaminants would have the greatest impacts on first-born young. The accumulation contaminants in females increase with age, but decrease after females reach reproductive age. This is the result of their transfer of contaminants to their offspring in milk. This process has been reported for sea lions, fur seals (Beckmen et al. 1999), and humans (Yang et al. 2002). This process occurs repeatedly for each offspring, consequently, the first-born offspring receives adult level contaminant loads during its most sensitive developmental stage. Beckmen et al. (1999) reported that first-born northern fur seal pups of primiparous mothers had higher PCB levels in their blood than pups of multiparous mothers. This higher load was correlated with a reduced ability to form antibodies to tentanus, along with reduced concentrations of thyroxine and vitamin A in their blood. Barron and Heintz (in press) compared reported PCB loads in juvenile Steller sea lions with loads known to cause deleterious effects in other pinnepeds and concluded that some sea lions in the mid-1980s likely experienced immunological impairment. Assessing impacts on humans is more difficult and controversial. While the acute impacts of contaminants on humans are known, the long-term impacts following neonatal exposure have not been explored.

Recent declines in apex predator populations in the EBS and northern GOA may be related to contaminant loading in the region. Over the last 25 years, the populations of Steller sea lions, harbor seals, northern fur seals, and many birds have declined. The reasons underlying these declines are likely complex and may not be the same for all species. For example, the decline in Steller sea lions is presumed to have resulted from nutritional stress, but more recent evidence suggests other factors, including contaminants, may be limiting their recovery (De Master et al. 2001). Contaminants are unlikely to be causing acutely toxic effects in the regions. Sublethal impacts of contaminants, however, could be working indirectly to impair populations through reduced immune function (Beckmen 2001) or reproduction (Reinjders 1986). Both of these characters are displayed by Steller sea lion populations from the affected region. York et al. (1996) attributed continuing declines in affected populations to a failure to recruit offspring to maturity. Zenteno-Savin et al. (1997) reported elevated levels of haptoglobin, an acute-phase reaction protein in the blood of Steller sea lions and harbor seals from affected populations relative to levels observed in stable or increasing populations. This protein is indicative of non-specific stressors that could include injury, disease, or toxicity. Thus, a recent panel was unable to reject contaminants as a factor contributing to the failed recovery of Steller sea lion populations (Barron and Heintz 2001).

Impacts may also occur at lower trophic levels, but there has been even less research in this area. Atlantic salmon in the Baltic Sea and salmonids in the Great Lakes have both experienced a common syndrome variously named M74 or early mortality syndrome. The syndrome is characterized by low thiamine content in eggs, resulting in near complete mortality of affected brood years. While the cause for the reduced thiamine content in spawning adults remains unknown, increased levels of PCB and dibenzofurans and dibenzo-dioxins were correlated with the onset of the disease in Baltic salmon (Vuorinen et al. 2002).

The impacts of persistent contaminants on populations in Alaska waters are not likely to be acute. The impacts are more likely be expressed as sublethal impacts in apparently healthy animals. These sublethal impacts ultimately lead to reduced reproductive fitness or decreased survival to maturity; therefore, they manifest themselves indirectly. Science is certain that the physical properties of these compounds couple with global climate patterns to ensure that they will be deposited in Alaska habitats, while maintaining their toxicity and perfusing through Alaska food webs, which include some of the most valuable fisheries on the planet. What is uncertain is how these compounds impact the health of organisms deriving sustenance from those food webs and how those impacts might feed back into the food web.

G.5.7.2 Recommended Conservation Measures

No mitigation strategies are proposed at this time relative to contaminants. There are too many unknowns. POP contaminants are present in Alaska waters and forage species and in predators up through apex predators, but the significance of the present loads is not known. Also, the relative concentrations in forage species (pollock for example) from the EBS, near Russia, or the northern GOA are not known. Comprehensive studies on a geographical, temporal, or widespread species scale to determine any relationship between contaminant loads and population changes have not been conducted. POP contaminants may contribute to poor recovery in some species, but mitigation strategies, whether they would be changes in fishing regulations or international regulation to curb contaminant releases, will likely need a better research foundation to support changes.

REFERENCES

Abbe, T.B. and D.R. Montgomery. 1996. “Large woody debris jams, channel hydraulics, and habitat formation in large rivers.” *Regulated Rivers: Research and Management*. 12:201-221.

Abbott, R. and E. Bing-Sawyer. 2002. Assessment of pile driving impacts on the Sacramento blackfish (*Othodon microlepidotus*). Draft report prepared for Caltrans District 4. October 10, 2002.

Able, K.W., J.P. Manderson, and A.L. Studholme. 1998. “The distribution of shallow water juvenile fishes in an urban estuary: the effects of man-made structures in the lower Hudson River.” *Estuaries.* 21:731-744.

Addison, R.F. and T.G. Smith. 1996. “Trends in organochlorine residue concentrations in ringed seal (*Phoca hispida*) from Holman, Northwest Territories 1972-1991.” *Arctic*. 51:253-561.

Alaska Department of Fish and Game and Alaska Department of Public Transportation of Public Facilities, Memorandum of Agreement for the Design, Permitting, and Construction of Culverts for Fish Passage. August 2001. http://www.sf.adg.state.ak.us/SARR/fishpassage/pdfs/dot_adfg_fishpass080301.pdf.

Alaska Department of Natural Resources. 1999. Cook Inlet Areawide 1999 Oil and Gas Lease Sale, Final Finding of the Director. Volume II. Appendix B: “Laws and Regulations Pertaining to Oil and Gas Exploration, Development, Production, and Transportation.”

Alaska Division of Public Health. 2003. PCB blood test results from St. Lawrence Island recommendations for consumption of traditional foods. State of Alaska Epidemiology Bulletin. 7(1): 1-5.

American Fisheries Society. 2000. AFS Policy Statement #13:Effects of Surface Mining on Aquatic Resources in North America (Revised). (Abbreviated) (http://www.fisheries.org/Public_Affairs/Policy_Statements/ps13ashtml).

Aono, S, S. Tanabe, Y. Fujise, H. Kato, and R. Tatsukawa. 1997. “Persistent organochlorines in minke whale (*Balaenoptera acutorostrata*) and their prey species from the Antarctic and the north Pacific.” *Env. Poll.* 98:81-89.

Arctic Monitoring and Assessment Programme (AMAP). 2002. Arctic pollution 2002: Persistent organic pollutants, heavy metals, radioactivity, human health, changing pathways. Arctic Monitoring and Assessment Programme. Oslo Norway. pp. iii - 111.

Arkoosh, M.R., E. Casillas, E. Clemons, P. Huffman, A.N. Kagley, T. Collier, and J.E. Stein. 2001. “Increased susceptibility of juvenile chinook salmon (*Oncorhynchus tshawytscha*) to vibriosis after exposure to chlorinated and aromatic compounds found in contaminated urban estuaries.” *Journal of Aquatic Animal Health*. 13:257-268.

Barron, M.G., M.G. Carls, J.W. Short, and S.D. Rice. 2003. Photoenhanced toxicity of aqueous phase and chemically dispersed weathered Alaska North Slope crude oil to Pacific herring eggs and larvae. Environmental Toxicology and Chemistry 22(3):650-660.

Barron, M.G. and R.A. Heintz. 2001. Workshop to assess contaminant impacts on Steller sea lions in Alaska. Anchorage, AK September 5-6, 2001. National Marine Fisheries Service, Auke Bay Laboratory. Juneau, AK.

Barron, M.G. and R.A. Heintz. *In press*. “Contaminant exposure and effects in pinnipeds: implications for steller sea lion declines in Alaska.” *Sci. Tot. Env.*

Bay, S. and D. Greenstein. 1994. Toxic effects of elevated salinity and desalination waste brine. *In* J. Cross, ed. Southern California Coastal Water Research Project, Annual Report 1992-93, pp. 149-153. SCCWRP, Westminster, CA.

Beckmen, K.B. 2001. Blood organochlorines, immune function and health of free-ranging northern fur seal pups (*Callorhinus ursinus*). PhD. Dissertation. University of Alaska, Fairbanks. Fairbanks, Alaska. 151 pp.

Beckmen, K.B., G.M. Ylitalo, R.G. Towell, M.M. Krahn, T.M. O'Hara, and J.E. Blake. 1999. "Factors affecting organochlorine contaminant concentrations in milk and blood of northern fur seal (*Callorhinus ursinus*) dams and pups from St. George Island, Alaska." *Sci. Total Environ*. 231:183-200.

Beckmen, K.B., K.W. Pitcher, G.M. Ylitalo, M.M. Krahn, and K.A. Burek. 2001. Contaminants in Free-ranging Steller Sea Lions, 1998-2001: Organochlorines in Blood, Blubber, Feces and Prey. Workshop to Assess Contaminant Impacts on Steller Sea Lions in Alaska. Anchorage, AK, September 5-6, 2001. Sponsored by Auke Bay Laboratory.

Beechie, T., E. Beamer, and L. Wasserman. 1994. "Estimating coho rearing habitat and smolt production losses in a large river basin, and implications for habitat restoration." *North American Journal of Fisheries Management.* 14(4):797-811.

Belford, D.A. and W.R. Gould. 1989. "An evaluation of trout passage through six highway culverts in Montana." *North American Journal of Fisheries Management.* 9(4):437-445.

Benfield, M.C. and T. J. Minello. 1996. "Relative effects of turbidity and light intensity on reactive distance and feeding of an estuarine fish." *Environmental Biology of Fishes*. 46:211-216.

Beschta, R.L., M.R. Pyles, A.E. Skaugset, and C.G. Surfleet. 2000. "Peakflow response to forest practices in the western Cascades of Oregon, U.S.A." *Journal of Hydrology*. 233:102-120.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. *In* Salo, E., T. Cundy, eds. Streamside management: forestry and fishery interactions. Contribution 57. Seattle: University of Washington, College of Forest Resources: 191-232. 437-445.

Bilby, R.E. and J.W. Ward. 1991. "Characteristics and function of large woody debris in streams draining old-growth, clear-cut, and second-growth forests in southwestern Washington." *Canadian Journal of Fisheries and Aquatic Sciences.* 48:2499-2508.

Bilby, R.E., K. Sullivan, and S.H. Duncan. 1989. "The generation and fate of road-surface sediment in forested watersheds of southwestern Washington." *Forest Science*. 35:453-468.

Bisson, P.A., J.L. Nielsen, and J.W. Ward. 1988. "Summer production of coho salmon stocked in Mount St. Helens streams 3-6 years after the 1980 eruption." *Transactions of the American Fisheries Society*. 117(4):322-335.

Blanton, S.L., R.M. Thom, and J.A. Southard. 2001. Documentation of ferry terminal shading, substrate composition, and algal and eelgrass coverage. Letter Report prepared for University of Washington, School of Aquatic and Fishery Sciences, Seattle, Washington by Battelle Marine Sciences Laboratory, Sequim, Washington. 17 pp.

Blaxter, J. H. S. 1969. Development: Eggs and larvae. In W. S. Hoar., and D. J. Randall. eds. Fish Physiology. Vol. 3. Academic Press, Inc. New York, NY. pp. 177-252.

Bond, A.B., J.S. Stephens, Jr, D. Pondella, II, M.J. Allen, and M. Helvey. 1999. "A method for estimating marine habitat values based on fish guilds, with comparisons between sites in the Southern California Bight." *Bull. Mar. Science*. 64:219-242.

Botkin, D., K. Cummins, T. Dunne, H. Regier, M. Sobel, L. Talbot, and L. Simpson. 1995. Status and Future of salmon of Western Oregon and Northern California: Findings and Options. Report #8. The Center for the Study of the Environment, Santa Barbara, California. 300 pp.

Brady, N.C. and R.R. Weil. 1996. The nature and properties of soils. 11th ed. Prentice-Hall, Inc. Upper Saddle River, New Jersey 07458. 740 pp.

Burroughs, E.R. Jr., G.R. Chalfant, and M.A. Townsend. 1976. Slope stability in road construction: a guide to the construction of stable roads in western Oregon and northern California. Portland, OR: U.S. Department of the Interior, Bureau of Land Management. 102 pp.

Caltrans. 2001. Fisheries Impact Assessment, Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Seismic Safety Project, August 2001. 59 pp.

Cardwell, R.D., M.I. Carr, and E.W. Sanborn. 1980. Water quality and flushing of five Puget Sound marinas. Technical Report No. 56. Washington Department of Fisheries Research and Development. Olympia, Washington. 77 pp.

Carls, M.G., R.E. Thomas, and S.D. Rice. 2003. "Mechanism for transport of oil-contaminated water into pink salmon redds." *Mar. Ecol. Prog. Ser.* 248:245-255.

Carls, M.G., S.D. Rice, and J.E. Hose. 1999. "Sensitivity of fish embryos to weathered crude oil: Part 1. Low level exposure during incubation causes malformations and genetic damage in larval Pacific herring (*Clupea pallasi*)." *Environmental Toxicology and Chemistry*. 18:481-493.

Carlson, T.J., G. Ploskey, R.L. Johnson, R.P. Mueller, M.A. Weiland, and P.N. Johnson. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigation channel and channel maintenance activities. Prepared for the U.S. Army, Corps of Engineers, Portland District by Pacific Northwest National Laboratory, U.S. Department of Energy, Richland, WA. 35 pp. + appendices.

Carr, M.H., T.W. Anderson, and M.A. Hixon. 2002. Biodiversity, population regulation, and the stability of coral-reef fish communities. Proceedings of the National Academy of Sciences. 99:11241-11245.

Castro, J. 2003. Geomorphologic impacts of culvert replacement and removal: avoiding channel incision. U.S. Fish and Wildlife Service—Oregon Fish and Wildlife Office, Portland, Oregon.

Cederholm, C.J. and L.M. Reid. 1987. Impact of forest management on coho salmon (*Oncorhynchus kisutch*) populations of the Clearwater Rivers, Washington: A project summary. *In* Streamside management: forestry and fishery interactions. Salo, E.O, and T.W. Cundy, eds. College of Forest Resources, University of Washington, Seattle, Washington. University of Washington, Institute of Forest Resources. Contribution No. 57.

Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Elliott City, MD, www.cwp.org, 141 pp.

Chabreck, R.H. 1972. Vegetation, water and soil characteristics of the Louisiana coastal region. Louisiana State University Agriculture Experiment Station. Baton Rouge, LA.

Chapman, D.W. 1988. "Critical review of variables used to define effects of fines in redds of large salmonids." *Transactions of the American Fisheries Society*. 117(1):1-21.

Christie, D., E. Allen, and G. J. Jobsis. 1993. Diversions. *In* Bryan, C.F. and D.A. Rutherford eds. Impacts on warmwater streams: Guidelines for evaluation. pp. 181-186. Southern Division, American Fisheries Society, Little Rock, AR.

Christopherson, A. and J. Wilson. 2002. Technical Letter Report Regarding the San Francisco-Oakland Bay Bridge East Span Project Noise Energy Attenuation Mitigation. Peratrovich, Nottingham & Drage, Inc. Anchorage, Alaska. 27 pp.

Clancy, C.G. and D.R. Reichmuth. 1990. "A detachable fishway for steep culverts." *North American Journal of Fisheries Management*. 10(2):244-246.

Clayton, J.L. 1983. Evaluating slope stability prior to road construction. Res. Pap. INT-307. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 6 pp.

Cloern, J.E. 1987. "Turbidity as a control on phytoplankton biomass and productivity in estuaries." *Continental Shelf Research*. 7:1367-1381.

Collins, B.D., D.R. Montgomery, and A.D. Haas. 2002. "Historical changes in the distribution and functions of large wood in Puget Lowland rivers." *Canadian Journal of Fisheries and Aquatic Sciences*. 59:66-76.

Collins, B.D., D.R. Montgomery, and A.J. Sheikh. 2003. Reconstructing the historic riverine landscape of the Puget Lowland. pp 79-128. *In* Bolton, S, D.R. Montgomery, and D. Booth, eds. Restoration of Puget Sound Rivers. University of Washington Press. Seattle, WA.

Collins, K.J., A.C. Jensen, A.P.M. Lockwood, and S.J. Lockwood. 1994. "Coastal structures, waste materials and fishery enhancement." *Bulletin of Marine Science*. 55(203):1240-1250.

Corbett, C.W., M. Wahl, D.E. Porter, D. Edwards, and C. Moise. 1997. "Nonpoint source runoff modeling: A comparison of a forested watershed and an urban watershed o the South Carolina coast." *Journal of Experimental Marine Biology and Ecology*. 213(1):133-149.

Craig, N.J., R.E. Turner, and J.W. Day, Jr. 1979. "Land loss in coastal Louisiana." *Environmental Management*. 3:134-144

Culp, J.M. and R.W. Davies. 1983. An assessment of the effects of streambank clear cutting on macroinvertebrate communities in a managed watershed. Canadian Technical Report of Fisheries and Aquatic Sciences. No. 1208. 116 pp

de Brito, A.P.X., D. Ueno, S. Takahasi, and S. Tanabe. 2002. "Contamination by organochlorine compounds in walleye pollock (*Theragra chalcogramma*) from the Bering Sea, Gulf of Alaska, and the Japan Sea." *Marine Pollution Bulletin*. 44:164-177.

DeLorenzo, M.E., G.I. Scott, and P.E. Ross. 2001. "Toxicity of pesticides to aquatic microorganisms: A review." *Environ. Toxicol. Chem.* 20:84-98.

DeMaster, D., S. Atkinson, and R. Dearborn. 2001. Is it food? II Workshop. Alaska Sea Life Center, Seward, Alaska. May 30-31. Sponsored by National Marine Fisheries Service and Alaska Sea Grant Office.

Dennison, W.C. 1987. "Effect of light on seagrass photosynthesis, growth and depth distribution." *Aquatic Botany*. 27:15-26.

Department of the Interior, Bureau of Land Management, in cooperation with the Minerals Management Service. 1998. Northeast National Petroleum Reserve-Alaska, Final Integrated Activity Plan/Environmental Impact Statement. Table II.F.1. "Federal, State, and North Slope Borough Permits and/or Approvals for Oil and Gas Exploration and Development/Production Activities."

Dolat, S.W. 1997. Acoustic measurements during the Baldwin Bridge demolition (final, dated March 14, 1997). Prepared for White Oak Construction by Sonalysts, Inc, Waterford, CT. 34 pp. + appendices.

Duffy-Anderson, J.T., and K.W. Able. 1999. "Effects of municipal piers on the growth of juvenile fishes in the Hudson River estuary: a study across a pier edge." *Mar. Biol.* 133:409-418.

Dugan, J.E., D.M. Hubbard, D.L. Martin, J.M. Engle, D.M. Richards, G.E. Davis, K.D. Lafferty, and R.F. Ambrose. 2000. Macrofauna communities of exposed sandy beaches on the Southern California mainland and Channel Islands. pp 339-346. *In* Brown, D.R., K.L. Mitchell, and H.W. Chang, eds. Proceedings of the Fifth California Islands Symposium. Minerals Management Service Publication # 99-0038.

Ebeling, A.W., R.J. Larson, and W.S. Alevizon. 1980. Annual variability of reef-fish assemblages in kelp forest off Santa Barbara, California. U.S. Natl. Mar. Fish. Serv. Fish. Bull. 78:361-377.

Emmett, Brian. 2002. A discussion document associated with shellfish aquaculture in Baynes Sound. Prepared for Mr. Joe Truscott, Coast and Marine Planning Office, Ministry of Sustainable Resource Management, 78 Blanshard St., Victoria, B.C. V8W 9M2, Canada.

Engås, Arill, Svein Løkkeborg, Egil Ona, and Aud Vold Soldal. 1996. "Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*)." Can. J. Fish Aquat. Sci. 53: 2238-2249.

Enger, P.S., H.E. Karlsen, F.R. Knudsen, and O. Sand. 1993. Detection and reaction of fish to infrasound. Fish Behaviour in Relation to Fishing Operations., 1993, pp. 108-112, ICES marine science symposia. Copenhagen. Vol. 196.

Evans, W.A., B. Johnston. 1980. Fish migration an fish passage: a practical guide to solving fish passage problems. Rev. ed. EM-7100-2. Washington DC. U.S. Department of Agriculture, Forest Service. 163 pp.

Everest, F.H., R.L. Beschta, J.C. Scrivener, K.V. Koski, J.R. Sedell, and C.J. Cederholm. 1987. Fine sediment and salmonid production B a paradox. In: Salo, E.; Cundy, T. eds. Streamside management: forestry and fishery interactions: proceedings of a symposium held at the University of Washington, February 12-14, 1986. Contribution 57. Seattle: University of Washington, Institute of Forestry Resources. pp. 98-142.

Ewald, G., P. Larsson, H. Linge, L. Okla, and N. Szarzi. 1998. "Biotransport of organic pollutants to an inland Alaska lake by migrating sockeye salmon (*Oncorhynchus nerka*)." *Arctic*. 51:40-47.

Fajen, O.F. and J.B. Layzer. 1993. Agricultural practices. *In* Bryan, C.F. and D.A. Rutherford, eds. Impacts on warmwater streams: Guidelines for evaluation. pp. 257-267. Southern Division, American Fisheries Society. Little Rock, AR.

Fawcett, J.A. and H.S. Marcus. 1991. Are port growth and coastal management compatible? Coastal Management. Vol. 19. pp. 275-295.

Fay, V. 2002. Alaska Aquatic Nuisance Species Management Plan. Alaska Department of Fish and Game Publication. Juneau, AK. http://www.adfg.state.ak.us/special/invasive/ak_ansmp.pdf.

Feder, H.M., C.H. Turner, and C. Limbaugh. 1974. Observations on fishes associated with kelp beds in southern California. California Department of Fish and Game, Fish Bull. 160. 144 pp.

Ferraro, S.P., R.C. Swartz, F.A. Cole, and D.W. Schults. 1991. "Temporal changes in the benthos along a pollution gradient: discriminating the effects of natural phenomena from sewage-industrial wastewater effects." *Estuarine Coastal Shelf Science.* 33:383-407.

Franco, J., S. Schad, and C.W. Cady. 1994. "California's experience with a voluntary approach to reducing nitrate contamination of groundwater: The Fertilizer Research and Education Program." *J. Soil and Water Conser.* 49: S76.

Fulton, M.H., G.I. Scott, A. Fortner, T.F. Bidleman, and B. Ngabe. 1993. "The effects of urbanization on small high salinity estuaries of the southeastern United States." *Archives for Environmental Contamination and Toxicology*. 25(4):476-484.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. *In* Meehan W.R., ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD. American Fisheries Society. pp. 297-323.

Gausland, Ingebert. 2003. Report for Norwegian Oil Industry Association (OLF): Seismic Surveys Impact on Fish and Fisheries. Stavanger, March 2003.

Glasby, T.M. 1999. "Effects of shading on subtidal epibiotic assemblages." *J. Exp. Mar. Biol. Ecol.* 234(1999). pp. 275-290.

Good, J.W. 1987. "Mitigating estuarine development impacts in the Pacific Northwest: from concept to practice." *Northwest Environmental Journal*. Vol. 3. No. 1.

Gowen, A.W. 1978. The Environmental Effects of OCS Pipelines. Initial Findings. New England River Basins Commission. Boston, MA. 4:24-43

Greenberg, C.H., S.H. Crownover, and D.R. Gordon. 1997. "Roadside soils: a corridor for invasion of xeric scrub by nonindigenous plants." *Natural Areas Journal*. 17(2):99-109.

Gregory, S.V. and P.A. Bisson. 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. *In* Stouder, J.D., P.A. Bisson, and R.J. Naiman, eds. Pacific Salmon and Their Ecosystems: Status and Future Options, pp. 277-314. Chapman and Hall, New York.

Grimes, C.B. 1975. "Entrapment of fishes on intake water screens at a steam electric generating station." *Chesapeake Science*. 16:172-177.

Haas, M.A., C.A. Simenstad, J.R. Cordell, D.A. Beauchamp, and B.S. Miller. 2002. Effects of large overwater structures on epibenthic juvenile salmon prey assemblages in Puget Sound, Washington. Final Research Report No. WA-RD 550.1. Prepared for the Washington State Transportation Commission, Washington State Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration. 114 pp.

Hall, J.D., C.J. Cederholm, M.L. Murphy and KV. Koski. 2004. Fish-foresrty interactions in Oregon, Washington, and Alaska, USA. In T.G. Northcote and G.F.Hartman, editors, Fishes and Forestry Worldwide Watershed Interactions and Management, Blackwell Publishing, pp365-412.

Hammond, C.J., S.M Miller, and R.W. Prellwitz. 1988. Estimating the probability of landslide failure using Monte Carlo simulation. In Proceedings of the 24th symposium on engineering geology and soils engineering. Febrary 29, 1988. Coeur d'Alene, ID. Utah State University, Department of Civil and Environmental Engineering, Logan, UT. pp. 319-331.

Hanrahan, L., C. Falk, H.A. Anderson, L. Draheim, M. S. Kanarek, J. Olson, and The Great Lakes Consortium. 1999. "Serum PCB and DDE levels of frequent Great Lakes sport fish consumers - a first look." *Env. Res.* Section A. 80:S26-S37.

Hanson, C.H., J.R. White, and H.W. Li. 1977. "Entrapment and impingement of fishes by power plant cooling water intakes: an overview." *Marine Fisheries Review*. 39:7-17.

Hastings, K., P. Hesp, and G. Kendrick. 1995. “Seagrass loss associated with boat moorings at Rottnest Island, Western Australia.” *Ocean and Coastal Management.* 26:225-246. *In* Shafer, D.J. 2002. Recommendations to minimize potential impacts to seagrasses from single-family residential dock structures in the Pacific Northwest. U.S. Army Corps of Engineers, Seattle, WA. 28 pp.

Hastings, M.C. 2002. Clarification of the meaning of sound pressure levels and the known effects of sound on fish. Document in support of Biological Assessment for San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. August 26, 2002. Revised August 27, 2002. 8 pp.

Heady, H.F. and R.D. Child. 1994. Rangeland ecology and management. Westview Press, Inc., Boulder, Colorado.

Heifetz, J., M.L. Murphy, and K.V. Koski. 1986. (Effects of logging on winter habitat of juvenile salmonids in Alaskan streams.” *North American Journal of Fisheries Management. 6:52-58.*

Heintz, R.A., J.W. Short, and S.D. Rice. 1999. Sensitivity of fish embryos to weathered crude oil: Part II. Incubating downstream from weathered Exxon Valdez crude oil caused increased mortality of pink salmon (*Onchorhynchus gorbuscha*) embryos. Environmental Toxicol. Chem. 18:494-503.

Heintz, R.A., S.D. Rice, A.C. Wertheimer, R.F. Bradshaw, F.P. Thrower, J.E. Joyce, and J.W. Short. 2000. “Delayed effects on growth and marine survival of pink salmon *Oncorhynchus gorbuscha*, after exposure to crude oil during embryonic development.” *Mar. Ecol. Prog. Ser.* 208:205-216.

Helfman, G.S. 1981. The advantage to fishes of hovering in shade. Copeia. 1981(2):392-400.

Helvey, M. 1985. “Behavioral factors influencing fish entrapment at offshore cooling-water intake structures in southern California.” *Marine Fisheries Review.* 47:18-26.

Helvey, M. 2002. “Are southern California oil and gas platforms essential fish habitat?” *ICES Journal of Marine Science*. 59:S266-S271.

Helvey, M. and P.B. Dorn. 1987. “Selective removal of reef fish associated with an offshore cooling-water intake structure.” *J. Applied Ecology* 24:1-12.

Herke, W.H. and B.D. Rogers. 1993. Maintenance of the estuarine environment. Pages 263-286 in C.C. Kohler and W.A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J.R. Sedell, J.R. 1991. Responses of salmonids to habitat changes. In: Meehan, W.R. (Ed.) 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society: 483-518.

Hoagland, K.D., J.P. Carder, and R.L. Spawn. 1996. Effects of organic toxic substances. pp. 469-496. *In* Stevenson, R.J., M.L. Bothwell, and R.L. Lowe, eds. *Algal Ecology: Freshwater Benthic Ecosystems*. Academic Press. New York, NY.

Holler, J.D. 1990. “Nonpoint source phosphoros control by a combination wet detention/filtration facility in Kissimmee, Florida.” *Florida Scientist.* 53(1):28-37.

Horner, R., C. May, E. Livingston, and J. Maxted. 1999. Impervious cover, aquatic community health, and stormwater BMP’s: is there a relationship? *In* Proceedings of the Sixth Biennial Stormwater Research and Watershed Management Conference. Sept. 14-17, 1999. Tampa Florida. Southwest Florida Water Management District. Available on line: www.stormwater-resources.com/proceedings_of_the_sixth_biennia.htm.

Hoss, D.E. and G.W. Thayer. 1993. The importance of habitat to the early life history of estuarine dependent fishes. American Fisheries Society Symposium. 14:147-158.

Hurme, A.K. and E.J. Pullen. 1988. Biological effects of marine sand mining and fill placement for beach replenishment: Lesson for other use. Marine Mining. Vol. 7.

Ikonomou, M.G., S. Rayne, and R.F. Addison. 2002. "Exponential increases of the brominated flame retardants, polybrominated diphenyl ethers, in the Canadian Arctic from 1981 to 2000." *Environ. Sci. Technol.* 36:1886-1892.

Jackson, R.G. 1986. "Effects of bark accumulation on benthic infaunal at a log transfer facility in Southeast Alaska." *Marine Pollution Bulletin*. 17(6):258-262.

Johnson, S.W., M.L. Murphy, D.J. Csepp, P. M. Harris, and J. F. Thedinga. 2003. A survey of fish assemblages in eelgrass and kelp habitats of southeastern Alaska. NOAA Technical Memorandum NMFS-AFSC-139, 39 pp.

Johnson, K.L. 1992. Management for water quality on rangelands through best management practices: the Idaho approach. pp. 415-441. *In* Naiman, R.J., ed. Watershed management: Balancing sustainability and environmental change. Springer-Verlag, New York.

Johnson, L. 2000. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. White Paper from National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. 29 p.

Johnson, L., S.Y. Sol, G.M. Ylitalo, T. Hom, B. French, O.P. Olson, and T.K. Collier. 1999. "Reproductive injury in English sole (*Pleuronectes vetulus*) from the Hylebos Waterway, Commencement Bay, Washington." *Journal of Aquatic Ecosystem Stress and Recovery.* 6:289-310.

Johnson, S.W., S.D. Rice, and D.A. Moles. 1998a. Effects of submarine mine tailings disposal on juvenile yellowfin sole (*Pleuronectes asper*): a laboratory study. Marine Pollution Bulletin. *36:278-287.*

Johnson, S.W., R.P. Stone, and D.C. Love. 1998b. Avoidance behavior of ovigerous Tanner crabs *(Chionoecetes bairdi*) exposed to mine tailings: a laboratory study. Alaska Fish. Res. Bull. 5:39-45.

Jordan, T.E. and D.E. Weller. 1996. "Human contributions to terrestrial nitrogen flux: Assessing the sources and fates of anthropogenic fixed nitrogen." *BioScience*. 46:655.

Kagan, R.A. 1991. The dredging dilemma: economic development and environmental protection in Oakland Harbor. Coastal Management, Vol. 19, pp. 313-341.

Kahler, T., M. Grassley, and D. Beauchamp. 2000. A summary of the effects of bulkheads, piers, and other artificial structures and shorezone development on ESA listed salmonids in lakes. Final Report to the City of Bellevue, Washington. 74 pp.

Kauffman, J.B. and W.C. Krueger. 1984. "Livestock impacts on riparian ecosystems and streamside management implications–a review." *Journal of Range Management*. 37:430-438.

Kawano, M., S. Matsushita, T. Inoue, H. Tanaka, and R. Tatsukawa. 1986. "Biological accumulation of chlordane compounds in marine organisms from the northern North Pacific and Bering Sea." *Mar. Poll. Bull.* 17:512-516.

Kennish, M.J. 1998. *Pollution Impacts on Marine Biotic Communities*. CRC Press, New York, NY. 310 pp.

Kirkpatrick, B., T.C. Shirley, and C.E. O'Clair. 1998. Deep-water bark accumulation and benthos richness at log transfer and storage facilities. Alaska Fishery Research Bulletin 5(2):103-115.

Klein, R. 1997. The effects of marinas and boating activities upon tidal waters. Community and Environmental Defense Services. Owings Mills, Maryland. 23 pp.

Knudsen, F.R., C.B. Schreck, S.M. Knapp, P.S. Enger, and O. Sand. 1997. "Infrasound produces flight and avoidance responses in Pacific juvenile salmonids." *Journal of Fish Biology.* 51:824-829.

Knudsen, F.R., P.S. Enger, and O. Sand. 1994. "Avoidance responses to low frequency sound in downstream migrating Atlantic salmon smolt, Salmo salar." *Journal of Fish Biology.* 45:227-233.

Kohler, C.C. and W.R. Courtenay, Jr. 1986. "Introduction of aquatic species." *Fisheries.* 11(2):39-42. Proceedings of the Seventh International Zebra Mussel and Aquatic Nuisance Species Conference. 1997.

Koski, K V. 1993. Riparian zone functions and interactions with sediment. *In* Proceedings of a Technical Workshop on Sediments, February 3-7, 1992, Corvallis, OR, Terrene Institute, Sept. 1993, pp 61-69.

Koski, K.V. 1992. Restoring stream habitats affected by logging activities. Pages 343-404 in G. W. Thayer (editor) Restoring the nation's marine environment. Publication UM-SG-TS-92-06. Maryland Sea Grant College, College Park, MD.

Koski, K.V. 1981. The survival and quality of two stocks of chum salmon (Oncorhynchus keta) from egg deposition to emergence. Rapp. P.-v. Reun. Conx. int. Explor. Mer, 178:330-333.

Langford, T.E., N.J. Utting, and R.H.A. Holmes. 1978. Factors affecting the impingement of fishes on power station cooling-water intake screens. *In* Physiology and Behaviour of Marine Organisms. D.S. McLusky and A.J. Berry, eds. pp. 281-288. Pergamon Press, Oxford and New York.

Larimore, R.W. and P.W. Smith. 1963. The fishes of Champaign County, Illinois, as affected by 60 years of stream changes. Illinois Natural History Survey Bulletin 28:299-382.

Larsen, M.C. and J.E. Parks. 1997. How wide is a road? The association of roads and mass-wasting in a forested montane environment. Earth Surface Processes and Landlords 22:835-848.

Larson, K. and C. Moehl. 1990. Entrainment of anadromous fish by hopper dredge at the mouth of the Columbia River. *In* C.A. Simenstad, ed. Effects of dredging on anadromous Pacific coast fishes. University of Washington Sea Grant. pp. 102-112.

Lee, G.F. and S. Taylor. 2000. Review of the water quality characteristics of Upper Newport Bay, Orange County CA and its Tributaries. California Coastal Conservancy, Oakland, CA 94612.

Levings, C.D. and T. G. Northcote. 2004. Effects of forestry on estuarine ecosystems supporting fishes. *In* T.G. Northcote and G.F.Hartman, editors, Fishes and Forestry Worldwide Watershed Interactions and Management, Blackwell Publishing, pp 320 -335.

Longmuir, C. and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Report by Fraser River Pile & Dredge Ltd., New Westminster, British.Columbia. 9 pp.

Lonsdale, W.N. and A.M. Lane. 1994. "Tourist vehicles as vectors of weed seeds in Dadoed National Park, northern Australia." *Biological Conservation.* 69(3):277-283.

Love, M.S. and W. Westphal. 1990. Comparison of fishes taken by a sportfishing party vessel around oil platforms and adjacent natural reefs near Santa Barbara, California. Fishery Bulletin, U.S. 88:599-605.

Love, M., J. Hyland, A. Egeling, T. Herrlinger, A. Brooks, and E. Imamura. 1994. “A pilot study of the distribution and abundance of rockfishes in relation to natural environmental factors and an offshore oil and gas production platform off the coast of southern California.” *Bulletin Marine Science.* 55(2-3): 1062-1085.

Love, M.S., M. Nishimoto, D. Schroeder, and J. Caselle. 1999. The ecological role of natural reefs and oil and gas production platforms on rocky reef fishes in southern California: Final interim report. U.S. Geological Survey, Biological Resources Division. USGS/BRD/CR-1999-007. 208 pp.

Luce, A. and M.Crowe. 2001. “Invertebrate terrestrial diversity along a gravel road on Barrie Island, Ontario, Canada.” *Great Lakes Entomologist.* 34(1):55-60 SPR-SUM.

Luchetti, G. and R. Feurstenburg. 1993. Relative fish use in urban and non-urban streams. Proceedings of a Conference on Wild Salmon. Vancouver, British Columbia, Canada.

MacDonald, L.H., R.W. Sampson, and D.M Anderson. 2001. “Runoff and road erosion at the plot and road segment scales, St. John, U.S. Virgin Islands.” *Earth Surface Processes and Landforms.* 26:251-272.

Madej, M.A. 2001. “Erosion and sediment delivery following removal of forest roads.” *Earth Surface Processes and Landforms.* 26:175-190.

Marcus, M.D., M.K. Young, L.E. Noel, and B.A. Mullan. 1990. Salmonid-habitat relationships in the western United States: a review and indexed bibliography. General Technical Report RM-GTR-188. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Martin, D. J. and D. J. Grotefendt. 2001. Buffer Zones and LWD supply. Project Report prepared for Alaska Forest Association and Alaska Department of Environmental Conservation. Community Water Quality Grant No: NP-01-12.

Martin, D.J. and A. Shelly. 2004. Status and trends of fish habitat condition on private timberlands in southeast Alaska: 2003 Summary. Report to Sealaska Corporation and Alaska Department of Natural Resources, Juneau, Alaska.

Maser, C. and J.R. Sedell. 1994. From the Forest to the Sea: the Ecology of Wood in Streams, Estuaries and Oceans. St. Lucie Press, Delray Beach, FL. 200 pp.

May, C., R. Horner, J. Karr, B. Mar, and E. Welch. 1997. Effects of urbanization on small streams in the Puget Sound lowland ecoregion. Watershed Protection Techniques 2(4):483-494.

McCauley, R.D., Fewtrell, J., and Popper A.N. 2003. “High intensity anthropogenic sound damages fish ears.” J. Acoust. Soc. AM. 113 (1), January 2003. pp. 638-642.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch and K. McCabe. 2000. Marine seismic surveys:Analysis and propegation of air-gun signals; and the effects of exposure on humpback whales, sea turtles, fishes and squid. Centre for maine Science and Technology, Curtain University, R99-15, Perth, Western Australia. 185 pp.

McGraw, K. and D. Armstrong. 1990. Fish entrainment by dredges in Grays Harbor, Washington. *In* C.A. Simenstad, ed. Effects of dredging on anadromous Pacific coast fishes. University of Washington Sea Grant. pp. 113-131.

Meehan, W.R., W.A. Farr, D.M. Bishop, and J.H. Patric. 1969. Some effects of clearcutting on salmon habitat of two southeast Alaska streams. U.S. Department of Agriculture, Forest Service. General

Technical Report PNW-82. Institute of Northern Forests, Pacific Northwest Forest and Range Experiment Station.

Michel, J. and M.O. Hayes. 1999. "Weathering patterns of oil residues eight years after the Exxon Valdez oil spill." *Marine Pollution Bulletin*. 38(10):855-863.

Miller, D.J. and J.J. Geibel. 1973. Summary of blue rockfish and lingcod life histories; A reef ecology study; and giant kelp, *Macrocystis pyrifera*, experiments in Monterey Bay, California. California Dept. of fish and Game, Fish Bull. 158.

Minerals Management Service (MMS). 2003. OCS EIS/EA MMS 2003-055. Alaska Outer Continental Shelf Cook Inlet Planning Area, Oil and Gas Lease Sale 191 and 199, Final Environmental Impact Statement. Volume II (Section VII and Appendices). Appendix E: "Applicable Federal laws, Regulatory Responsibilities, and Executive Orders."

Moazzam, M. and S.H.N. Rizvi. 1980. "Fish entrapment in the seawater intake of a power plant at Karachi coast." *Environ. Biology of Fishes*. 5:49-57.

Moles, A. and N. Hale. 2003. Use of physiological responses in *Mytilus trossulus* as integrative bioindicators of sewage pollution. Marine Pollution Bulletin. 46:954-958.

Montgomery, D.R. 1994. "Road surface drainage, channel initiation, and slope instability." *Water Resources Research*. 30:1925-1932.

Montgomery, D.R., R.D. Smith, K.M. Schmidt, and G.R. Pess. 1995. "Pool Spacing in Forest Channels." *Water Resources Research*. 31:1097-1105.

Moore, A. and Waring, C.P. 2001. "The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon (*Salmo salar* L)." *Aquatic Toxicology*. 52:1-12.

Muir, D., B. Braune, B. DeMarch, R. Norstrom, R. Wagemann, L. Lockhart, B. Hargrave, D. Bright, R. Addison, J. Payne, and K. Reimer. 1999. "Spatial and temporal trends and effects of contaminants in the Canadian Arctic marine ecosystem: a review." *Sci Total Environ.* 230:83-144.

Muir, D.C.G. and R.J. Norstrom. 2000. "Geographical differences and time trends of persistent organic pollutants in the Arctic." *Toxicol. Lett.* 112-113:93-101.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska—requirements for protection and restoration. U.S. Dep. Commer., NOAA Coastal Ocean Program, Decision Analysis Series No. 7, 156 + xxii p.

Murphy, M.L., S.W. Johnson, and D.J. Csepp. 2000. "A comparison of fish assemblages in eelgrass and adjacent subtidal habitats near Craig, Alaska." *AK. Fish. Res. J.* 7:11-21.

Murphy, M.L. and K V. Koski. 1991. Reform of logging practices in Alaska. Pages 220-21 *in* B. White and I Guthrie, eds. Pro. 15th Northe. Pac. Pink and Chum Salmon Workshop, Parksville, BC. Can. Dep. Fish. Oceans, Vancouver.

Murphy, M.L. and K.V. Koski. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. North American Journal of Fisheries Management 9, 427-436.

Myren, R.T. and R.J. Ellis. 1984. Evaportranspiration in forest succession and long-term effects upon fishery resources: a consideration for management of our old-growth forests. pp. 183-186. *In* Meehan, M.R., T.R. Merrill, Jr., and T.A. Hanley, eds. Fish and wildlife relationships in old growth forests. American Institute of Fishery Research Biologists.

Neff, J.M. 1985. Polycyclic aromatic hydrocarbons. *In* G.M. Rand and S.R. Petrocelli. Fundamentals of aquatic toxicology. pp. 416-454. Hemisphere Publishing, Washington, D.C.

Nelson, R.L., M. McHenry, and W.S. Platts. 1991. Mining. Influences of forest and rangeland management in salmonid fishes and their habitats. pp. 425-457. *In*: Meehan, W. ed. Influences of forest and range management on salmonid fishes and their habitats. AFS Special Publication 19. Bethesda, MD.

Newell, R.C., L.J. Seiderer, and D.R. Hitchcock. 1998. "The impact of dredging on biological resources of the sea bed." *Oceanography and Marine Biology Annual Review.* 36:127-178.

Nightingale, B. and C.A. Simenstad. 2001a. Dredging activities: Marine issues. Washington State Transportation Center, University of Washington, Seattle, WA 98105. (Document available through the National Technical Information Service, Springfield, VA 22616).

Nightingale, B. and C.A. Simenstad. 2001b. Overwater Structures: Marine Issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. www.wa.gov/wdfw/hab. 133 pp.

National Marine Fisheries Service (NMFS). 2004. Draft National Gravel Extraction Policy. 1335 East-West Highway, Silver Spring, MD 20910. http://www.nmfs.noaa.gov/habitat/habitatprotection/pdf/gravelguidance.pdf

NMFS. 2003. Biological Opinion for the Benicia-Martinez New Bridge Project, Southwest Region, Santa Rosa, California. Admin. Rec. 151422SWR02SR6292.

NMFS. 2002. Environmental Assessment, NMFS' Restoration Plan for the Community-Based Restoration Program. Prepared by the NOAA Restoration Center, Office of Habitat Conservation. Silver Spring, MD.

NMFS. 2001. Biological Opinion for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. Southwest Region, Santa Rosa, California. Admin. Rec. 151422SWR99SR190.

NMFS. 1998a. Draft document - Non-fishing threats and water quality: A reference for EFH consultation

NMFS. 1998b. Final recommendations: Essential Fish Habitat for Pacific Coast Groundfish. Prepared by: The Core Team for EFH for Pacific Coast Groundfish June 3, 1998. 2725 Montlake Blvd. E. Seattle, WA 98112. http://www.psmfc.org/efh/groundfish_desc.pdf.

North Pacific Fisheries Management Council (Council). 1999. Environmental Assessment for Amendment 55 to the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area; Amendment 55 to the Fishery Management Plan for Groundfish of the Gulf of Alaska; Amendment 8 to the Fishery Management Plan for the King and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands; Amendment 5 to the Fishery Management Plan for Scallop Fisheries off Alaska; Amendment 5 to the Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska, Essential Fish Habitat. 605 West 4th Ave, Suite 306, Anchorage, AK 99501-2252. 20 January.

Northcote, T.G. and G.F. Hartman. 2004. Fishes and Forestry - Worldwide Watershed Interactions and Management, Blackwell Publishing, Oxford, UK, 789 pp.

Northwest Power Planning Council. 1986. Compilation of information on salmon and steelhead losses in the Columbia River Basin. Columbia River Basin and Wildlife Program. Portland, OR.

National Research Council (NRC), Committee on Hardrock Mining. 1999. Hardrock Mining on Federal Lands. Appendix B. Potential Environmental Impacts of Hardrock Mining. (http://www.nap.edu/html/hardrock_fed_lands/appB.html).

NRC. 1996. Upstream: salmon and society in the Pacific Northwest. Report of the committee on protection and management of Pacific Northwest anadromous salmonids. Board on Environmental Studies and Toxicology, and Commission on Life Sciences. National Academy Press. Washington, D.C. 20055.

NRC. 1989. Irrigation-induced water quality problems: what can be learned from the San Joaquin Valley experience. National Academy Press, Washington, D.C.

O'Hara, T. 2001. *Evaluating Environmental Contaminant Trends in Arctic Alaska Marine Mammals: Biological and Experimental Design Considerations.* Workshop to Assess Contaminant Impacts on Steller Sea Lions in Alaska. Anchorage, AK, September 5-6, 2001. Sponsored by Auke Bay Laboratory.

Oil and Gas Technologies for the Arctic and Deepwater. 1985. U.S. Congress, Office of Technology Assessment, OTA-O-270, May 1985. Library of Congress Catalog Card Number 85-600528. U.S. Government Printing Office, Washington, DC 20402.

Omori, M., S. Van der Spoel, C.P. Norman. Impact of human activities on pelagic biogeography. Progress in Oceanography 34 (2-3):211-219.

Oregon Water Resource Research Institute (OWRRI). 1995. Gravel disturbance impacts on salmon habitat and stream health, volume 1. summary report. Oregon State University, Corvallis, Oregon. (Also available Vol. II: Technical background report). Available from Oregon Division of State Lands, Salem, Oregon, 503-378-3805.

Peterson, C. H., S. D. Rice, J. W. Short, D. Esler, J. L. Bodkin, B. E.Ballachey, and D. B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302: 2082-2086.

Pezeshki, S.R., R.D. Delaune, and W.H. Patrick, Jr. 1987. "Response of the freshwater marsh species, *Panicum hemitomon Schult.*, to increased salinity." *Freshwater Biology*. 17:195-200.

Pacific Fishery Management Council. 1999. Appendix A: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast Salmon Plan. Portland, OR. 146 pp.

Pacific Northwest Pollution Control Council. 1971. Log storage and rafting in public waters. Task Force report. p. 56.

Phillips, R.C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: a community profile. U.S. Fish and Wildlife Service. FWS/OBS-84/24. 85 pp.

Platts, W.S. 1991. Livestock grazing. pp. 389-424. *In* Meehan, W.R, ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. American Fisheries Society, Bethesda, MD.

Polasek, L.G. 1997. Assessment of wetland habitat alterations resulting from construction of a pipeline through coastal marshes in Orange County, Texas. Final Report: Texas Parks and Wildlife Department, Port Arthur, TX. 40 pp.

Poston, T. 2001. Treated wood issues associated with overwater structures in marine and freshwater environments. White Paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation by Batelle. 85 pp.

Preston, B.L. 2002. "Indirect effects in aquatic ecotoxicology: implications for ecological risk assessment." *Environmental Management*. 29:311-323.

Raco-Rands, V.E. 1996. Characteristics of effluents from power generating stations in 1994. *In* Allen, M.J, ed. Southern California Coastal Water Research Project, Annual Report 1994-95. SCCWRP, Westminster, CA. pp. 29-36.

Ralph, S., G. Poole, L. Conquest, and R. Naiman. 1994. "Stream channel morphology and woody debris in logged and unlogged basins in western Washington." *Can. J. Fish. Aquatic Sciences.* 51:37-51.

Raymond, H. 1979. "Effects of dams and impoundment on migrations of juvenile chinook salmon and steelhead from the Snake River, 1966 to 1975." *Trans. Amer. Fish. Soc.* 108:505-529.

Reinjders, P.J.H. 1986. "Reproductive failure in common seals feeding on fish from polluted coastal waters." *Nature*. 324:456-457

Reiser and Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in the Western United States and Canada. Meehan, W.R., ed. U.S. Department of Agriculture, Forest Service. General Technical Report PNW-96. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. Portland, OR.

Reyff, J.A and P. Donovan. 2003. Benicia-Martinez Bridge Bubble Curtain Test - Underwater Sound Measurement Data. Memo to Caltrans dated January 31, 2003. 3 pp.

Reyff, J.A. 2003. Underwater sound levels associated with seismic retrofit construction of the Richmond-San Rafael Bridge. Document in support of Biological Assessment for the Richmond-San Rafael Bridge Seismic Safety Project. January 31, 2003. 18 pp.

Rice, S.D., J.W. Short, R.A. Heintz, M.G. Carls, and A. Moles. 2000. Life-history consequences of oil pollution in fish natal habitat. pp. 1210-1215. *In* Catania, P., ed. *Energy 2000*. Balaban Publishers, Lancaster, England.

Riedman, M. 1990. *The Pinnipeds*. University of California Press. Berkeley, California. 439 pp.

Rogers, P.H. and M. Cox. 1988. Underwater sound as a biological stimulus. pp. 131-149. *In* Sensory biology of aquatic animals. Atema, J, R.R. Fay, A.N. Popper, and W.N. Tavolga, eds. Springer-Verlag. New York.

Rosecchi, E., A.J. Crivelli, G. Catsadorakis. 1993. The establishment and impact of Pseudorabora parva, an exotic fish species introduced into lake Mikri Prespa (northwestern Greece). Aquatic Conservation: Marine and Freshwater Ecosystems 3:223-231.

Ruus, A., K.I. Ugland, and J.U. Skaare. 2002. "Influence of trophic position on organochlorine concentrations and compositional patterns in a marine food web." *Env. Tox. Chem.* 21(11):2356-2364.

Safavi, H.R. 1996. Quality control of urban runoff and sound management. Hydrobiologia: Diapause in the Crustacea. pp. 131 -141.

Sand, O., P.S. Enger, H.E. Karlsen, F. Knudsen, T. Kvernstuen. 2000. "Avoidance responses to infrasound in downstream migrating European silver eels, *Anguilla anguilla.*" *Environmental Biology of Fishes*. 57:327-336.

Scholz, N.L., N.K. Truelove, B.L. French, B.A. Berejikian, T.P. Quinn, E. Casillas, and T.K. Collier. 2000. "Diazinon disrupts antipredator and homing behaviors in chinook salmon (*Oncorhynchus tsawytscha*)." *Canadian Journal of Fisheries and Aquatic Sciences.* 57:1911-1918.

Schueler, T. 1994. The importance of imperiousness. Watershed Protection Techniques 2(4):100-111.

Schult, D.T. and D.J. McGreer 2001. Effects of forest harvesting and roads on streamflow processes and application to watersheds of Southeast Alaska. Summary of Monitoring Studies of the Effectiveness of Practices under the Alaska Forest and Resources Practices Act 1990-2002. Compiled by Alison Arians, DNR Division of Forestry, April 2003. A report funded by the Alaska Coastal Management Program, Office of the Governor, pursuant to NOAA Award No. NA17OZ1113.

Science Applications International Corporation. 2001. Information Collection Request for National Pollutant Discharge Elimination System (NPDES) and Sewage Sludge Monitoring Reports. Prepared by the Science Applications International Corporation, 11251 Roger Bacon Drive, Reston, VA 20190, for Tetra Tech, Inc., Fairfax, VA, for the U.S. Environmental Protection Agency, Office of Wastewater Management, Washington, D.C. EPA ICR# 0229.15. p. 11.

Scott G.I., M.H. Fulton, D.W. Moore, E.F. Wirth, G.T. Chandler, P.B. Key, J.W. Daugomah, E.D. Strozier, J. Devane, J.R. Clark, M.A. Lewis, D.B. Finley, W. Ellenberg, and K.J. Karnaky. 1999. "Assessment of risk reduction strategies for the management of agricultural nonpoint source pesticide runoff in estuarine ecosystems." *Toxicology and Industrial Health*. 15:200-213.

Scrivener, J.T. and M.J. Brownlee. 1989. "Effects of forest harvesting on spawning gravel and incubation survival of chum (*Oncorhynchus kata*) and coho (*O. kisutch*) salmon in Carnation Creek, British Columbia." *Canadian Journal of Fisheries and Aquatic Sciences.* 46(4):681-696.

Sedell, J.R., and K.J. Luchessa. 1982. Using the historical record as an aid to salmonid habitat enhancement. In Armantrout, N.B. (ed.), Acquisition and utilization of aquatic habitat inventory information, p. 210-222. American Fisheries Society, Western Division, Bethesda, MD.

Sengupta, M. 1993. Environmental Impacts of Mining: Monitoring, Restoration, and Control. CRC Press, Inc. 2000 Corporate Blvd., N.W. Boca Raton, FL. 33431. p.1.

Shafer, D.J. 2002. Recommendations to minimize potential impacts to seagrasses from single-family residential dock structures in the Pacific Northwest. U.S. Army Corps of Engineers, Seattle, WA. 28 p.

Short, J. W., M. R. Lindeberg, P. M. Harris, J. M. Maselko, J. J. Pella, and S. D. Rice. 2004. Estimate of oil persisting on beaches of Prince William Sound, 12 after the Exxon Valdez oil spill. Environmental Science and Technology 38(1): 19-25.

Short, Jeffrey W., Stanley D. Rice, Ron A. Heintz, Mark G. Carls, and Adam Moles. 2003. Long-term Effects of Crude Oil on Developing Fish: Lessons from the Exxon Valdez Oil Spill. Energy Sources 25: 509-517.

Short, J.W., M.R. Lindeberg, P.M. Harris, J. Maselko, and S.D. Rice. 2002. Vertical Oil Distribution Within the Intertidal Zone 12 Years After the *EXXON VALDEZ* Oil Spill in Prince William Sound, Alaska. Pp. 57-72 In: Proceedings of the Twenty-fifth Arctic and Marine Oilspill Program (AMOP) Technical Seminar. Environment Canada, Ottawa, Ontario.

Sidle, R.C., A.J. Pearce, and C.L. O'Loughlin. 1985. Hillslope stability and land use. Water Resources Monograph 11. Washington D.C.: American Geophysical Union 140 pp.

Simenstad, C.A., C.D. Tanner, F. Weinmann, and M. Rylko. 1991. The estuarine habitat assessment protocol. Puget Sound Notes. No. 25. June 1991.

Sogard, S.M. and K.W. Able. 1991. "A comparison of eelgrass, sea lettuce macroalgae and marsh creeks as habitats for epibenthic fishes and decapods." *Estuarine, Coastal and Shelf Science.* 33, 501-519.

Soil Conservation Service, U.S. Department of Agriculture, Forest Service, and Economic Research Service. 1984. Southeast Washington cooperative river basin study. U.S. Department of Agriculture, Washington, D.C.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. 356 pp. (Available from the NMFS Habitat Branch, Portland, OR).

Stadler, J.H. 2002. Personal observation of fish-kill occurring during pile driving activity at the Winslow Ferry Terminal, Winslow, WA. October 7, 2002. Fish Biologist, DOC/NOAA/National Marine Fisheries Service/HCD, Lacey, WA.

Stehr, C.M., D.W. Brown, T. Hom, B.F. Anulacion, W.L. Reichert, and T.K. Collier. 2000. "Exposure of juvenile chinook and chum salmon to chemical contaminants in the Hylebos Waterway of Commencement Bay, Tacoma, Washington." *Journal of Aquatic Ecosystem Stress and Recovery*. 7:215-227.

Stein, J., T. Hom, T. Collier, D. Brown, and U. Varanasi. 1995. "Contaminant exposure and biochemical effects in outmigrant juvenile chinook salmon from urban estuaries of Puget Sound, WA." *Environ. Toxicol. Chem.* 14:1019-1029.

Steward, C. 1983. Salmonoid populations in an urban environment - Kelsy Creek, Washington. M.S. Thesis, University of Washington.

Stewart, R K. and D.R. Tangarone. 1977. Water Quality Investigations Related to Seafood Processing Wastewater Discharges at Dutch Harbor, Alaska - October 1975 and October 1976. Region X, U.S. Environmental Protection Agency. Working Paper #EPA 910/8-77-100. 78 pp.

Stotz, T. and J. Colby. 2001. January 2001 dive report for Mukilteo wingwall replacement project. Washington State Ferries Memorandum. 5 pp. + appendices.

Swanston, D.N. 1974. The forest ecosystem of southeast Alaska. Soil mass movement. General Technical Report PNW-17. U.S. Department of Agriculture, Forest Service. Pacific Northwest Forest and Range Experiment Station. Portland, OR.

Thayer, G.W., W.J. Kenworthy, and M.S. Fonseca. 1984. The ecology of eelgrass meadows of the Atlantic coast: a community profile. U.S. Fish and Wildlife Service FWS/OBS-84/02. 147 pp.

Travnichek, V.H., A.V. Zale, and W.L. Fisher. 1993. "Entrainment of ichthyoplankton by a warmwater hydroelectric facility." *Trans. Amer. Fish. Soc.* 122:709-716.

Trombulak, S.C. and C.A. Frissell. 2000. "Review of ecological effects of roads on terrestrial and aquatic communities." *Conservation Biology.* 14(10):18-30. February.

U.S. Army Corps of Engineers (USACE). 1993. Engineering and Design: Environmental; Engineering for Small Boat Basins. EM 1110-2-1206. Dept. of the Army, CECW-EH-W. Washington DC.

U.S. Environmental Protection Agency (USEPA). 2002. National Water Quality Inventory: 2000 Report to Congress. EPA-841-R-02-001. EPA Office of Water, Washington, D.C.

USEPA. 2001. Reissuance of the NPDES General Permit for Seafood Processors Operating Throughout Alaska in Waters of the United States (NPDES General Permit No. AK-G52-0000) Federal Register: July 27, 2001. U.S. Environmental Protection Agency (EPA), Region X.

USEPA. 2000. Environmental Screening Checklist and Workbook for the Water Transportation Industry. August 2000.

USEPA, Region 10. 2000. Authorization to discharge under the National Pollutant Discharge Elimination System (NPDES) for Section 402 modifications of Section 404 permits for log Transfer Facilities which received a Section 404 permit prior to October 22, 1985. NPDES Permit Number AK-G70-0000. March 2000. 1200 Sixth Avenue, OW-130 Seattle, Washington 98101.

USEPA, Region 10. 1996. Authorization to discharge under the National Pollutant Discharge Elimination System (NPDES) for Section 402 modifications of Section 404 permits for log Transfer Facilities which received a Section 404 permit prior to October 22, 1985. NPDES Permit Number AK-G70-1000. EPA Response to Comments from September 1996 Public Notice http://info.dec.state.ak.us/DECPermit/water31rtc.pdf.

USEPA. 1995. National Water Quality Inventory: 1994 Report to Congress. EPA-841-R-95-005. EPA Office of Water, Washington, D.C.

USEPA. 1993. Guidance for specifying management measures for sources of nonpoint pollution in coastal waters. EPA Office of Water. 840-B-92-002. 500+ pp.

USEPA. 1979. Impact of Seafood Cannery Waste on the Benthic Biota and Adjacent Waters at Dutch Harbor, Alaska.

USEPA. 1974. Development Document for Effluent Limitations Guidelines and Standards of Performance for the Catfish, Crab, Shrimp, and Tuna segments of the Canned and Preserved Seafood Processing Industry Point Source Category. Effluent Guidelines Division, Office of Water and Hazardous Material, Washington, D.C. EPA-44011-74-020-a. 389 pp.

U.S. Fish and Wildlife Service. 1980. FWS/OBS-80/09. Gravel Removal Guidelines Manual for Arctic and Subarctic Floodplains. June 1980. Prepared by Woodward Clyde Consultants. Contract Number FWS-14-16-0008-970. Performed for the Water Resources Analysis Project, Office of Biological Services. U.S. Department of the Interior, Washington, D.C. 20240.

U.S. Geologic Survey (USGS). 1999. The quality of our nation's waters: Nutrients and pesticides. pp. 33-55. USGS, Reston, VA.

U.S. Department of Agriculture (USDA) Forest Service. 2003. Tongass Best Management Practice Implementation Monitoring Report.

USDA Forest Service. 2000. Tongass National Forest Draft Annual Monitoring Report.

Van der Veer, H., M.J.N. Bergmen, and J.J. Beukema. 1985. "Dredging activities in the Dutch Wadden Sea effects on marcobenthic infauna." *Netherlands Journal for Sea Research*. 19:183-190.

Van Dolah, R.E., P.P. Maier, M.H. Fulton, and G.I. Scott. 1997. "Comparison of azinphomethyl toxicity to juvenile red drum (*Scianops ocellatus*) and the mummichog (*Fundulus heteroclitus*)." *Environmental Toxicology and Chemistry*. 16:1488-1493.

Vuorinen, P.J., R. Parmanne, T. Vartiainen, M. Keinanen, H. Kiviranta, O. Kotovuori, and F. Hallig. 2002. "PCDD, PCF, PCB and thiamin in Baltic herring (*Clupea harengus* L.) and sprat (*Sprattus sprattus* L.) as a bacground to the M74 syndrome of Baltic salmon (*Salmo salar* L.)." *ICES J. Mar. Sci.* 59:480-496.

Waisley, S.L. 1998. Projections for U.S. and Global Supply and Demand for 2010 and 2020. presented at U.S. and China Oil and Gas Industrial Forum, Beijing, People's Republic of China, November 2-4, 1998. Office of Natural Gas and Petroleum Technology, U.S. DOE, Washington, D.C. (http://www.fe.doe.gov/oil_gas/china_forum/cl04000.html).

Walker, D., R. Lukatelich, R.G. Bastyan and A.J. McComb. 1989. "The effect of boat moorings on seagrass beds near Perth, Western Australia." *Aquatic Botany*. 36:69-77. *In* Shafer, D.J. 2002. Recommendations to minimize potential impacts to seagrasses from single-family residential dock structures in the Pacific Northwest. U.S. Army Corps of Engineers, Seattle, WA. 28 pp.

Wania, F. and D. Mackay. 1999. "Global chemical fate of hexachlorocyclohexane. 2. Use of a global distribution model for mass balancing, source apportionment, and trend prediction." *Environ Toxicol Chem*. 18: 1400B1407.

Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of seismic airguns on marine fish. Fisheries Research Services, Marine Laboratory. Continental Shelf Research, 21 (8-10). pp. 1005-1027.

Warrington, P.D. 1999. Impacts of outboard motors on the aquatic environment. http://www.nalms.org/bclss/impactsoutboard.htm.

Washington State Department of Wildlife. 1998. Gold and fish. Rules and regulations for mineral prospecting and mining in Washington State. Draft, February 1998. Olympia, WA.

Weaver, T.M. and J.J. Fraley. 1993. "A method to measure emergence success of westslope cutthroat trout fry from varying substrate compositions in a natural stream channel." *North American Journal of Fisheries Management*. 13(4):817-822.

Wemple, B.C., F.J. Swanson, and J.A. Jones. 2001. "Forest roads and geomorphic process interactions, Cascade Range, Oregon." *Earth Surface Processes and Landforms*. 26:191-204.

Wemple, B.C., J.A. Jones, and G.E. Grant. 1996. "Channel network extension by logging roads in two basins, western Cascades, Oregon." *Water Resources Bulletin.* 32:1195-1207.

West, C., L. Galloway, and J. Lyon. 1995. Mines, Stormwater Pollution, and You. Mineral Policy Center, Washington, D.C.

Williams, G.D. and R.M. Thom. 2001. Marine and estuarine shoreline modification issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. www.wa.gov/wdfw/hab/ahg. 99 pp.

Würsig, B., C.R. Greene, Jr., and T.A. Jefferson. 2000. "Development of an air bubble curtain to reduce underwater noise of percussive pile driving." *Marine Environmental Research*. 49:79-93.

Wyllie-Echeverria, S. and R.C. Phillips. 1994. pp. 1-4. *In* Wyllie-Echeverria, S., A.M. Olson and M.J. Hershman, eds. Seagrass science and policy in the Pacific Northwest: proceedings of a seminar series (SMA 94-1) EPA 910/R-94-004. 63 pp.

Yang, J., D. Shin, S. Park, Y. Chang, D. Kim, and M.G. Ikonomou. 2002. "PCDDs, PCDFs and PCBs concentrations in breast milk from two areas in Korea: body burden of mothers and implications for feeding infants." *Chemosphere*. 46(3):419-28.

Yelverton, J.T., D.R. Richmond, W. Hicks, K. Saunders, and R. Fletcher. 1975. The relationship between fish size and their response to underwater blast. Lovelace Foundation for Medical Education and Research, Albuquerque, NM.

Ylitalo, G.M. C.O. Matkin, J. Buzitis, M.M. Krahn, L.L. Jones, T. Rowles, and J.E. Stein. 2001a. "Influence of life-history parameters on organochlorine concentrations in fee-ranging killer whales (*Orcinus orca*) from Prince William Sound, AK." *Sci. Tot. Env.* 281:183-203.

Ylitalo, G.M., J.W. Bickham, J. Buzitis, G.K. Yanagida, J.E. Stein, and M.M. Krahn. 2001b. *Contaminant Bioaccumulation and Feeding ecology of Steller Sea Lions from Alaska*. Workshop to Assess Contaminant Impacts on Steller Sea Lions in Alaska. Anchorage, AK, September 5-6, 2001. Sponsored by Auke Bay Laboratory.

York, A.E., R.L. Merrick, and T.R. Loughlin. 1996. An analysis of the Steller sea lion metapopulation in Alaska. *In* McCullough, D., ed. Metapopulations and wildlife conservation and management. Island Press, Covelo, CA. pp. 259-292.

Young, M.K., W.A. Hubert, and T.A. Wesche. 1991. "Selection of measures of substrate composition to estimate survival to emergence of salmonids and to detect changes in stream substrates." *North American Journal of Fisheries Management*. 11 (3):339-346.

Zale, A.V., O.E. Maughan, D.J. Orth, and W. Layher. 1993. Withdrawals. *In* Bryan, C.F and D.A. Rutherford, eds. Impacts on warmwater streams: Guidelines for evaluation. Pp. 271-281. Southern Division, American Fisheries Society, Little Rock, AR.

Zedler, J.B., C.S. Nordby, and B.E. Kus. 1992. The ecology of the Tijuana Estuary, California: A National Estuarine and Research Reserve. NOAA Office of Coastal Resource Management, Sanctuaries and Reserves Division, Washington, D.C.

Zenteno-Savin, T., M. Castellini, L.D. Rea, and B.S. Fadely. 1997. "Plasma haptoglobin in threatened Alaskan pinniped populations." *J. Wildlife Dis.* 33:64-71.

Zeppelin, T.K., K.A. Call, D.J. Tollit, T.J. Orchard, and C.J. Gudmundson. 2003. Estimating the size of walleye pollock and Atka mackerel consumed by the western stock of Steller sea lions. Marine Science in the Northeast Pacific. Sponsored by Exxon Valdez Oil Spill Trustee Council, GLOBEC-Northeast Pacific Program, Steller Sea Lion Investigations, North Pacific Reesarch Board, North Pacific Marine Research Institute and Pollock Conservation Cooperative. Anchorage, Alaska. January 13-17.

Zielger, A.D., R.A. Sutherland, and T.W. Gaimbelluca. 2001. "Interstorm surface preparation and sediment detachment by vehicle traffic on unpaved mountain roads." *Earth Surface Processes and Landforms*. 26:235-250.

Additional Resources

American Association of Port Authorities (AAPA). Environmental Management Handbook. http://www.aapa-ports.org/govrelations/env_mgmt_hb.htm

Aquatic Invasive Species Research and Outreach: http://www.nsgo.seagrant.org/research/nonindigenous/.

Baird, R.C. 1996. "Toward new paradigms in coastal resource management: Linkages and institutional effectiveness." Spagnolo, RJ; E. Ambrogio, F.J. Rielly, Jr., eds. *Estuaries*. 19(2A): 320-335.

Beckmen, K.B., K.A. Burek, K.W. Pitcher, G.M. Ylitalo, and L.K. Duffy. *In press*. Mercury concentrations in the fur of Steller sea lions and northern fur seals from Alaska. Mar. Poll. Bull.

Benaka, L., ed. 1999. Fish Habitat: essential fish habitat and rehabilitation. American Fisheries Society, Symposium 22, Bethesda, Maryland, 459 pp.

Bettinger, P., J. Sessions, and K.N. Johnson. 1998. "Ensuring the compatibility of aquatic habitat and commodity production goals in eastern Oregon with a Tabu search procedure." *Forest Science*. 44(1):96-112.

Bilby, R.E. and J.W. Ward. 1991. "Characteristics and function of large woody debris in streams draining old-growth, clear-cut, and second-growth forests in southwestern Washington." *Canadian Journal of Fisheries and Aquatic Sciences*. 48:2499-2508.

Bisson, P.A., J.L. Nielsen, and J.W. Ward. 1988. "Summer production of coho salmon stocked in Mount St. Helens streams 3-6 years after the 1980 eruption." *Transactions of the American Fisheries Society*. 117(4):322-335.

Blanton, S.L., R.M. Thom, A.B. Borde, H. Diefenderfer, and J.A. Southard. 2002. Evaluation of methods to increase light under ferry terminals. Final Research Report prepared for Washington State Department of Transportation by Battelle, Pacific Northwest Division of Battelle Memorial Institute. PNNL-13714. 26 pp.

Blanton, S.L., R.M. Thom, J.A. Southard. 2001. Documentation of ferry terminal shading, substrate composition, and algal and eelgrass coverage. Letter Report prepared for University of Washington, School of Aquatic and Fishery Sciences, Seattle, Washington by Battelle Marine Sciences Laboratory, Sequim, Washington. 17 pp.

Bue, B.G., S. Sharr, and J.E. Seeb. 1998. "Evidence of damage to pink salmon populations inhabiting Prince William Sound, Alaska, two generations after the *Exxon Valdez* oil spill." *Transactions of the American Fisheries Society.* 127: 35-43.

Cardwell, R.D., M.I. Carr, and E.W. Sanborn. 1980. Water quality and flushing of five Puget Sound marinas. Technical Report No. 56. Washington Department of Fisheries Research and Development. Olympia, WA. 77 pp.

Castro, J. 2003. Geomorphologic impacts of culvert replacement and removal: avoiding channel incision. USFWS-Oregon Fish and Wildlife Office, Portland, OR.

Cederholm, C.J. and L.M. Reid. 1987. Impact of Forest Management on Coho Salmon (*Oncorhynchus kisutch*) Populations of the Clearwater Rivers, Washington: A Project Summary. *In* Streamside Management: Forestry and Fishery Interactions. Salo, E.O. and T.W. Cundy, eds. College of Forest Resources, University of Washington, Seattle, Washington. University of Washington, Institute of Forest Resources. Contribution No. 57.

Cederholm, C.J. and N.P. Peterson. 1985. "The retention of coho salmon (*Oncorhynchus kisutch*) carcasses by organic debris in small streams." *Canadian Journal of Fisheries and Aquatic Sciences*. 42:1222-1225.

Cederholm, C.J., D.B. Houston, D.L. Cole, and W.J. Scarlett. 1989. "Fate of coho salmon (*Oncorhynchus kisutch*) carcasses in spawning streams." *Canadian Journal of Fisheries and Aquatic Sciences*. 46, 1347-1355.

Chambers, J.R. 1992. Coastal degradation and fish population losses. pp 45-51. *In* Stroud, R.H. ed. Stemming the tide of coastal fish habitat loss. Proceedings of a symposium on conservation of coastal fish habitat. National Coalition for Marine Conservation, Inc., Savannah GA.

Cross, J.N. and L.G. Allen. 1993. Fishes. *In* Dailey, M.D. D.J. Reish, and J.W. Anderson,eds. Ecology of the Southern California Bight, Univ. Calif. Press, Berkeley, CA. Pp.459-540.

Coffin, B.A. and R.D. Harr. 1992. Effects of forest cover on volume of water delivery to soil during rain-on-snow. Washington Department of Natural Resources Timber/Fish/Wildlife Program. TFW-SH1-92-001.

Collins, M.A. 1995. Dredging-induced near-field re-suspended sediment concentration and source strengths. Miscellaneous Paper D-95-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. NTIS No. AD A299 151.

Culp, J.M. and R.W. Davies. 1983. "An assessment of the effects of streambank clear cutting on macroinvertebrate communities in a managed watershed." *Canadian Technical Report of Fisheries and Aquatic Sciences*. No. 1208. 116 pp.

Drinkwater, K.F. and K.T. Frank. 1994. "Effects of river regulation and diversion on marine fish and invertebrates." *Aquatic Conservation.: Mar. Freshwat. Ecosyst.* 4(2):135-151.

Ellis, D.V. 1982. *Marine Tailings Disposal*. Ann Arbor Science Publishers. Ann Arbor, Michigan. 368 pp.

EPA (U.S. Environmental Protection Agency). 2000. Scoping Document for the Proposed Pogo Mine Site. U.S. EPA, Region 10, 1200 Sixth Ave., Seattle, WA 98101. 11 August. (http://www.pogomineeis.com/documents/ScopingDraft.pdf).

EPA, Office of Water (http://www.epa.gov/water/) and Office of Pesticide Programs (http://www.epa.gov/pesticides/).

EPA, Office of Wetlands, Oceans and Watersheds, Ocean and Coastal Protection Division, Marine Debris Abatement (http://www.epa.gov/owow/oceans/debris/)

EPA. 1975. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottom fish, clam, oyster, sardine, scallop, herring, and abalone segment of the canned and preserved fish and seafood processing industry point source category. Effluent Guidelines Division, Office of Water and Hazardous Material, Washington, D.C. EPA 440/1-75/041a. 485 pp.

EPA. 1992. Turning the Tide on Trash: Marine Debris Curriculum. A Learning Guide on Marine Debris. EPA842-B-92-003 (http://www.epa.gov/owow/OCPD/Marine/contents.html)

EPA. 1993. Guidance specifying management measures for sources of nonpoint pollution in coastal waters. 640-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C., January.

EPA. 1997. Office of Water. Guidance specifying management measures for sources of nonpoint pollution in coastal waters. Chapter 5: Management measure for marinas and recreational boating. (http://www.p2pays.org/ ref/04/03686/index-5.html).

Ewing, R.D. 1999. Diminishing returns: salmon decline and pesticides. Oregon Pesticide Education Network, Eugene, Oregon. 52 pp.

Faris, T.L. and K.D. Vaughan. 1985. Log transfer and storage facilities in Southeast Alaska: a review. USDA Forest Service General Technical Report PNW-174. Portland, OR.

Farnworth, E.G., M.C. Nichols, C.N. Vann, L.G. Wolfson, R.W. Bosserman, P.R. Hendrix, F.B. Golley, and J.L. Cooley. 1979. Impacts of sediment and nutrients on biota in surface waters of the United States. U.S. Environmental Protection Agency. Athens, GA (USA)., Oct 1979. Ecol. Res. Series. 331 pp.

Flanders, L.S. and J. Cariello. 2000. Tongass Road Condition Survey Report. Alaska Department of Fish and Game, Southeast Regional Office of the Habitat and Restoration Division, Alaska Department of Fish and Game, 802 3rd Street, Douglas, AK., 99824. Technical Report 00-7. 48 pp.

Fresh, K. 1997. The role of competition and predation in the decline of Pacific salmon and steelhead. *In* Stouter, D., P. Bisson, and R. Naiman, eds. *Pacific Salmon and Their Ecosystems: Status and Future Options.* Chapman and Hall, New York.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. *In* Meehan W.R., ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society: 297-323.

Gayaldo, P., S. Wyllie-Echeverria, and K. Ewing. 2001. Transplantation and alteration of submarine environment for restoration of Zostera marina (eelgrass); a case study at Curtis Wharf (Port of Anacortes), Washington. Presented at Puget Sound Research 2001, February 12-14, 2001, Bellevue, WA.

Gibbons, D.R., W.R. Meehan, K.V. Koski, and T.R. Merrell, Jr. 1987. History of fisheries and forestry interactions in southeastern Alaska. *In* Salo, E.O. adn T.W. Cundy, eds. Streamside Management: Forestry and Fishery Interactions. Contribution No. 57, University of Washington, College of Forest Resources, Seattle. pp. 297-329.

Good, J.W. 1987. Mitigating estuarine development impacts in the Pacific Northwest: from concept to practice. Northwest Environmental Journal. Volume 3, Number 1.

Gregory, R.S. 1993. "Effect of turbidity on the predator avoidance behavior of juvenile chinook salmon (*Oncorhynchus tshawytcha*)." *Canadian J. Fish. Aquatic Sciences*. 50:241-246.

Gucinski, H., M.J. Furniss, R.R. Ziemer, and M.H. Brookes. 2000. Forest Roads: A Synthesis of Scientific Information, USDA Forest Service. June 2000. 117 pp.

Harvey, B.C. and T.E. Lisle. 1998. "Effects of suction dredging on stream: A review and an evaluation strategy." *Fisheries*. 23:8-17.

Hastings, K., P. Hesp, and G. Kendrick. 1995. "Seagrass loss associated with boat moorings at Rottnest Island, Western Australia." *Ocean and Coastal Management*. 26:225-246.

Herke, W.H. and B.D. Rogers. 1993. Maintenance of the estuarine environment. pp. 263-286. *In* Kohler, C.C. and W.A. Hubert, eds. Inland fisheries management in North America. American Fisheries Society, Bethesda, MD.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J.R. Sedell. 1991. Responses of salmonids to habitat changes. *In* Meehan, W.R., ed. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19, 483-518.

Hilderbrand, R.H., A.D. Lemly, C.A. Dolloff, and K.L. Harpster. 1998. "Design considerations for large woody debris placement in stream enhancement projects." *North American Journal of Fisheries Management*. 18 (1):161B167.

Independent Multidisciplinary Science Team. 2002. Recovery of Wild Salmonids in Western Oregon Lowlands. Technical Report 2002-1 to the Oregon Plan for Salmon and Watersheds, Governor's Natural Resources Office, Salem, OR.

Johnson, S.W., J. Heifetz, and K.V. Koski. 1986. "Effects of logging on the abundance and seasonal distribution of juvenile steelhead in some southeastern Alaska USA streams." *North American Journal of Fisheries Management.* 6, 532-537.

King County Department of Natural Resources and Parametrix, Inc. 2002. Bioaccumulation and King County secondary treated effluent: data review, method evaluation, and potential on Puget Sound aquatic life. Unpublished paper in support of the draft Habitat Conservation Plan-in-progress. 38 pp + appendix.

Klimley, A.P. and S.C. Beavers. 1998. "Playback of ATOC-type signal to bony fishes to evaluate phonotaxis." *Journal of Acoustic Society of America*. 104:2506-2510.

Kline, E.R. 1994. Potential biological consequences of submarine mine-tailings disposal: a literature synthesis. U.S. Dept. of the Interior, Bureau of Mines, Juneau, AK, OFR 36-94.

Koski, K.V. 1975. The survival and fitness of two stocks of chum salmon (*Oncorhynchus keta*) from egg deposition to emergence in a controlled-stream environment at Big Beef Creek. Ph.D. Dissertation, University of Washington, Seattle, WA.

Koski, K.V., J. Heifetz, S. Johnson, M. Murphy, and J. Thedinga. 1984. Evaluation of buffer strips for protection of salmonid rearing habitat and implications for enhancement. *In* Hassler, T.J., ed. Proceedings: Pacific Northwest Stream Habitat Management Workshop, American Fisheries Society, Humboldt State University, Arcata, CA. pp.138-155.

LaSalle, M.W., D.G. Clarke, J. Homziak, J.D. Lunz, and T.J. Fredette. 1991. A framework for assessing the need for seasonal restrictions on dredging and disposal operations. Technical Report D-91-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. NTIS No. AD A240 567.

Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams, D. Burns, J. Clayton, L. Decker, R. Gresswell, R. House, P. Howell, K.N. Lee, K. MacDonald, J. McIntyre, S. McGivney, T. Noel, J.E. O'Connor, C.S. Overtone, D. Perkinson, K. Tu, and P. VanEimeren. 1997. Broadscale assessment of aquatic species and habitats. Vol III, Chapter 4. *In* Quigley, T.M. and S. J. Arbelbide, eds. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins. Gen. Tech. Rep. PNW-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Leonard, J.N. 1994. Ocean outfalls for wastewater discharges – meeting CWA 403C requirements. Marine Technology Soc. '94, Conference Proceedings. Challenges and Opportunities in the Marine Environment, Washington, DC, 7-9 Sept. pp. 115-120.

Love, M.S., J.E. Caselle, and L. Snook. 1999. "Fish assemblages on mussel mounds surrounding seven oil platforms in the Santa Barbara Channel and Santa Maria Basin." *Bulletin Marine Science.* 55:1062-1085.

McFadden, J.T. 1969. Dynamics and regulation of salmonid populations in streams. In: Northcote, T.E., ed. Symposium on salmonid populations in streams. Vancouver: University of British Columbia, Institute of Fisheries. pp. 313-329.

McLusky, D.S., D.M. Bryant, and M. Elliot. 1992. "The impact of land-claim on macrobenthos, fish and shorebirds on the Forth Estuary, eastern Scotland." *Aquat. Conserv.: Mar. Freshwat. Ecosyst.* 2 (3):211-222.

Meehan, W.R., W.A. Farr, D.M. Bishop, and J.H. Patric. 1969. Some effects of clearcutting on salmon habitat of two southeast Alaska streams. USDA Forest Service General Technical Report PNW-82. Institute of Northern Forests., Pacific Northwest Forest and Range Experiment Station.

Murphy, M.L. and J.D. Hall. 1981. "Varied effects of clear-cut logging on predators and their habitat in small streams of the Cascade Mountains, Oregon." *Canadian Journal of Fisheries and Aquatic Sciences*. 38:137-145.

Myren, R.T. and R.J. Ellis. 1984. Evaportranspiration in forest succession and long-term effects upon fishery resources: a consideration for management of our old-growth forests. Pages 183-186 IN: M.R. Meehan, T.R. Merrill, Jr. and T.A. Hanley, eds. Fish and wildlife relationships in old growth forests. American Institute of Fishery Research Biologists.

NOAA (National Oceanic and Atmospheric Administration). 1991. National Status and Trends Program for marine environmental quality. Progress report on secondary summary of data on chemical contaminants in sediments from the National Status and Trends Program. Tech. Mem. NOS OMA 59. NOAA, NOS, Silver Spring, MD. 29 pp.

NMFS. 2001. Guidelines for salmonid passage at stream crossings. Southwest Region, Santa Rosa, CA. 14 pp. (http://swr.nmfs.noaa.gov/hcd/NMFSSCG.PDF).

NRC (National Research Council). 2003. Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. Committee on the Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. The National Academies Press, Washington, D.C. Prepublication Copy. 452 pp. (www.nap.edu).

Paul, J.F., K.J. Scott, A.F. Holland, S.B. Weisberg, J.K. Summers, and A. Robertson. 1992. "The estuarine component of the U.S. EPA's Environmental Monitoring and Assessment Program." Papers from the First International Ocean Pollution Symposium, 28th April 1991--2nd May 1991. University of Puerto Rico, Puerto Rico, (Part Two). *Chem. Ecol.* 7 (1-4): 93-116.

Peddicord, R.K. and J. B. Herbich, ed. 1979. Impacts of open-water dredged material discharge. Proceedings of the eleventh dredging seminar. Published by TAMU, College Station, TX (USA). Oct 1979. pp. 24-40. Rep. Texas A&M University Sea Grant Program.

Pickett, G.D., D.R. Eaton, R.M.H. Seaby, and G.P. Arnold. 1994. Results of bass tagging in Poole Bay, England during 1992. Laboratory Leaflet No. 74. British Ministry of Agriculture, Fisheries and Food.

Reiser and Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in the Western United States and Canada. Meehan, W.R. ed. USDA Forest Service General Technical Report PNW-96. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. Portland, OR.

Rice, S.D., D.A. Moles, J.F. Karinen, S. Korn, M.G. Carls, C.C. Brodersen, J.A. Gharrett, and M.M. Babcock. 1984. Effects of petroleum hydrocarbons on Alaskan aquatic organisms: A comprehensive review of all oil-effects research on Alaskan fish and invertebrates conducted by the Auke Bay Laboratory, 1970 - 81. U.S. Department of Commerce, NOAA Technical Memorandum NMFS F/NWC-67. 128 pp.

Rich Passage Wave Action Study Team. 2001. Rich Passage Wave Action Study Final Report, WAC 197-11-970. Prepared for Washington State Ferries. August 27.

Rozengurt, M.A., I. Haydock, and B.P. Anderson. 1994. Running on entropy: The effect of water diversion on the coastal zone. 37th Conference of the International Association for Great Lakes Research and Estuarine Research Federation: Program and Abstracts., Buffalo, NY (USA). 166 pp.

Schaumburg, F.D. 1970. The influence of log handling on water quality, annual report 1969-1970, Department of Civil Engineering, Oregon State University. Corvallis, Oregon.

Sea Grant. 2002. National Coastal Ecosystem Restoration Manual. Sea Grant Communications, Oregon State University, Corvallis, OR. Pacific Northwest: http://seagrant.oregonstate.edu/hot/exotics.html.

Sedell, J.R., F.N. Leone, and W.S. Duvall. 1991. Water transportation and storage of logs. *In* Meehan, W.R., ed. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19:325-368.

Shafer, D.J. 2002. Recommendations to minimize potential impacts to seagrasses from single-family residential dock structures in the Pacific Northwest. U.S. Army Corps of Engineers, Seattle, WA. 28 pp.

Simenstad, C.A. 1994. pp. 11-19. *In* Wyllie-Echeverria, S., A.M. Olson, and M.J. Hershman, eds. Seagrass science and policy in the Pacific Northwest: proceedings of a seminar series (SMA 94-1) EPA 910/R-94-004. 63 pp.

Simenstad, C.A., B.J. Nightingale, R.M. Thom, and D.K. Shreffler. 1999. Impacts of Ferry Terminal on Juvenile Salmon Migrating along Puget Sound Shorelines Phase I: Synthesis of State of Knowledge.

Sogard, S.M. and K.W. Able. 1991. "A comparison of eelgrass, sea lettuce macroalgae and marsh creeks as habitats for epibenthic fishes and decapods." *Estuarine, Coastal and Shelf Science*. 33:501-519.

Stone, R.P. and S.W. Johnson. 1998. "Prolonged exposure to mine tailings and survival and reproductive success of ovigerous Tanner crabs (*Chionoecetes bairdi*)." *Bull. Environ. Contam. Toxicol*. 61: 548-556.

Stull, J.K. and C.I. Haydock. 1989. Discharges and environmental responses: the Palos Verdes case. *In* Managing inflows in California's bays and estuaries. The Bay Institute, Sausalito, Calif. pp. 44-49.

Swanston, D.N. 1974. The forest ecosystem of southeast Alaska. Soil mass movement. General Technical Report PNW-17. U.S. Department of Agriculture. Forest Service. Pacific Northwest Forest and Range Experiment Station. Portland, OR.

TAPS (Trans-Alaska Pipeline System) Draft Environmental Impact Statement. 2002. Renewal of the Federal Grant for the Trans-Alaska Pipeline System (TAPS) Right-of-Way. U.S. Dept. of the Interior, Bureau of Land Management. 4.3: 50.

Thayer, G.W., ed. 1992. Restoring the Nation's Marine Environment. Publication UM- SG-TS-92-06. Maryland Sea Grant College, College Park, MD, 716 pp.

Thorsteinson, F.V. and L.K. Thorsteinson. 1982. Finfish Resources. Chapter 6. *In* Hameedi, M.J., ed. The St. George Basin Environment and Possible Consequences of Planned Offshore Oil and Gas Development. Proceedings of a Synthesis Meeting. U.S. Department of Commerce, NOAA, Office of Marine Pollution Assessment.

Turek, J.G., T.E. Bigford, and J.S. Nichols. 1987. Influence of freshwater inflows on estuarine productivity. NOAA Tech. Memo. NMFS-F/NEC-46. 26 pp.

U.S. Army Corps of Engineers, Alaska District. 1999. Final Environmental Impact Statement. Beaufort Sea Oil and Gas Development/Northstar Project. P.O. Box 898, Anchorage, Alaska. February 1999.

U.S. Department of Agriculture (U.S. Department of Agriculture). 2002. Southern Intertie Project Final Environmental Impact Statement. U.S. Dept. of Agriculture. Rural Utilities Service. Washington D.C.

USDA. 1989. The second RCA appraisal: Soil, water, and related resources on nonfederal land in the United States, analysis of conditions and trends. Washington, D.C. 280 pp.

USDA. ____. Tongass Land Management Plan. _____.

USDA. ____. Chugach Land and Resources Management Plan. _____.

USDA. ____. Alaska Forest Resources and Practices Act. _____.

USDA. ____. Tongass Best Management Practices Implementation Monitoring Report. 2003.

Vernberg F.J., W.B. Vernberg. 2001. The Coastal Zone. Past, Present, and Future. University of South Carolina.

Vetter, E.W. 1995. "Detritus based patches of high secondary production in the nearshore benthos." *Mar. Ecol. Prog. Ser.* 120:251-262.

Washington State Department of Ecology, Water Quality Program, Sand & Gravel General Permit (http://www.ecy.wa.gov/programs/wq/sand/escp.html).

Wertheimer, A.C., R.A. Heintz, J.F. Thedinga, J.M. Maselko, and S.D. Rice. 2000. Straying of adult pink salmon from their natal stream following exposure as embryos to weathered Exxon Valdez crude oil. Trans. Amer. Fish. Soc. 129: 989-1004.

Wicker, K.M., R.E. Emmer, D. Roberts, and J. van Beek. 1989. Pipelines, navigation channels, and facilities in sensitive coastal habitats: an analysis of Outer Continental Shelf impacts, Coastal Gulf of Mexico. Volume I: technical narrative. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Report MMS 89-0051.

Williams, R.N., L.D. Calvin, C.C. Coutant, M.W. Erho Jr., J.A. Lichatowich, W.J. Liss, W.E. McConnaha, P.R. Mundy, J.A. Stanford, R.R. Whitney, D.L. Bottom, and C.A Frissell. 1996. Return to the river: restoration of salmonid fishes in the Columbia River ecosystem. Development of an alternative conceptual foundation and review and synthesis of science underlying the Columbia River Basin fish and wildlife program of the northwest power planning council by the independent scientific group. Northwest Power Planning Council, Portland, Oregon. 584 pp.

Williams, J.E., C.A. Wood, and M.P. Dombeck, eds. 1997. Watershed Restoration: Principles and Practices. American Fisheries Society, Bethesda, MD. 561 pp.

Woltemade, C.J. 2000. "Ability of restored wetlands to reduce nitrogen and phosphorus concentrations in agricultural drainage water." *J. Soil and Water Cons.* 55: 303.

Young, K.A. 2000. "Riparian zone management in the Pacific Northwest: who's cutting what?" *Environmental Management*. 26, 131-44.

Online Resources

BMPs are often specific to certain geographical locations or pesticide application programs, with the aim of reducing or eliminating pesticide transport to surface waters. An example of a pesticide use reduction strategy for a large city (Seattle) is available at http://www.metrokc.gov/hazwaste/ipm/.

Information can also be found at the following websites and in the following publications:

ADEC, Division of Environmental Health's Pesticide Control Program: http://www.state.ak.us/dec/eh/pest/index.htm

EPA. 1984. Best Management Practices for Agricultural Nonpoint Source Control: IV. Pesticides. EPA Number: 841S84107.

Dredging BMPs: http://www.spn.usace.army.mil/ltms2001/appi.pdf

Various integrated pest management strategies can be found at the following websites:

U.S. Department of Agriculture. Cooperative State Research, Education, and Extension (CSREES) Program: http://www.reeusda.gov/ipm

Federal and state invasive species activities and programs: http://www.invasivespecies.gov/new/whatsnew.shtml

Logging effects studies on fish habitat (bibliography): http://www.afsc.noaa.gov/abl/ habitat/pdfs/logging.pdf

The following links provide detailed standards and guidance:

Best Management Practices: http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_C.PDF

Stream Process Groups: http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_D.PDF

Watershed Analysis: http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_J.PDF

Riparian: http://www.fs.fed.us/r10/ TLMP/F_PLAN/FPCHAP4.PDF

Transportation: http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

Beach and Estuary Fringe: http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

Fish: http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

Wetlands: http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

Soils and Water: http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

Alaska's Invasive Species: http://www.adfg.state.ak.us/special/invasive/invasive.php

Aquatic Nuisance Species: http://www.anstaskforce.gov/

Alaska Department of Fish and Game and Alaska Department of Public Transportation of Public Facilities, Memorandum of Agreement for the Design, Permitting, and Construction of Culverts for Fish Passage. August 2001: http://www.sf.adg.state.ak.us/SARR/fishpassage/pdfs/dot_adfg_fishpass080301.pdf

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Appendix H
EFH EIS Methods of Data Analysis

Prepared by

National Marine Fisheries Service

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ACRONYMS AND ABBREVIATIONS

ABUN	a relative abundance estimate
ADF&G	Alaska Department of Fish and Game
AI	Aleutian Islands
AKFIN	Alaska Fisheries Information Network
CBV	Catch By Vessel
CIA-R	Catch-In-Areas with Redistribution
Council	North Pacific Fishery Management Council
CPUE	catch per unit effort
CUMULATED	a cumulated column
EBS	Bering Sea
EFH	essential fish habitat
FMP	Fishery Management Plan
GIS	geographic information system
GOA	Gulf of Alaska
m	meter
mt	metric tons
nm	nautical miles
NMFS	National Marine Fisheries Service
NORPAC	NMFS domestic groundfish observer program database
OTC	official total catch
NPT	nonpelagic trawl
PTR	pelagic trawl
SEIS	Supplemental EIS
sq. km	square kilometers
sq. m	square meters
StQ	status quo

H.1 Introduction

This appendix describes several methods and databases used in this analysis. In the following list, the key contact for each model or database is noted in parentheses.

- Fisheries Analysis: Database of Fisheries Catch-In-Areas with Redistribution and associated economic value [S. Lewis]
- Spatial Area Analysis [S. Lewis; C. Coon]
- Database for Catch and catch per unit effort (CPUE) of target fisheries inside and outside of essential fish habitat (EFH) restriction areas; also used for fisheries analysis under Aleutian Islands (AI) Alternative 5B [C. Coon]
- Methods used for finding the known concentrations and general distributions of species managed under the current Fishery Management Plan (FMP) [J. Olson]
- Creation of Alternative 5B [J. Olson]
- Alaska Fisheries Information Network's (AKFIN) methods for finding commercial harvest of crab, halibut, herring, and scallops by state statistical area [P. Murphy]
- Use of the AKFIN database in the community/social assessment

H.2 Purpose of Fisheries Analysis

The purpose of this fisheries analysis is to model fishery restrictions by gear type and probable target species (dominant species by haul target), as described by the North Pacific Fishery Management Council EFH Committee alternatives, and to assign a value to the associated catch placed at risk by the restrictions (catch-at-risk). The spatial resolution of the catch data was the state statistical area (described later), but because the alternatives' restrictions did not line up with these statistical areas, proportional allocation (with the exception of Alternative 5B in the Aleutian Islands [AI]) was used to assign catch in and out of areas. This analysis was limited to groundfish.

H.3 Creation of Geodatabase Feature Classes

The first step in the spatial fisheries analysis was integrating the spatial EFH fishing impact minimization measures developed by the EFH Committee into current closures and protection measures. The process involved creating a comprehensive status quo geodatabase (see Figure H-1 and Table H-1). A geodatabase is simply a database-ready version of a geographic information system (GIS) shapefile (a vector representation of a polygon or shape). Note that due to the complex nature of the closures, some smaller areas were not coded into the status quo.

The principal attributes of the status quo geodatabase represent restrictions on gear, season, target species, and/or other features. Each feature in the geodatabase includes the Alaska Department of Fish and Game (ADF&G) groundfish statistical area, the gear type it restricts, the probable target it restricts, the restriction start and end dates, and the polygon area in square meters. Since the management is highly complex, there are overlaps where, for instance, bottom trawl is restricted to all species but the area is also restricted to all trawling (pelagic and nonpelagic) for the Steller sea lion prey species—Atka mackerel, P. cod, and pollock.

The design of the database ensures that catch is not double-counted by requiring that catch meets all of the following criteria: state statistical area of catch, gear type, probable target, and the start and end dates of the closure or protection measure. For instance, if the database has a catch record for a proportion of a state statistical area, an "NPT" (for nonpelagic trawl), a "K" (for a probable target for Rockfish), and start and end dates of 0815 (August 15) and 0920 (September 20), the record will not be counted if the restriction was pelagic trawl (PTR), K, 0814, and 0901 because all the criteria did not match; in this case, the gear type was PTR rather than NPT.

The projection (how the Earth's surface is projected on a flat map) used in this analysis was the Alaska Albers equal-area conic projection using ArcGIS 8.3. Instead of shapefiles, the ESRI geodatabase was used throughout the process. The ESRI geodatabase is a database-ready version of a shapefile. The shape-area field in a geodatabase is a generated field, and the square meters calculation is updated as the topology is changed.

Each EFH fishing impact minimization alternative's spatial fisheries restrictions were then coded with their own similar attributes. The status quo geodatabase was merged with each EFH alternative shapefile. The final process of integration included manually changing the geodatabases' attributes to ensure that the EFH measures would not double-count restricted catch. The status quo was coded to always take precedence. For example, in the AI, where most of the EFH closures overlapped status quo closures, the EFH closures would count only the catch that was not already closed to other protection measures.

The spatial analysis addressed each of the eight alternatives in combination with status quo measures. To account for the rotating closure areas in Alternatives 4, 5A, and 5B, the analysis considered each rotational management area individually.

H.4 Data Used

Fisheries data were limited to 2001 data for two main reasons: 1) ADF&G groundfish statistical areas changed in 2001, so analysis cannot span across this and prior years without many assumptions being made, and 2) 2002 fisheries catch data were not yet available at the time of analysis.

H.5 2001 Management Review

The November 2000 Biological Opinion for Steller sea lions was ruled arbitrary and capricious, so between January 1 and June 10, 2001, management reverted to the No-Trawl for Prey Species areas and Pollock Revised Final Reasonable and Prudent Alternatives from 2000. Between June 10 and July 17, 2001, the November 2000 Biological Opinion's reasonable and prudent alternatives open and closed districts were in place. Then from July 17 to the end of 2001, and to present (July 2003), the Steller Sea Lion Supplemental EIS (SEIS) closures were in place. Each of these three management scenarios is in addition to the fisheries management measures already in place, including legacy trawling restrictions and other various closures and bycatch restriction areas.

H.6 Rotating Closures

Alternatives 4, 5A, and 5B include rotating closures in the Northern Bering Sea. To create equal sized (sized perpendicular to EBS shelf break and not by square meters) rotating sub-blocks, two parallel lines were created inside and perpendicular to each block and then the lines were cut into three or four equal sections, depending on each alternative's specifications (see Figure H-2). The points at which the lines were segmented were used for snapping the GIS cutting tools. Since the blocks identified by the EFH Committee match closely to NMFS reporting area boundaries but extend past the 1,000-meter (m) contour, many assumptions would have been necessary if the blocks were to be cut into areas based on square units of area. Instead, blocks were cut into areas of equal width.

H.7 Fisheries Database

The fisheries Catch-In-Areas with Redistribution (CIA-R) database was developed using 2001 fisheries catch data from the Catch-By-Vessel (CBV) [D. Ackley] and 2001 Blend data [G. Tromble]. These two datasets were combined using an iteration process [J. Noel]. Both datasets have useful information: the CBV has the spatial resolution of ADF&G groundfish statistical areas and has catch by vessel information, gear, probable target, and several other useful attributes. The Blend is often used as a baseline for modeling at the Alaska Fisheries Science Center and has useful data for retained and discarded catch.

Table H-2 summarizes the sequence of matching operations that was performed to match the Blend data to the CBV data. The process begins with a high-resolution set of grouping fields, including processor ID. With that set, we were able to match 89 percent (by weight) of the Blend data to records in the CBV dataset and find multipliers to distribute the reporting area catch of the Blend among 6-digit statistical areas. The remaining Blend data were handled by repeating the process several times with progressively lower-resolution groupings. Each iteration decreased the resolution by either removing a field from the previous grouping list or replacing it with an equivalent, coarser-resolution field. The resulting final database table includes a field called "iteration," which indicates which iteration created the record. Because Iteration 9 contributed only 311 metric tons (mt) of catch and its spatial resolution was null, Iteration 9 was not carried through in this analysis.

H.8 Proportional Allocation

Since most of the StQ and EFH fishing impact minimization alternatives' boundaries do not correspond directly to ADF&G groundfish statistical areas (the first 3 nautical miles [nm] from shore are the inside waters state statistical areas; beyond this, the state statistical areas are generally bounded by 1 degree of longitude by 30 minutes of latitude, approximately 35 nm wide by 30 nm long), proportional allocation was used to assign catch from the database to closed areas. However, since EFH Alternative 5B was designed with observer data by latitude and longitude, observer data were used to assign catch to EFH Alternative 5B in the AI subarea. (See Section H.13, Catch and CPUE of Target Fisheries Inside and Outside of EFH Mitigation Alternatives.)

Observer data alone were not generally used for this fisheries analysis since they lack spatial resolution for catcher vessels delivering to shoreside processors. However, observer data are accurate for representing trawl catch in the larger fisheries in the AI.

To spatially refine proportional allocation of catch for those statistical areas that traversed the 1,000-m contour, all catch were assumed to be inside of 1,000 m. The alternatives were cut at the 1,000-m boundary for this analysis as well; otherwise, the numerator (square meters [sq. m] of the alternative) may have exceeded the denominator (sq. m of the state statistical area cut at the 1,000-m boundary) or otherwise inflated the significance of a given restriction.

In a step called Prop-Areas, the CIA-R database created a unique record for each ADF&G groundfish statistical area, gear type, probable target, start date, end date, and returns proportional area by dividing each alternative's Shape-Area field by the State-Stat-Area_1000meters Shape-Area field.

The next step is the actual Catch-In-Areas algorithm. The database compares Prop_Areas to the catch data. Where it finds an exact match from the Prop-Areas step, the catch for that given record is multiplied by the proportional amount from that record and then inserted into the new table.

H.9 Finding the Delta

The next operation performs two functions: 1) it checks whether the database return numbers are negative or otherwise unreasonable, and 2) it provides the actual delta or difference between the catch under status quo and under the selected EFH fishing impact minimization alternative. This is done by subtracting Alternative 1 (status quo) from each of the EFH alternatives. This determines the net change in catch due only to the EFH fishing impact minimization measures (delta or catch-at-risk). This function is possible because the EFH alternatives were integrated into the status quo. The delta values from each alternative were used for assigning the actual value to the EFH alternatives. Some data noise is created in this process, but it amounts generally to less than 10 kilograms per statistical area.

H.10 Valuing the Catch

To assign a value to the catch-at-risk, catcher vessels delivering to shoreside processors had separate pricing from the catcher-processors and motherships. This is due to the large difference between the ex-vessel price a catcher vessel receives by selling unprocessed fish and that of the catcher-processor or mothership selling processed fish to the first wholesaler.

Pricing was provided for catcher vessels by Council staff (Elaine Dinneford) and for catcher-processors and motherships by NMFS economists using first wholesale values. The pricing was matched to the database with processor ID, gear, species, and subregion. Where there was no match for processor ID, processor ID was dropped, and a weighted average was leveraged on remaining processor IDs by gear, species, and subregion. Each alternative's delta was multiplied by this associated value per metric ton for the final value. All summaries of data beyond this point in the analysis are averages of the value per metric ton.

Summary tables were created that filtered out discarded catch and more obscure species and data noise such as shrimp, salmon, halibut and many of the obscure non-FMP species. The catch data did not fully account for many of these species, and it would have been inaccurate to include them. Table H-3 is an example of these summary tables. The actual alternatives are not shown in this summary table.

H.11 Catch and Redistribution Maps

The analysis for these maps restricts the catch by area, probable target, gear type, and, if seasonal, the start and stop dates of the closure. Proportional allocation of catch is based on state statistical areas relative to the size of the closure. The state statistical areas have been cut at 1,000 meters in order to add resolution to the catch data. [Limiting the area size of the state statistical areas that straddle the 1,000-meter bathymetric line to only that area within 1,000 meters, reduces the size of the denominator in the proportional allocation method. Proportional allocation simply divides the size of the restricted area (numerator) by the size of the state statistical area (denominator). The resulting ratio is then multiplied by the catch in that state statistical area.] The assumption is that the catch is evenly distributed in the state statistical area within the 1,000-meter depth range.

The green state statistical areas (X_delta) represent two concepts:

1. All the state statistical areas where a species was caught in 2001 - targeted or incidental.

2. All the catch that occurred in 2001 that would be prohibited under the EFH alternative. See the legend for alternative numbers and the species groups represented. This restricted catch accounts only for

that additional catch that would not have been restricted under the current management scenario. The darker the green, the more net catch that is being restricted by the EFH Alternative.

The red bars (Amt_In) represent the amount of catch in the 2001 catch data that would be prohibited by the current management and the EFH Alternative.

The blue bars (Amt_Out) represent the amount of actual 2001 catch that can still be caught under the current management and the EFH Alternative.

The purple bars (Amt_After) represent the amount of catch in 2001 that has been redistributed (by species and relative to how much of that species was taken in each statistical area) to other ADF&G statistical areas within the same NMFS reporting area. This redistributed catch includes the original species catch weight and the catch that must be redistributed by the EFH Alternative's closure.

Redistributed catch (purple bar) illustrates a probable location where catch may be displaced by the alternative. It is possible that catch will be redistributed into areas partially closed by an alternative since there still may be open or outside catch of that species in that statistical area.
Redistributed catch is equal to the weight of that species that can still be caught in the given state statistical area multiplied by the ratio of total weight of that species in the related NMFS reporting area by the total weight of that species that can still be caught in that NMFS reporting area. In simpler terms, it redistributes the species weight proportional to how much weight of that species remains open in each state statistical area within the same NMFS reporting area.

$$Wr = Wo\left(\frac{\sum Wt}{\sum Wo}\right)$$

Where:

Wr = Redistributed catch by state statistical area
Wt = Total weight by species by state statistical areas
Wo = Catch that is outside restricted\closed state statistical areas
Σ = *The sum of the species over the entire NMFS reporting areas*

The redistribution analysis was intended for use in qualitative assessments, representing areas to which the catch may be redistributed if an alternative's restrictions were put into place. This does not account for localized depletion or the rate of change in the catch of one species complex relative to another after the distribution.

The number next to the three bars in the legend represents the metric tons of catch that would be displaced by the EFH alternative and the current management (status quo) because the status quo measures differ from the 2001 catch data. It is not intended to be consistent with the X_delta (gradients of green of the state statistical areas), which represents only the net change in the catch due to the EFH Alternative.

Dark blue outlines represent the EFH Alternative in question. The yellow-orange outlines represent most of the current spatial management closures. Bycatch limitation zones are not shown or analyzed in this analysis.

H.12 Spatial Analysis

Each EFH fishing impact minimization alternative has an associated closure area as a component. To effectively compare each alternative with another, a series of calculations was performed to find the affected area. Each alternative had area calculations performed for the full extent of the closure, the extent of the closure within 1,000 m (defined here as the fishable area), and the extent of the closure beyond the 1,000-m depth. Additionally, the percent affected was calculated for each alternative by taking the areas of the alternative as a ratio to the extent of the management area. Results were provided in both square kilometers and square nautical miles.

The area calculations are completed by first dissolving and then integrating the alternative's polygons. This procedure dissolves overlaps and polygonic regions that may otherwise double count area. A double-precision field is created and then updated with a function called pArea. This function uses the Gauss calculation of polygon area, the industry standard.

The analysis did not take into account partial closures such as the Steller sea lion protection measures, which generally limit fishing by gear type only to the Steller prey species: pollock, Atka mackerel, and Pacific cod. It should be noted, however, that the only areas that currently fully protect habitat from all bottom contact are the thirty-seven 3-nm No Transit zones and the Sitka Pinnacles. Other status quo measures protect habitat through trawl or nonpelagic trawl restrictions, which do not apply to all bottom-contact gear types. Where many of the EFH alternatives restrict all bottom trawling, an insignificant amount of these EFH closures overlap current closures.

H.13 Catch (OTC) and CPUE of Target Fisheries Inside and Outside of EFH Fishing Impact Minimization Alternatives

Observer data was gathered for the years 1998 through 2002 from the North Pacific groundfish observer program database NORPAC. Each haul or set for those years was assigned a target fishery, similar to the algorithm used by NMFS Alaska Region. Each haul or set included an overall observed catch recorded in metric tons, a latitude and longitude of gear retrieval, year, duration, and a calculation of effort. The effort calculation was to approximate the area swept by that gear type. The calculation was based on the vessel's duration in hours multiplied by an effort adjustment for each gear type and vessel size, yielding a value in square kilometers (sq. km) (see Appendix B).

The observer data was brought into a GIS environment using ArcGIS 8.3. Additional polygon coverages representing closure areas of the fishing impact minimization alternatives were in the GIS project. Each target fishery that applied to that EFH fishing impact minimization measure was summarized as follows: The observer data was used to summarize the total amount in mt (Official Total Catch, OTC) harvested by that summary for all hauls/sets for the 5-year period. The data were also summarized for the calculated effort. The next step joined the observer data to the EFH fishing impact minimization measure, and the amount of catch and effort within each closure area was tabulated. Calculations were made for both catch and effort inside and outside of each EFH fishing impact minimization measure (Table H-4).

H.14 Geographic Distribution of Fisheries

This portion of the analysis used data provided by the NMFS domestic groundfish observer program database (NORPAC), years 1990 to 2002. Data were sorted by gear types: nonpelagic trawl, pelagic trawl, hook and line (longline), and pot. Each haul or set had a target assigned based on haul and weekly catch, similar to the algorithm used by NMFS Alaska Region (E. Dinneford, Council staff). Locations of each haul or set of each fishery (denoted as retrieval position of hauls) were plotted spatially using GIS technology to aid in analysis of spatial patterns. The locations of all fishing activities were plotted as point data. Fishing effort locations were summarized on a geographical scale of 25 sq. km. This summary provided a clearer depiction of fishing density since many hauls/sets are close together and would overlap when looked at over multiple years. An Alaska Albers projection was used to encompass the data on both sides of the 180º A polygon coverage, composed of 25-sq. km grid squares overlaid onto the trawl location data. An intersect function allowed the point data 25-sq. km areas to be summarized by effort and trawl time within grid squares. The data were categorized by an ArcView function of natural breaks to display both effort and trawl time by three groupings. This method identifies breakpoints between classes using a statistical formula (Jenk's optimization) that minimizes the sum of the variance within each of the classes. The data were displayed in three categories. This step was repeated for each fishery within the GOA, AI, and EBS.

H.15 Habitat Species Distribution

For EFH description Alternatives 2, 3, and 4, EFH would be defined as a subset of each species' range, generally between 75 and 95 percent of the spatial distribution of the entire species' range, or for each particular life history stage, as the alternatives dictate. EFH Definition Alternative 3 is referred to as Revised General Distribution – 95 percent. Alternative 4 is referred to as Presumed Known Concentration – 75 percent.

To find this subset of each species's range, RACE (1961 to 2001) and NORPAC (1987-2002) databases were queried. Population estimates were based on extrapolated weight/duration for trawls and thousands of hooks for longline. For each record, CPUE was divided by total CPUE for a relative abundance estimate (ABUN). The ABUN column was sorted by highest relative abundance to lowest relative abundance. A cumulative column (CUMULATED) was created, as shown in Table H-5.

H.16 Creation of Alternative 5B

The Aleutian Seafloor Habitat Protection Alternative, Alternative 5B, forwarded by Oceana at the December 2002 Council meeting, had four components: 1) no expansion of bottom trawl fisheries to new areas, 2) areas that had a high rate of bycatch of corals and sponges and a low rate of catch should be closed to bottom trawling, with an accompanying decrease in TAC, 3) area-specific bycatch limits should be imposed, and 4) a comprehensive research and monitoring plan should be implemented. Also required under this alternative for the AI was 100 percent observer coverage and 100 percent VMS coverage of vessels fishing for groundfish in the AI and use of the CADRES program when possible. The Council added this alternative as a sub-option under EFH fishing impact minimization Alternative 5.

There are two parts to this analysis, open and closed areas. For the open area approach, bottom trawling is limited to historic areas, and closed areas are those that had a high rate of bycatch of coral and sponges and a low rate of targeted catch. The open area analysis was based on effort data (defined by number of hauls), where the number of hauls was broken into three categories based partially on the distribution of the data. The initial analysis of the AI used data from 1990 through 2001, so the top effort category also represented areas fished more than one time per year over 11 years. Subsequent analyses of the EBS and GOA were based on data from 1997 to 2001 and 1990 to 2000, respectively. All grids in the top category of effort were included in open areas.

This method of analysis was used for the attached maps of the EBS, GOA, and AI, and included the following steps to accomplish the first two of the four Alternative 5B components noted above:

NO EXPANSION OF BOTTOM TRAWL FISHERIES TO NEW AREAS

1. Display effort data, categorized into 1-3, 4-10, >10 trawls.
2. Overlay latitute/longitude grid
3. Attempt to make open areas that include all of the highest category of effort (>10)
4. Attempt to make areas as linear as possible (least number of sides).

CLOSE AREAS WITH HIGH BYCATCH RATES AND LOW CATCH RATES

1. Query the point data for the correct gear type, area, and range of years
2. Sum the point data to grid
3. Create CPUE columns and calculate CPUE for both bycatch and total catch grid files (catch/duration)
4. Join bycatch and catch grids
5. Display quantities, graduated colors with ration of bycatch CPUE/catch CPUE in natural breaks, in categories.
6. Select all blocks from highest two categories, any two contiguous blocks from third category
7. Overlay 5k grid layer, set as selectable. Display catch data (OTONS) under chosen blocks to aid in selection of at least four square blocks. Select configuration that impacts least number of OTONS. These are the areas closed for bycatch reasons.

H.17 Alaska Fisheries Information Network's (AKFIN) Methods for Finding Commercial Harvest of Crab, Halibut, Herring, and Scallops by State Statistical Area

Vessel and Processor Diversification

Groundfish catch by vessels fishing in each of the EFH alternative areas was filtered from the fisheries Catch-In-Areas with Redistribution (CIA-R) database by NOAA Fisheries and provided to AKFIN. AKFIN used this dataset to create a database for evaluation of vessel and processor diversification and community impacts of the EFH alternatives. Statewide catch and value were estimated for major groundfish species (Pacific cod, pollock, other groundfish, and total groundfish), halibut, crab, scallops, salmon, herring, and other non-groundfish species (clams, octopi, squid, shrimp, urchin, and other finfish) by impacted vessel through 2001.

Similarly to the vessel diversification data, commercial harvest was aggregated by processor for those receiving deliveries from impacted vessels or impacted catcher-processors. Processor characteristics were included from the federal permit and State Intent to Operate databases.

Catch was filtered to exclude noncommercial harvests, discards, ancillary products, and bycatch. Characteristics of each vessel and vessel owner area of residency were also added to the database. Source of the catch data and estimated value depended on the type of vessel. The data source for catcher vessels delivering to shoreside processors was ADF&G fish tickets and CFEC ex-vessel prices. The data source for catcher-processors and motherships was NOAA Fisheries Blend and NorPAC harvest. Wholesale prices were derived by species grouping, Council area, and gear for catcher-processors.

Catch and value of major groundfish species was included in AKFIN's database to demonstrate similarity of the AKFIN and CIA-R estimates for 2001 and allow extension of analysis of diversification and community impacts to the years 1998, 1999, and 2000.

Fishing Intensity

For each groundfish statistical area in the Council GIS, AKFIN summarized ADF&G fish ticket commercial harvest of crab, scallops, herring, and halibut for 1998 through 2001. The summary catch included deadloss but excluded discards, bycatch, and ancillary products. For groundfish areas where the data were confidential, an indicator was provided for use by the GIS system. Two to five percent of the harvest of crab, herring, and halibut was excluded due to confidentiality. Twelve percent of the scallop harvest was confidential. Halibut data (based on IPHC areas) were extrapolated to ADF&G groundfish statistical areas. Herring statistical areas were also translated to groundfish statistical areas with manual translation where a herring area contained more than one groundfish area.

Methodology for the diversification and fishing intensity datasets detailing extrapolation of halibut harvest by statistical area and federal groundfish harvest to ADF&G groundfish statistical area can be found elsewhere in the NOAA Fisheries administrative record.

H.18 Methodology for Minimization Alternative 5B TAC Reductions and Bycatch Limits

Alternative 5B for minimizing the adverse effects of fishing on EFH would allow bottom trawling in the AI only in designated open areas, defined as those areas with higher effort distribution (with the exception of specific areas with high coral/bryozoan and sponge bycatch rates and low CPUE). The TAC reduction and coral/byrozoan and sponge bycatch limit components of Alternative 5B were developed through data analysis described in this section.

A draft analysis of TAC reductions and bycatch limits pertinent to Alternative 5B was prepared for the June 2003 Council meeting, and has since been revised. The revisions were: (1) including the 2002 blend data for establishing bycatch limits, (2) including the number and percent of sample hauls with associated bycatch of other, non-groundfish species, (3) including in the counts of observed vessels a small number of vessels that had not observed bycatch in any haul in an entire year, and (4) adjusting the denominators for the coral and sponge bycatch rates to reflect only the extrapolated weights of the weekly target species in a given area (in the previous draft, these denominators included the total weekly target extrapolated weights regardless of area). The following discussion of methodology incorporates these revisions, and the results are reflected in the bycatch numbers contained in the Alternative 5B description.

TAC Reductions

Council staff examined observer data from 1998-2002 to estimate the percent of catch taken from areas that would be closed to bottom trawling under Alternative 5B. Based on the amount of total catch (all species) across all five years, the percent of catch outside the 'open' areas in the trawl fisheries was as follows: Atka mackerel, 5.55 percent; Pacific cod, 10.23 percent; and rockfish, 11.99 percent (Table H-6). No other fisheries would be affected, as the amounts are insignificant for other species. Note that these numbers are substantially different than the 3.7 percent which had been reported in the draft Chapter 2, because the previous figure was based on 1990-2001 data (which had included 1990-1998 AI pollock fisheries in the official tons of catch).

In the case of Atka mackerel, the TAC reduction is straightforward, because the TAC is set for the AI management areas, and 98 percent is allocated to the trawl fishery (2 percent to jig gear). Thus the TAC reduction for trawl gear within each regulatory area (541, 542, 543) would be a 6 percent reduction in AI Atka mackerel trawl TAC (rounded number).

For Pacific cod, a TAC reduction is more complex. The Pacific cod TAC is specified BSAI-wide, so any TAC reduction would also reduce catches in the Bering Sea as well as the AI area. Further, the BSAI Pacific cod TAC is allocated to trawl (47 percent), jig (2 percent), and fixed gear, 51 percent (fixed gear is then further suballocated to many sectors). The TAC reduction would be applied to the 47 percent BSAI trawl Pacific cod TAC, resulting in a 10 percent reduction in the BSAI Pacific cod trawl TAC (rounded number). The draft EIS assumes that the catch would be reduced in both the AI and EBS; these reductions would likely occur in similar proportion to recent catches (approximately 25 percent AI; 75 percent EBS).

For rockfish, the TAC reductions are fairly straightforward. In the BSAI area, rockfish TACs are set separately for the EBS and AI region. AI rockfish are managed in the following complexes: Pacific ocean perch, northern rockfish, shortraker/rougheye, and other rockfish. Nearly all the catch is taken by trawl gear, with the exception of shortraker/rougheye, whose AI TAC is allocated to trawl (80 percent) and fixed gear (20 percent). Thus the TAC reductions would be as follows: 12 percent for POP, northerns, and other rockfish, and a 12 percent reduction in the AI shortraker/rougheye TAC apportioned to trawl gear (rounded numbers).

Application of these percentages to the 2003 TACs results in the reductions shown in Table H-7. The preliminary draft EFH EIS analysis and RIR were prepared using these TAC reductions.

Coral/Bryozoan and Sponge Bycatch Limits

Council staff examined observer data from 1998-2002 for trawl fisheries in the Aleutian Islands to generate estimates of bycatch rates for two groups (coral/bryozoans and sponges) by target fishery and regulatory area (541, 542, 543). The corals and bryozoans are combined because this is how they are treated in the observer data. Estimates of coral/bryozoan and sponge bycatch in the Atka mackerel, Pacific cod, and rockfish trawl fisheries in the Aleutian Islands (federal zones 541, 542, and 543) were developed by creating an annual bycatch rate from observer data[1] and then applying this rate to parallel NMFS blend data. The rates included data from Community Development Quota (CDQ) harvests as well as discarded harvests. Likewise, the rates were applied to blend data containing both CDQ and discarded harvests.

Coral/bryozoan and sponge bycatch rates were computed from sampled haul information taken from the 1998-2002 NPFMC Observer report file in the following manner:

1. Vessel specific annual coral/bryozoan and sponge bycatch rates were computed for each federal zone by dividing the sum of the coral/bryozoan (or sponge) extrapolated weights from the observer data (kg) by the sum of the round metric tons in that zone of the specie identified as the weekly target for a given vessel and year. Vessel specific rates were created for two reasons:

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[1] NPFMC Observer EFH Report file. This file was developed from observer data by Council staff with the assistance of Dr. Craig Rose. Observer data were assigned a weekly target species specifically intended to mirror the weekly targeting algorithm used by the NMFS Sustainable Fisheries Division.

First, vessel specific records allow an enumeration of unique vessels in subsequent summarizations, which in turn are required for confidentiality assessments. Second, the researchers would be able to review the incidence and relative amounts of coral/bryozoan (or sponge) bycatch among the vessels in a given fishery. Note that these data are not discloseable to the public.

2. A fleetwide bycatch rate was computed from the vessel specific data by, again, summing the total sampled coral/bryozoan weights (kg) and dividing by the total target species' round metric tons within each zone. The rate is expressed in kilograms of coral/bryozoans (or sponge) per round metric ton of the target species.

Estimates of the coral/bryozoan and sponge bycatch were computed by multiplying the above rates with the trawl-caught Atka mackerel, Pacific cod, or rockfish total catch where these species were identified as targets in the NMFS 1998-2002 blend data for federal zones 541, 542, and 543.

The fleetwide incidental catch rates for each bycatch group, target fishery, area, and year (Tables H-8 and H-9) were applied to the corresponding best blend catch estimate of the target species to generate total bycatch estimates (mt). The catches across all management areas by target fishery and bycatch group are shown in Tables H-10 and H-11.

Bycatch limits were set at or near the upper end of the observed bycatch levels. This procedure has been used by the Council in previous actions to establish initial bycatch limits for salmon, herring, and crab. The intent of these limits is to control bycatch within historically observed levels. Once the fishing industry adapts to these limits, they can been reduced over time (as has been done with crab and chinook salmon limits). The preliminary draft EFH EIS analysis and RIR assume that under these bycatch limits, closures of the fleet would be relatively uncommon.

The expanded catch amounts shown in Tables H-12 and H-13 were used to set the bycatch limits based on the maximum annual amount estimated for the years examined. In the cases where data were limited by confidentiality (e.g., the Pacific cod fishery in 543), the amount for the adjacent area was used. In some cases, the bycatch limits were reduced if there appeared to be outliers, defined as an annual bycatch estimate over 2 mt that was more than twice the amount estimated for any of the other years examined [note that outliers occurred in a few instances: 1998 sponge catch in the 541 Pacific cod fishery, 1998 coral/bryozoan catch in the 541 Pacific cod fishery, 2002 sponge catch in the 543 rockfish fishery, and 1999 catch of coral/bryozoans in the 542 rockfish fishery]. In all cases, the limits were rounded to the nearest mt. The resulting bycatch limits are show in Table H-14.

There are other ways to estimate bycatch of corals/bryozoans and sponges. Galen Tromble from the NMFS in-season management program noted that if NMFS scientists had to make estimates of catch for these organisms, they would apply the same methodology used for PSC estimates. The rates are generated by dividing the EXTRAPOLATED_WEIGHT (this is a column in the observer data) of the species in question by the total of the EXTRAPOLATED_WEIGHT of the GROUNDFISH SPECIES in the haul. Therefore, the denominator would not be the OTC, the weight of just the 'target' species, or the sum of all the extrapolated weights—just those of the FMP groundfish species. Mr. Tromble further noted that when establishing a proposed "cap" setting, the results would likely be reasonably accurate, but that they would not exactly match the methodology that NMFS uses to monitor.

H.19 Use of the AKFIN Database for Community/Social Assessment

The goal of the social or community-oriented description of the status quo and analysis of the range of alternatives is to describe the number and distribution (in terms of communities) of fisheries participants (harvesters and processors), the patterns of their fisheries activities, and the level of their fisheries participation for each of the alternatives. For quantitative analysis purposes, the status quo alternative is used as the base case, and differences between the characteristics of this alternative and each of the other alternatives are discussed as potential effects of the proposed actions defining that alternative. Of central importance is an assessment of changes in engagement and dependency on the relevant fisheries.

Limitations of the Analysis

Several methodological challenges to the analysis were met in the following ways:

- The base year for the community and social fisheries activity description and analysis (as for other analyses) is 2001, due to its being the most recent year for which complete information is available. Using a single year as a base case is inherently challenging due to normal year-to-year fluctuations in the overall fishery(ies) as well as variations in the annual patterns of activity, but comparisons with prior years proved problematic, both for methodological reasons (changing boundaries of ADF&G groundfish statistical areas) and for practical reasons (time constraints). One additional complication is introduced by the fact that the status quo alternative is based on 2001 fisheries activities as constrained by 2002/2003 spatial management (Steller Sea Lion RPAs). Thus, the "status quo" is an analytical construction like the other alternatives, which are essentially 2001 fisheries activities as constrained by the management actions proposed under each specific alternative.

- To establish a linkage between fisheries participants and communities, we have assumed that for harvesters the community of reference (that place or social collective most likely to be affected by changes in the fisheries activities of the harvesters in question) is the official (documented) community of residence of the owner (or the majority owner in the case of multiple ownership) of the harvesting entity. While this assumption has the advantage of being a practical way to assign a direction to the "flow" of revenues or related impacts on a community basis, caution is needed in interpretation of the results.. For example, even if the owner of a vessel is a resident of one community, substantial benefits can and do accrue to other communities, as skipper and crew may live elsewhere, deliveries may be made in any number of locations, vessel service and repair work may take place in yet another community, and so on. Further, the official address of a harvesting business may not represent the domicile of the owner at all, but rather may be a location chosen for documentation based on a number of business related factors. For catcher-processors, the community of reference used is also the documented address of the owner of the vessel, and the same caveats apply. For shoreplants, the community of reference is taken to be the physical location of the plant, due to the local importance of the activities (especially for municipal revenue related impacts). Despite these known shortcomings in terms of precise quantification of outcomes, the results of the analysis do provide useful indicators of the likely nature, direction, and magnitude of community level change associated with the alternatives. The methods and assumptions used for these analyses also have the advantage of being consistent with those used for other similar and recent analyses, such as those included in the Steller sea lion resource protection measures SEIS, the revised draft programmatic groundfish SEIS, and the crab rationalization EIS.

- Issues of confidentiality of information impose practical limits on the discussion of potential effects on a community basis, since it is not unusual for there to be fewer than four unique entities, especially for processors, in any given community. Even if there are more than four harvesting entities from a community, their distribution by sector or their pattern of delivery of harvest (if to fewer than four unique processors) can require that their information be used only in ways that protect the confidentiality of any single entity. As a result, much of the community and social analysis is presented on a regional basis.

- Information for and about different entities, even when apparently measuring the same variable, may not be strictly comparable. In terms of comparing total values, for example, catcher vessels generally have their catch reported in terms of ex vessel value, while seemingly analogous catcher processor catch data are provided in terms of first wholesale price. The data are more useful for examining relative values, establishing rough comparisons and rankings of effects, and identifying overall trends than for focusing exact values derived for any particular variable examined. The data sets used for the community and social impacts analysis were compiled and provided by members of the EFH analytical team. Documentation of these data sets indicate that the data sets are the result of combining information that in other contexts would be considered incongruous or not strictly comparable (Alaska Fisheries Information Network 2003a, 2003b). None contain all of the same information, and so each file illuminates a different aspect of the data in the absence of a comprehensive fisheries database.

Community/Social Assessment

The five data sets of central relevance to the community/social impact analysis were the “EFH harvest vessel diversification” file, the “EFH processor diversification” file, and the individual “EFH harvest/processor” files for crab, halibut, and scallops. The vessel and processor diversification files were used for all alternatives and their data are focused on groundfish. The crab, halibut, and scallop files were used in conjunction with the other two files in the Alternative 6 analysis. The vessel and processor diversification files are both designed as broad and comprehensive data sets, but have limitations. The vessel diversification file presents information on the number of vessels and their total harvest for all fisheries by community. However, this file does not include the regionalization or localization information for potentially affected groundfish harvests, and includes only those vessels that harvested groundfish in 2001 in an area potentially closed by one of the alternatives under consideration. Thus, it is a tool to approximate the effects of alternatives on communities (and regions) due to effects on the groundfish fleet. In the case of Alternatives 1 through 5, where only groundfish fisheries would experience direct impacts, this is a useful simplification.

Further, “revenue at risk”, although known for regions as a whole, cannot be explicitly assigned to community fleets since harvest regionalization was not maintained in this file. Only the community and social analysis attempts to link vessels and harvest to communities, so this information is not available from other portions of the EFH analysis. Local knowledge (“on-the-ground” information about community fisheries participation patterns) provides some guidance in this area, and is used at a very general level in this document based on fieldwork associated with earlier studies. No additional fieldwork was undertaken as part of the EFH analysis.

For the groundfish fleet, the files provide information on the relative contribution of groundfish and other fisheries for communities and regions as part of total overall harvest, with numbers that are useful in attempting to sort out issues of relative dependency. For non-groundfish fisheries, the files provide only partial potential effects information for those vessels that participate in the crab, halibut, and scallop fisheries as well as groundfish fisheries.

The processor diversification file was constructed from the vessel diversification file by aggregating the total harvest for those vessels delivering to a given processor and attributing that total harvest (and not just what the vessel delivered to that particular processor) to the processor. Thus, vessels that deliver to more than one processor are counted at least as many times as processors they deliver to, so that processor volumes are overestimated. It is likely that the count and distribution information for larger processors is reasonably accurate, but similar information for smaller and more specialty-oriented processors is inflated by the "distributed catch", as discussed in the AKFIN documentation. The chosen threshold, 0.001 ton of fish, does not affect the total volume or weight of fish numbers as much as it does the numbers of participating vessels and small processors. The threshold was chosen so that it pragmatically gave results that "make sense" in terms of vessel numbers potentially affected by each alternative, but again likely inflates the number of small processors involved. Thus, the information from this file is generally most useful for the enumeration and distribution of groundfish processors by community and region. It is somewhat useful for discussing the number of different species that community/regional processors work with, and not very useful for estimating processing volume attributable to any given community or region. Such information would, in most cases, be confidential in any event, given the typically low numbers of unique processors in each community (with the few exceptions of Kodiak, Unalaska/Dutch Harbor, and some ports in Southeast Alaska for various fisheries). Count and distribution information can be (and are) used to discuss the potential effects of the alternatives, at least in relative terms.

Catcher processors appear in both of the harvester and processor diversification files and compose a relatively easily identified sector, with ownership concentrated in one region (the Pacific Northwest). As with other processors, much of the processing information for communities, other than for the largest, is confidential. Thus count and distribution information was used to support a more general discussion.

The species-specific files include data on those fleets targeting each particular species, and contain no information on other fisheries in which those vessels may also participate. As a result, these data are useful for discussing engagement in the fishery, but not relative dependency (except in the very limited sense of relative distribution within the single species itself). The file does contain harvest localization information, however, so that it can be used to estimate what percentage of a community's fleet and processing production is from harvests that are placed "at-risk" under Alternative 6. This is clearly useful information, although it does not illuminate the importance of the specific fishery to the local fleet. These files proved most useful for crab- and halibut-related analyses, because most of the scallop fishery information is confidential.

REFERENCES

AKFIN (Alaska Fisheries Information Network). 2003a. AKFIN Documentation: Vessel and Processor Diversification Submitted to NOAA Fisheries Alaska Region, for Essential Fish Habitat, Draft Environmental Impact Statement, June 10, 2003. PSMFC, AKFIN, 612 W. Willoughby, Suite B., Juneau, AK 99801.

AKFIN. 2003b. AKFIN Documentation: Commercial Harvest of Crab, Halibut, Herring and Scallops by State Statistical Area, Submitted to NOAA Fisheries Alaska Region, for Essential Fish Habitat, Draft Environmental Impact Statement June 10, 2003. PSMFC, AKFIN, 612 W. Willoughby, Suite B., Juneau, AK 99801.

MAPS

Example maps indicating redistribution of fishing effort appear on the following pages. A complete set of the 70+ maps used in the analysis is provided on the CD-ROM version of the EIS.

Figure H-1. EFH Fishing Impact Minimization Alternative 3 - Status Quo

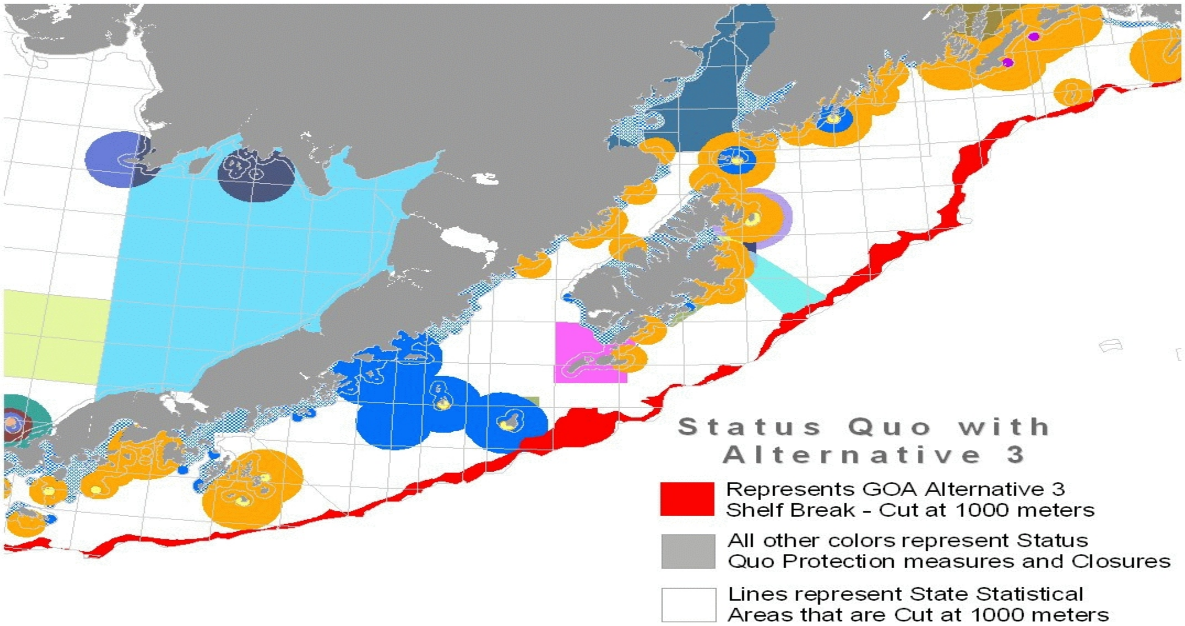

Figure H-2. Example of Bering Sea Rotating Closure

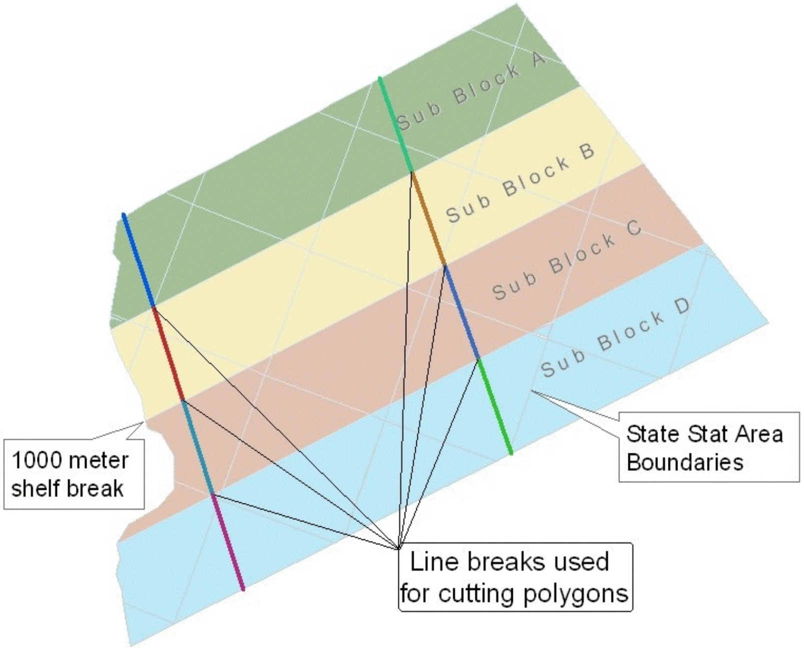

Table H-1. Contents of the Status Quo Geodatabase

What the Status Quo Geodatabase Includes	What the Status Quo Geodatabase Does Not Include
Red King Crab No Nonpelagic Trawl (NPT) Area (does not include limited open areas inside this area)	Bogoslof Pacific Cod Exempt Area
Near Shore Bristol Bay Area	Cape Peirce Walrus Protection Area
Pribilof Habitat Conservation Area	Bycatch limitation areas
Sitka Pinnacles	Partial year open area inside Near Shore Bristol Bay Area
Southeast No Trawl Area	
State Inshore No NPT Areas	
Gulf Type 1 and 2 Areas	
Steller Sea Lion Protection Measures 3nm No Transit Areas Hook and Line and Pot Closures Seasonal Closures Closed Foraging Areas Trawl Closures Atka Mackerel and P. Cod Harvest Limit Dependent Fisheries	

Table H-2. Blend to Catch-By-Vessel Matching Iteration Process

Iteration	Grouping Fields	Weight (mt)	% of Total
1	Processor ID, processor type, week, reporting area, gear, species	1,794,938	88.73%
2	Processor type, week, reporting area, gear, species	173,508	8.58%
3	Processor type, week, reporting area, gear, SpecGrp	26,746	1.32%
4	Processor type, quarter, reporting area, gear, SpecGrp	12,337	0.61%
5	Processor type, quarter, subregion, gear, SpecGrp	5345	0.26%
6	Quarter, subregion, gear, SpecGrp	4799	0.24%
7	Subregion, gear, SpecGrp	709	0.035%
8	Gear, SpecGrp	4210	0.208%
9	SpecGrp	311	0.015%

Total weight of blend: 2,022,903 mt.

Table H-3. Example of Data Output

FMP	DESG	GEAR	Total Wt	CV Value	Average CV Value\Ton	CP Value	Average CP Value\Ton
BSAI	M	NPT	3,811			$4,767,104	$1,177
BSAI	M	POT	1,364			$1,712,334	$1,075
BSAI	M	PTR	141,287			$104,297,864	$1,197
BSAI	P	HAL	116,083			$141,890,951	$1,103
BSAI	P	NPT	204,026			$179,260,011	$988
BSAI	P	POT	3,091			$3,891,220	$1,138
BSAI	P	PTR	608,507			$448,804,818	$990
BSAI	S	HAL	1,827	$4,060,780	$1,382		
BSAI	S	JIG	74	$43,586	$622		
BSAI	S	NPT	16,137	$8,124,283	$306		
BSAI	S	POT	12,763	$7,576,714	$649		
BSAI	S	PTR	606,871	$102,907,576	$108		
GOA	M	NPT	0			$7	$1,176
GOA	M	PTR	67			$78,748	$1,176
GOA	P	HAL	5,563			$11,851,690	$3,240
GOA	P	NPT	19,754			$20,282,279	$1,725
GOA	P	POT	1,629			$2,098,888	$1,184
GOA	P	PTR	573			$300,481	$1,172
GOA	S	HAL	17,867	$52,067,217	$1,660		
GOA	S	JIG	345	$270,980	$926		
GOA	S	NPT	42,145	$16,094,291	$393		
GOA	S	POT	5,468	$3,590,583	$696		
GOA	S	PTR	67,880	$9,698,304	$205		
Retained	**Total**		**1,877,133**	**$204,434,313**		**$919,236,395**	

Notes: M = Mothership
P = Catcher Processor
S = Shoreside
CV = catcher vessel
CP = catcher-processor

NPT = nonpelagic trawl
POT = pot
PTR = pelagic trawl
JIG = jig
HAL = hook and line

Table H-4. EFH Fishing Impact Minimization Alternative 5

Fishery	**Atka Mackerel Trawl**	**Pacific Cod Trawl**	**Pollock Trawl**	**Rockfish Trawl**	**Sablefish & Greenland Turbot trawl**
Amount (OTC)	312,513	101,562	6,134	53,669	9,226
Amount (OTC) inside closures	4,908	2,294	0	6,185	0
Amount (OTC) outside	307,604	99,268	6,134	47,483	9,226
% of fishery affected by closure	1.57%	2.26%	0.00%	11.53%	0
Effort overall	5,605	6,142	254	1,035	710
Effort sq. km within closures	82.64	121.24	0.00	149.90	0.00
CPUE =(OTC)/(Effort)	55.75	16.54	24.06	51.81	12.99
Amount (CPUE) inside closures	59.40	18.92	0.00	41.27	0.00
Amount (CPUE) outside (Catch T-Catch1_/(Effort T-Effort 1)	55.70	16.49	24.06	53.59	12.99

Note: Closes nonpelagic trawl fishing in five areas within the AI. Weights are recorded in mt, based on extrapolated observed total catch for the 1998-2002 period. Catch per unit effort is based on catch to area swept.

Table H-5. Example of Cumulative Calculation

ABUN	CUMULATED
1	1
2	1+2=3
3	3+3=6

Sample data:

ABUN	CUMULATED
0.10114895525	0.10114895525
0.05175383102	0.15290278627
0.03997601112	0.19287879739
0.03923292519	0.23211172258
0.03052224149	0.26263396407

The CUMULATED data serve as a proxy for population. These data were then displayed with CUMULATED <= 0.75 and <= 0.95, respectively for Presumed Known Concentration – 75 percent, and Revised General Distribution – 95 percent.

RACE and NORPAC CUMULATED values were displayed visually on screen in ArcGIS 8.3. Analysts used best professional judgement, knowledge of the species, and bathymetry to aid in drawing polygons around these point distributions at the 95 and 75 percent distribution levels.

Table H-6. Total Observed Catch (mt) for the Aleutian Islands Region, Inside and Outside the 'Open' Areas Designated for Mitigation Alternative 5B, Based on Observed Vessels, 1998-2002

Fishery	**Atka Mackeral Trawl**	**P cod trawl**	**Pollock trawl**	**Rockfish trawl**	**Sablefish & Greenland Turbot trawl**
Amount (OTC)	312,513.39	101,562.04	6,134.32	53,669.46	9,226.70
Amount (OTC)inside closures	17,331.85	10,393.50	106.10	6,433.45	0.06
Amount (OTC) outside	295,181.54	91,168.54	6,028.22	47,236.01	9,226.64
% of fishery effected by closure	**5.55%**	**10.23%**	**1.73%**	**11.99%**	0.00%
Effort overall	5,605.38	6,142.02	254.96	1,035.88	710.16
Effort km2 within closures	382.19	584.09	1.86	128.23	1.19
CPUE =(OTC)/(Effort)	55.75	16.54	24.06	51.81	12.99
Amount (CPUE) inside closures	45.35	17.79	57.04	50.17	0.05
Amount (CPUE) outside (Catch T-Catch1_/(Effort T-Effort 1)	56.51	16.40	23.82	52.04	13.01

Note: Effort is the area swept, which is based on haul duration and gear of each target fishery (C. Rose).

Table H-7. Reduction in 2003 TACs Based on Percent TAC Reductions Associated with Mitigation Alternative 5B

Species/Fishery Component	TAC Reduction %	2003 TAC (Trawl Only) (mt)	2003 TAC Reduction (mt)
AI Atka Mackerel	6.0%	45649	2739
EBS Pacific cod *	10.0%	67658	6766
AI Pacific cod *	10.0%	22553	2255
Total Pacific Cod		90210	9021
AI, POP, NRF, ORF	12.0%	17716	2126
AI, SRF/RRF	12.0%	538	65
Total Rockfish		18254	2190

Table H-8. Observed Aleutian Islands Trawl Bryozoan and Coral Bycatch by Target Species and Federal Zone, 1998-2002 (by Regulatory Area)

Weekly Target Species	Zone	Year	Observed Vessels	Vessels W/ Bryozoan bycatch	Un-sampled Hauls	Total Sampled Hauls	Hauls with Bycatch	%	Hauls W/ Bryozoan Bycatch	%	Bryozoan Bycatch Rate (kg/ton)	Observed Bryozoan Bycatch (kg)	Target Species (mtons)
Atka Mackeral	541	1998	7	0	46	210	134	63.8	0	0.0	.	.	8,872
		1999	10	6	74	287	205	71.4	39	13.6	0.076	893	11,821
		2000	9	8	67	232	168	72.4	39	16.8	0.096	1,105	11,490
		2001	9	7	44	116	83	71.6	29	25.0	0.238	1,301	5,468
		2002	9	3	5	70	41	58.6	3	4.3	0.005	17	3,604
		All	12	10	236	915	631	69.0	110	12.0	0.080	3,316	41,255
	542	1998	8	3	159	279	144	51.6	19	6.8	0.148	2,110	14,218
		1999	10	5	172	369	202	54.7	16	4.3	0.012	201	17,264
		2000	8	5	186	468	309	66.0	41	8.8	0.071	1,269	17,804
		2001	9	9	129	476	319	67.0	64	13.4	0.082	2,240	27,291
		2002	10	9	25	407	272	66.8	37	9.1	0.049	1,033	21,083
		All	13	12	671	1999	1246	62.3	177	8.9	0.070	6,853	97,660
	543	1998	9	6	229	557	282	50.6	25	4.5	0.151	2,764	18,264
		1999	9	7	138	417	326	78.2	45	10.8	0.149	1,883	12,617
		2000	6	3	30	206	113	54.9	47	22.8	0.432	4,116	9,535
		2001	8	8	165	439	272	62.0	65	14.8	0.388	6,233	16,053
		2002	8	7	32	435	304	69.9	86	19.8	0.369	6,126	16,608
		All	11	11	594	2054	1297	63.1	268	13.0	0.289	21,124	73,078
Pacific Cod	541	1998	16	9	267	382	221	57.9	51	13.4	0.510	3,796	7,438
		1999	15	9	128	431	344	79.8	69	16.0	0.120	1,322	11,041
		2000	29	13	162	587	322	54.9	31	5.3	0.029	256	8,796
		2001	18	7	109	416	284	68.3	80	19.2	0.106	735	6,959
		2002	25	12	243	656	305	46.5	28	4.3	0.103	1,216	11,788
		All	57	36	909	2472	1476	59.7	259	10.5	0.159	7,325	46,022
	542	1998	9	4	68	92	61	66.3	9	9.8	0.369	864	2,342
		1999	8	3	21	54	46	85.2	6	11.1	0.054	46	846
		2000	14	5	61	154	114	74.0	19	12.3	0.099	198	2,004
		2001	13	5	72	147	116	78.9	24	16.3	0.341	784	2,296
		2002	13	5	46	204	169	82.8	44	21.6	0.503	2,207	4,390
		All	29	15	268	651	506	77.7	102	15.7	0.345	4,098	11,878
	543	1998	2	0	1	3	2	66.7	0	0.0	.	.	.
		2000	2	2	23	41	33	80.5	26	63.4	.	.	.
		2001	2	1	5	5	4	80.0	3	60.0	.	.	.
		2002	4	3	17	44	35	79.5	29	65.9	5.016	4,517	900
		All	6	3	46	93	74	79.6	58	62.4	6.329	13,176	2,082
Rockfish	541	1998	6	0	11	22	7	31.8	0	0.0	.	.	1,146
		1999	5	1	19	39	18	46.2	2	5.1	.	.	2,172
		2000	5	4	13	34	27	79.4	5	14.7	0.101	157	1,556
		2001	4	2	54	48	34	70.8	3	6.3	.	.	1,472
		2002	5	1	24	52	20	38.5	1	1.9	.	.	1,755
		All	10	4	121	195	106	54.4	11	5.6	0.097	783	8,101
	542	1998	5	1	8	38	29	76.3	2	5.3	.	.	1,588
		1999	6	4	17	47	45	95.7	11	23.4	0.743	1,668	2,245
		2000	5	2	23	40	32	80.0	3	7.5	.	.	1,646
		2001	5	3	43	40	17	42.5	3	7.5	0.250	264	1,057
		2002	5	2	23	47	25	53.2	13	27.7	.	.	1,776
		All	9	7	114	212	148	69.8	32	15.1	0.310	2,576	8,312
	543	1998	5	2	17	56	33	58.9	5	8.9	.	.	3,273
		1999	4	2	19	90	68	75.6	5	5.6	.	.	5,546
		2000	6	4	25	72	55	76.4	7	9.7	1.697	6,018	3,547
		2001	4	1	12	30	20	66.7	5	16.7	.	.	2,135
		2002	5	1	25	67	52	77.6	8	11.9	.	.	3,235
		All	8	5	98	315	228	72.4	30	9.5	2.136	37,875	17,736

From NPFMC EFH Observer Report File, April 2003
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Table H-9. Observed Aleutian Islands Trawl Sponge Bycatch by Target Species and Federal Zone, 1998-2002 (All Regulatory Areas)

Weekly Target Species	Zone	Year	Observed Vessels	Vessels W/ Sponge bycatch	Un-sampled Hauls	Total Sampled Hauls	Hauls with Bycatch	%	Hauls W/ Sponge Bycatch	%	Sponge Bycatch Rate (kg/ton)	Observed Sponge Bycatch (kg)	Target Species (mtons)
Atka Mackeral	541	1998	7	6	46	210	134	63.8	57	27.1	0.822	7,289	8,872
		1999	10	8	74	287	205	71.4	90	31.4	0.342	4,042	11,821
		2000	9	8	67	232	168	72.4	89	38.4	0.685	7,872	11,490
		2001	9	9	44	116	83	71.6	33	28.4	0.250	1,369	5,468
		2002	9	4	5	70	41	58.6	10	14.3	0.078	281	3,604
		All	12	12	236	915	631	69.0	279	30.5	0.505	20,852	41,255
	542	1998	8	5	159	279	144	51.6	73	26.2	0.681	9,683	14,218
		1999	10	7	172	369	202	54.7	125	33.9	0.875	15,102	17,264
		2000	8	7	186	468	309	66.0	145	31.0	0.502	8,944	17,804
		2001	9	9	129	476	319	67.0	149	31.3	0.630	17,186	27,291
		2002	10	9	25	407	272	66.8	117	28.7	0.251	5,291	21,083
		All	13	12	671	1999	1246	62.3	609	30.5	0.576	56,206	97,660
	543	1998	9	6	229	557	282	50.6	108	19.4	1.194	21,798	18,264
		1999	9	9	138	417	326	78.2	239	57.3	4.087	51,571	12,617
		2000	6	4	30	206	113	54.9	67	32.5	0.758	7,228	9,535
		2001	8	8	165	439	272	62.0	77	17.5	0.438	7,026	16,053
		2002	8	8	32	435	304	69.9	157	36.1	3.511	58,303	16,608
		All	11	10	594	2054	1297	63.1	648	31.5	1.997	145,926	73,078
Pacific Cod	541	1998	16	13	267	382	221	57.9	108	28.3	3.777	28,091	7,438
		1999	15	10	128	431	344	79.8	161	37.4	0.867	9,573	11,041
		2000	29	17	162	587	322	54.9	75	12.8	0.262	2,303	8,796
		2001	18	13	109	416	284	68.3	126	30.3	0.317	2,207	6,959
		2002	25	15	243	656	305	46.5	74	11.3	0.288	3,396	11,788
		All	57	43	909	2472	1476	59.7	544	22.0	0.990	45,570	46,022
	542	1998	9	6	68	92	61	66.3	35	38.0	1.886	4,418	2,342
		1999	8	6	21	54	46	85.2	41	75.9	3.859	3,264	846
		2000	14	13	61	154	114	74.0	61	39.6	4.168	8,353	2,004
		2001	13	7	72	147	116	78.9	58	39.5	2.802	6,434	2,296
		2002	13	12	46	204	169	82.8	88	43.1	3.605	15,827	4,390
		All	29	24	268	651	506	77.7	283	43.5	3.224	38,296	11,878
	543	1998	2	0	1	3	2	66.7	0	0.0	.	.	.
		2000	2	1	23	41	33	80.5	6	14.6	.	.	.
		2001	2	1	5	5	4	80.0	3	60.0	.	.	.
		2002	4	1	17	44	35	79.5	7	15.9	.	.	900
		All	6	2	46	93	74	79.6	16	17.2	.	.	2,082
Rockfish	541	1998	6	0	11	22	7	31.8	0	0.0	.	.	1,146
		1999	5	2	19	39	18	46.2	4	10.3	.	.	2,172
		2000	5	2	13	34	27	79.4	2	5.9	.	.	1,556
		2001	4	2	54	48	34	70.8	3	6.3	.	.	1,472
		2002	5	3	24	52	20	38.5	7	13.5	4.834	8,483	1,755
		All	10	6	121	195	106	54.4	16	8.2	1.293	10,474	8,101
	542	1998	5	0	8	38	29	76.3	0	0.0	.	.	1,588
		1999	6	4	17	47	45	95.7	15	31.9	1.586	3,559	2,245
		2000	5	3	23	40	32	80.0	7	17.5	1.298	2,136	1,646
		2001	5	3	43	40	17	42.5	4	10.0	0.170	179	1,057
		2002	5	4	23	47	25	53.2	18	38.3	1.715	3,046	1,776
		All	9	7	114	212	148	69.8	44	20.8	1.073	8,921	8,312
	543	1998	5	3	17	56	33	58.9	5	8.9	0.512	1,676	3,273
		1999	4	2	19	90	68	75.6	10	11.1	.	.	5,546
		2000	6	3	25	72	55	76.4	13	18.1	2.136	7,574	3,547
		2001	4	2	12	30	20	66.7	8	26.7	.	.	2,135
		2002	5	5	25	67	52	77.6	32	47.8	13.91	44,989	3,235
		All	8	6	98	315	228	72.4	68	21.6	5.629	99,826	17,736

rom NPFMC EFH Observer Report File, April 2003
A '.' denotes confidential data
Report2a.sas

Table H-10. Observed Aleutian Islands Trawl Bryozoan and Coral Bycatch by Target Species and Federal Zone, 1998-2002 (by Regulatory Area)

Weekly Target Species	Zone	Year	Observed Vessels	Vessels W/ Bryozoan bycatch	Un-sampled Hauls	Total Sampled Hauls	Hauls with Bycatch	%	Hauls W/ Bryozoan Bycatch	%	Bryozoan Bycatch Rate (kg/ton)	Observed Bryozoan Bycatch (kg)	Target Species (mtons)
Atka Mackeral	ALL	1998	10	6	434	1046	560	53.5	44	4.2	0.118	4,874	41,355
		1999	10	9	384	1073	733	68.3	100	9.3	0.071	2,978	41,702
		2000	9	9	283	906	590	65.1	127	14.0	0.167	6,491	38,828
		2001	9	9	338	1031	674	65.4	158	15.3	0.200	9,775	48,813
		2002	10	10	62	912	617	67.7	126	13.8	0.174	7,175	41,295
		All	14	13	1501	4968	3174	63.9	555	11.2	0.148	31,293	211,993
Pacific Cod	ALL	1998	19	11	336	477	284	59.5	60	12.6	****	****	****
		1999	15	10	149	485	390	80.4	75	15.5	0.115	1,367	11,887
		2000	30	15	246	782	469	60.0	76	9.7	****	****	****
		2001	20	9	186	568	404	71.1	107	18.8	****	****	****
		2002	25	12	306	904	509	56.3	101	11.2	0.465	7,940	17,079
		All	58	36	1223	3216	2056	63.9	419	13.0	0.410	24,599	59,982
Rockfish	ALL	1998	6	2	36	116	69	59.5	7	6.0	.	.	****
		1999	7	4	55	176	131	74.4	18	10.2	3.292	32,794	9,963
		2000	6	5	61	146	114	78.1	15	10.3	****	****	****
		2001	5	3	109	118	71	60.2	11	9.3	0.232	1,081	4,664
		2002	5	3	72	166	97	58.4	22	13.3	0.097	658	6,767
		All	11	7	333	722	482	66.8	73	10.1	1.208	41,234	34,149

From NPFMC EFH Observer Report File, April 2003
A '.' denotes confidential data
Report2a.sas

Table H-11. Observed Aleutian Islands Trawl Sponge Bycatch by Target Species and Federal Zone, 1998-2002 (All Regulatory Areas)

Weekly Target Species	Zone	Year	Observed Vessels	Vessels W/ Sponge bycatch	Un-sampled Hauls	Total Sampled Hauls	Hauls with Bycatch	%	Hauls W/ Sponge Bycatch	%	Sponge Bycatch Rate (kg/ton)	Observed Sponge Bycatch (kg)	Target Species (mtons)
Atka Mackeral	ALL	1998	10	8	434	1046	560	53.5	238	22.8	0.938	38,769	41,355
		1999	10	10	384	1073	733	68.3	454	42.3	1.696	70,715	41,702
		2000	9	9	283	906	590	65.1	301	33.2	0.619	24,044	38,828
		2001	9	9	338	1031	674	65.4	259	25.1	0.524	25,581	48,813
		2002	10	10	62	912	617	67.7	284	31.1	1.547	63,874	41,295
		All	14	13	1501	4968	3174	63.9	1536	30.9	1.052	222,984	211,993
Pacific Cod	ALL	1998	19	16	336	477	284	59.5	143	30.0	****	****	****
		1999	15	11	149	485	390	80.4	202	41.6	1.080	12,837	11,887
		2000	30	21	246	782	469	60.0	142	18.2	****	****	****
		2001	20	15	186	568	404	71.1	187	32.9	****	****	****
		2002	25	17	306	904	509	56.3	169	18.7	****	****	****
		All	58	45	1223	3216	2056	63.9	843	26.2	1.404	84,231	59,982
Rockfish	ALL	1998	6	3	36	116	69	59.5	5	4.3	****	****	****
		1999	7	5	55	176	131	74.4	29	16.5	3.302	32,902	9,963
		2000	6	4	61	146	114	78.1	22	15.1	****	****	****
		2001	5	3	109	118	71	60.2	15	12.7	3.945	18,396	4,664
		2002	5	5	72	166	97	58.4	57	34.3	8.352	56,519	6,767
		All	11	8	333	722	482	66.8	128	17.7	3.491	119,221	34,149

From NPFMC EFH Observer Report File, April 2003
A '.' denotes confidential data
Report2B.sas

Table H-12. Estimated Aleutian Islands Trawl Bryozoan Bycatch by Fishery and Federal Zone, 1998-2002

		FEDERAL ZONE								
		541			542			543		
Weekly Target Species	Year	Bryozoan bycatch Rate (kg/ton)	Target* Total Tons	Bryozoan Expanded (tons)	Bryozoan bycatch Rate (kg/ton)	Target* Total Tons	Bryozoan Expanded (tons)	Bryozoan bycatch Rate (kg/ton)	Target* Total Tons	Bryozoan Expanded (tons)
Atka Mackeral	1998	.	10,673	.	0.15	19,904	2.95	0.15	24,193	3.66
	1999	0.08	14,565	1.10	0.01	21,505	0.25	0.15	16,187	2.42
	2000	0.10	13,961	1.34	0.07	22,203	1.58	0.43	10,200	4.40
	2001	0.24	7,686	1.83	0.08	31,780	2.61	0.39	20,008	7.77
	2002	0.00	3,820	0.02	0.05	21,984	1.08	0.37	17,433	6.43
Pacific Cod	1998	0.51	12,642	6.45	0.37	4,003	1.48	.	.	.
	1999	0.12	13,210	1.58	0.05	642	0.03	.	.	.
	2000	0.03	13,998	0.41	0.10	2,782	0.27	.	1,378	.
	2001	0.11	9,630	1.02	0.34	3,833	1.31	.	.	.
	2002	0.10	19,305	1.99	0.50	6,084	3.06	5.02	1,207	6.05
Rockfish	1998	.	1,562	.	.	2,022	.	.	4,198	.
	1999	.	2,495	.	0.74	2,913	2.16	.	6,577	.
	2000	0.10	1,939	0.20	.	2,074	.	1.70	4,483	7.61
	2001	.	2,745	.	0.25	2,326	0.58	.	2,921	.
	2002	.	2,627	.	.	2,560	.	.	4,355	.

From NPFMC EFH Observer Report File, April 2003,and from NMFS Blend data
A '.' denotes confidential data
* Taken from blend data. CDQ and discard data are included.

Table H-13. Estimated Aleutian Islands Trawl Sponge Bycatch by Fishery and Federal Zone, 1998-2002

		FEDERAL ZONE								
		541			542			543		
Weekly Target Species	Year	Sponge bycatch Rate (kg/ton)	Target* Total Tons	Sponge Expanded (tons)	Sponge bycatch Rate (kg/ton)	Target* Total Tons	Sponge Expanded (tons)	Sponge bycatch Rate (kg/ton)	Target* Total Tons	Sponge Expanded (tons)
Atka Mackeral	1998	0.82	10,673	8.77	0.68	19,904	13.55	1.19	24,193	28.87
	1999	0.34	14,565	4.98	0.87	21,505	18.81	4.09	16,187	66.16
	2000	0.69	13,961	9.56	0.50	22,203	11.15	0.76	10,200	7.73
	2001	0.25	7,686	1.92	0.63	31,780	20.01	0.44	20,008	8.76
	2002	0.08	3,820	0.30	0.25	21,984	5.52	3.51	17,433	61.20
Pacific Cod	1998	3.78	12,642	47.75	1.89	4,003	7.55	.	.	.
	1999	0.87	13,210	11.45	3.86	642	2.48	.	.	.
	2000	0.26	13,998	3.66	4.17	2,782	11.60	.	1,378	.
	2001	0.32	9,630	3.05	2.80	3,833	10.74	.	.	.
	2002	0.29	19,305	5.56	3.61	6,084	21.93	.	1,207	.
Rockfish	1998	.	1,562	.	.	2,022	.	0.51	4,198	2.15
	1999	.	2,495	.	1.59	2,913	4.62	.	6,577	.
	2000	.	1,939	.	1.30	2,074	2.69	2.14	4,483	9.57
	2001	.	2,745	.	0.17	2,326	0.39	.	2,921	.
	2002	4.83	2,627	12.70	1.71	2,560	4.39	13.91	4,355	60.56

From NPFMC EFH Observer Report File, April 2003,and from NMFS Blend data
A '.' denotes confidential data
* Taken from blend data. CDQ and discard data are included.

Table H-14. Bycatch Limit Results

Fishery	541	542	543
Atka mackerel	10	20	66
Sponge	10	20	66
Coral/bryozoans	2	3	8
Pacific cod			
Sponge	11	22	22
Coral/bryozoans	2	1	6
Rockfish			
Sponge	13	5	10
Coral/bryozoans	1	1	8

Appendix I
Consistency with Applicable Laws and Other Requirements

Prepared by

North Pacific Fishery Management Council and
National Marine Fisheries Service

April 2005

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ACRONYMS AND ABBREVIATIONS

AI	Aleutian Islands
BSAI	Bering Sea and Aleutian Islands
Council	North Pacific Fishery Management Council
EBS	Eastern Bering Sea
EFH	essential fish habitat
EIS	environmental impact statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FMP	Fishery Management Plan
GIS	Geographic Information System
GOA	Gulf of Alaska
HAPC	habitat areas of particular concern
IRFA	Initial Regulatory Flexibility Analysis
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
RFA	Regulatory Flexibility Act
RIR	Regulatory Impact Review
ROD	Record of Decision
SFA	Sustainable Fisheries Act
TACs	total allowable catches
USFWS	U.S. Fish and Wildlife Service

The following sections provide a review for consistency with major laws and regulations directly applicable to this action. These laws and regulations were described in Section 3.5. Consistency with other relevant laws and requirements (e.g., Executive Order [EO] for Federalism, Marine Protected Areas) will be addressed elsewhere in the Record of Decision (ROD), and/or in the decision memoranda for the proposed and final rules that implement essential fish habitat (EFH) measures.

I.1 National Environmental Policy Act

This analysis was prepared in full compliance with the requirements of the National Environmental Policy Act (NEPA). All established procedures to ensure that federal agency decision makers take environmental factors into account, including the use of a public process (see Appendix A) were followed. This environmental impact statement (EIS) contains all the components required by NEPA, including a brief discussion of the need for the proposal (Chapter 1), the alternatives considered (Chapter 2), the affected environment (Chapter 3), the environmental impacts of the proposed action and the alternatives (Chapter 4), a list of document preparers (Chapter 5), and other relevant information.

I.2 Magnuson-Stevens Fishery Conservation and Management Act

This analysis was prepared in accordance with the requirements of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and related regulatory requirements. A review of how this analysis, including the alternatives, comports with the Magnuson-Stevens Act national standards for fishery management and with the regulations implementing the EFH provisions of the Magnuson-Stevens Act is provided in this section.

I.2.1 Compliance with National Standards

The following section reviews the alternatives for describing and identifying EFH, adopting an approach to identify habitat areas of particular concern (HAPCs), and minimizing the effects of fishing on EFH in terms of compliance with the national standards contained in Section 301 of the Magnuson-Stevens Act.

National Standard 1 - Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery.

In terms of achieving ‘optimum yield’ from the fishery, the Magnuson-Stevens Act defines ‘optimum’ as the amount of fish that will provide the greatest overall benefit to the nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery.

National Standard 1 thus involves a number of tradeoffs to achieve optimum yield. Overall benefits to the nation may be affected by these tradeoffs, though our ability to quantify those effects is quite limited. Nevertheless, all alternatives considered in this analysis are consistent with National Standard 1. All alternatives for describing EFH (except for no action Alternative 1) would provide additional conservation benefits by increasing attention on the location and use of habitats by managed fish species. Likewise, the alternative approaches for identifying HAPCs (except for no action Alternative 1) would provide potential conservation benefits. Some EFH fishing impact minimization alternatives (e.g., Alternatives 2 and 3) would provide additional small ecological conservation benefits at minimal economic and social costs. Other alternatives (e.g., Alternatives 4, 5A, and 5B) would provide greater ecological and habitat conservation benefits, but at more costs to fishermen and fishing communities. Alternative 6 is also considered to have positive benefits to habitat and the ecosystem, but would result in relatively high costs to the fishing industry, associated industries, and fishing communities.

All EFH fishing impact minimization alternatives are designed to prevent overfishing. Except for Alternative 5B, which has two management options that would reduce total allowable catches (TACs) for specific species, no changes in the Council's precautionary TACs are proposed. None of the groundfish, scallop, or salmon stocks is considered overfished or subject to overfishing. For the three crab stocks that are considered overfished (Bering Sea C. bairdi, St. Matthew blue king crab, and Pribilof Islands blue king crab), aggressive rebuilding plans have been developed and/or implemented. Any additional measures taken to conserve EFH may result in benefits to Fishery Management Plan (FMP) species; however, the effects are not projected to be substantial relative to existing stock conservation and management measures.

Overall yields from one or more of the stocks may be affected by the suite of proposed actions. All alternatives to the status quo for minimizing the effects of fishing on EFH would be expected to reduce yields, with the scale of foregone yields generally increasing from Alternative 1 through Alternative 6. While differential distributional impacts among fishing vessels and processing sectors are implied by a comparison of the alternatives, the overall net benefits to the nation from the EFH fishing impact minimization alternatives under consideration cannot be quantified at this time.

National Standard 2 - Conservation and management measures shall be based upon the best scientific information available.

The information used in this analysis includes recent scientific literature, summary information from administrative reports, fish ticket data (through 2001), observer data (through 2001), and other relevant information. The information in this analysis represents the most current, comprehensive set of information available, recognizing that some significant information, including ecological, biological, economic, and sociocultural information, is unavailable. The portion of the analysis that evaluates the effects of fishing on EFH (Appendix B) incorporates the results of an independent peer review by the Center for Independent Experts. The National Marine Fisheries Service (NMFS) undertook that review expressly to ensure that the final analysis is based upon the best available scientific information. Each of the alternatives was analyzed based on information that appears to be consistent with this standard to the fullest extent practicable. However, as noted in Section 4.5.1.3 of the EIS, EFH description alternatives 1, 2, and 6 are not consistent with National Standard 2.

National Standard 3 - To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

All alternatives appear to be consistent with this standard. The groundfish, crab, salmon, and scallop stocks will continue to be managed as units throughout their respective ranges, consistent with the agency's understanding of the dynamics of these stocks and international agreements.

National Standard 4 - Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various U.S. fishermen, such allocation shall be (A) fair and equitable to all such fishermen, (B) reasonably calculated to promote conservation, and ©) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

None of the alternatives makes explicit or implicit differentiation among residents of different states, and no direct allocation or assignment of fishing privileges is included in any of the alternatives.

National Standard 5 - Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources, except that no such measure shall have economic allocation as its sole purpose.

Economic efficiency in the utilization of fishery resources is an explicit element of all alternatives analyzed. The analysis presents information relative to these perspectives, but does not point to a preferred alternative in terms of this standard. National Standard 5 recognizes the importance of various other issues in addition to economic efficiency. Not the least of these, in the current case, is the objective to protect marine ecosystems (that is, EFH in the Bering Sea and Aleutian Islands [BSAI] and the Gulf of Alaska [GOA]).

National Standard 6 - Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

Limitations imposed by the EFH fishing impact minimization alternatives would likely reduce the flexibility of fishermen to respond to variations among many FMP fisheries, fisheries resources, and catches. While the proposed alternatives take these effects into account, they are balanced with the requirement to achieve the primary objective of the action, which is to minimize, to the extent practicable, the adverse effects on EFH caused by fishing.

National Standard 7 - Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

Protection of EFH is a new requirement under the Sustainable Fisheries Act (SFA). The Council has taken prior conservation actions; however, this action represents the first comprehensive look at conservation measures designed expressly to protect EFH. As described earlier, some alternatives would impose more costs than others. Decision makers must balance conservation benefits with economic costs, consistent with the management objectives specified in this analysis.

National Standard 8 - Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

Many of the coastal communities in Alaska and the Pacific Northwest participate in these GOA and BSAI fisheries, in one way or another, whether it be as host to processing facilities and support businesses or as the harbor/home/operating port to vessel operators, fishermen, and processing workers. Major ports in Alaska that process catch from the EBS and GOA include Dutch Harbor, St. Paul, Akutan, Sand Point, King Cove, Chignik, Kodiak, Seward, Cordova, Juneau, Sitka, Petersburg, and Ketchikan. Additionally, Washington and Oregon are home ports to many catcher vessels, and Washington is home port to many of the catcher-processor vessels operating in these fisheries. In terms of potential impacts resulting from the proposed suite of EFH fishing impact minimization alternatives, the analysts reviewed data on 1) harvest levels by vessel in each sector; 2) price and revenues resulting from that harvest; 3) where those harvests are traditionally delivered for processing or for first wholesale (in the case of catcher-processors), and 4) the home port of vessels engaged in each fishery.

Much of the information used in the detailed economic and socioeconomic analysis cannot be presented in its disaggregate form due to confidentiality restrictions, but it is summarized qualitatively. The information presented in the EIS does not attempt to trace the full economic impact of these revenue changes through all of the communities involved, nor does the analysis attempt to predict overall changes in such economic activity for the region from the proposed alternatives. Instead, it is provided as a broad indicator of the relative importance of the FMP and state of Alaska managed target fisheries to vessels from these communities in the recent past, and it provides insight into significant localized community impacts that could result from adoption of the different alternatives.

<u>National Standard 9</u> - Conservation and management measures shall, to the extent practicable, (A) minimize bycatch, and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

None of the alternatives would be expected to substantially change the amount of bycatch or the mortality of bycatch taken incidentally in the fisheries. Regulatory provisions that are in place at present (e.g., improved retention/improved utilization and prohibited species caps) will continue to provide incentives to fleets to minimize bycatch and mortality of such bycatch to the maximum extent practicable.

<u>National Standard 10</u> - Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

The suite of alternatives appears to be consistent with this standard, while simultaneously achieving the mandate to minimize, to the extent practicable, adverse effects on EFH caused by fishing. None of the changes in the proposed alternatives would substantially change safety considerations for fishing vessels. Nonetheless, fishing in the EBS, AI, and GOA is a high-risk enterprise, fraught with potential dangers. The suite of alternatives for minimizing the effects of fishing on EFH, with the exception of the status quo (Alternative 1), would affect all sizes of vessels, including the smallest vessel classes, and impose area closures that would affect the flexibility of operations by some fleet components.

I.2.2 Compliance with Magnuson-Stevens Act Provisions and Regulations for EFH

This section provides a review of how this analysis addresses the required EFH contents of FMPs as specified in Section 303(a)(7) of the Magnuson-Stevens Act and the EFH final rule (50 CFR 600 Subpart J).

(1) Description and identification of EFH. This analysis provides alternatives that would describe and identify EFH in text that clearly states the habitats or habitat types determined to be EFH for each life stage of the managed species. The alternatives explain the physical, biological, and chemical characteristics of EFH and, if known, how these characteristics influence the use of EFH by the species/life stage. All EFH alternatives considered identify the specific geographic location or extent of habitats described as EFH. Maps of the geographic locations of EFH, or the geographic boundaries within which EFH for each species and life stage is found, for all alternatives considered are provided in Appendix D.

For all EFH description alternatives, the description of EFH provides information on the usage of various habitats by each managed species. Information is included on the geographic range and habitat requirements by life stage, the distribution and characteristics of those habitats, and current and historic stock size as it affects occurrence in available habitats. Appendices D and F, as well as Chapter 3 of this

EIS, provide information that summarizes the life history information in text, tables, and figures to explain each species' relationship to, or dependence on, various habitats.

Proposed descriptions and identification of EFH were based on the best available sources, including peer-reviewed literature, unpublished scientific reports, data files of government resource agencies, fisheries landing reports, and other sources of information. The best scientific information available was used in the description and identification of EFH, consistent with National Standard 2.

All EFH description alternatives include maps that display, within the constraints of available information, the geographic locations of EFH or the geographic boundaries within which EFH for each FMP managed species and life stage is found. The data used for mapping were incorporated into a geographic information system (GIS) to facilitate analysis and presentation.

(2) Fishing activities that may adversely affect EFH. This EIS contains an evaluation of the potential adverse effects of fishing on EFH, including effects of each fishing activity regulated under the affected FMPs or other federal FMPs, based upon the best scientific information available at the time of development (see Appendix B). This evaluation considers the effects of each fishing activity on each type of habitat found within EFH. Additionally, the evaluation describes each fishing activity, reviews and discusses all available relevant information (such as information regarding the intensity, extent, and frequency of any adverse effect on EFH; the type of habitat within EFH that may be affected adversely; and the habitat functions that may be disturbed), and provides conclusions regarding whether and how each fishing activity adversely affects EFH. The evaluation also considers the cumulative effects of multiple fishing activities on EFH.

The alternatives considered in this EIS were designed to minimize to the extent practicable adverse effects from fishing on EFH, including EFH designated under other federal FMPs. The regulations require that Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, based on the fishery evaluation (see Appendix B) and/or the cumulative impacts analysis (see Section 4.4 of this EIS). The EIS identifies a range of potential new actions that could be taken to address adverse effects on EFH (Section 2.3) and contains an analysis of the practicability of potential new actions (Section 4.5), which will allow the Council and NMFS to consider adopting any new measures that are necessary and practicable. Once the Council has taken final action, the EIS will be revised to explain the reasons for the Council's conclusions regarding the past and/or new actions that minimize to the extent practicable the adverse effects of fishing on EFH.

(3) Non-Magnuson-Stevens Act fishing activities that may adversely affect EFH. Fishing activities not managed under the Magnuson-Stevens Act that may adversely affect EFH are identified and discussed in Section 4.3.

(4) Non-fishing related activities that may adversely affect EFH. Appendix G identifies and discusses activities other than fishing that may adversely affect EFH. For each activity, the known and potential adverse effects to EFH are described.

(5) Cumulative impacts analysis. A cumulative impact analysis is provided in Section 4.4.

(6) Conservation and enhancement. The rule requires that FMPs must identify actions to encourage the conservation and enhancement of EFH, including recommended options to avoid, minimize, or compensate for any adverse effects, including effects of non-Magnuson-Stevens Act fisheries, non-fishing related activities, and cumulative effects. Conservation and enhancement recommendations are included in the current FMPs. Appendix G also recommends measures to promote the conservation and enhancement of EFH.

(7) Prey species. This EIS considers the loss of prey and its potential for adverse effect on EFH and managed species in Chapter 4.

(8) Identification of habitat areas of particular concern. This EIS describes alternative methods for identifying and describing HAPC. Concurrent with this EFH EIS, the Council is implementing a process to identify site-specific HAPCs. The HAPC process is described in Appendix J. Final regulations implementing HAPC identification, if any, and any associated management measures that result from this process, will be promulgated no later than August 13, 2006, and will be supported by appropriate NEPA analysis.

(9) Research and information needs. Recommendations for research to improve upon the description and identification of EFH, the identification of threats to EFH from fishing and other activities, and the development of conservation and enhancement measures for EFH, were previously adopted under Amendments 55/55/8/5/5.

(10) Review and revision of EFH components of FMPs. The Council and NMFS will periodically review the EFH provisions of FMPs and revise or amend EFH provisions as warranted based on available information. New EFH information is included as part of the annual Stock Assessment and Fishery Evaluation reports. A complete review of all EFH information should be conducted as recommended by the Secretary, but at least once every 5 years.

(11) Development of EFH recommendations for Councils. NMFS has developed written recommendations to assist the Council in the identification of EFH, adverse impacts to EFH, and actions that should be considered to ensure the conservation and enhancement of EFH for each FMP. These recommendations are included in Appendix E.

(12) Relationship to other fishery management authorities. To the extent practicable, the Council has coordinated with state and interstate fishery management agencies regarding the management of fisheries and the development of the EFH provisions of Council FMPs.

I.2.3 Fisheries Impact Statement (Spillover Impacts)

Section 303(a)(9) of the Magnuson-Stevens Act requires that any management measure submitted by the Council take into account potential impacts on the participants in the fisheries, as well as participants in adjacent fisheries. Impacts to participants in the FMP and state-managed fisheries is one of the topics of Chapter 4.3 of this EIS. Under several of the EFH fishing impact minimization alternatives, potential impacts to other fisheries could result from changes in areas open to bottom contact fishing, because vessels that may be constrained by these closures may redeploy their fishing effort into areas where other fisheries traditionally operate, creating gear conflicts. For example, bottom trawl fisheries constrained by closures in the usual EBS rock sole with roe fishing grounds may be displaced onto grounds normally fished by longline catcher-processors.

I.3 Executive Order 12866 – Regulatory Impact Review

The requirements for all regulatory actions specified in EO 12866 are summarized in the following statement from the order: *In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environment, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.*

The EO requires a determination of whether an action is "significant," as that term is defined under EO 12866. This determination is found in a Regulatory Impact Review (RIR). An RIR is included with this EIS in Appendix C.

I.4 Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA), first enacted in 1980, was designed to place the burden on the government to review all regulations to ensure that, while accomplishing their intended purposes, they do not unduly inhibit the ability of small entities to compete. The RFA emphasizes predicting significant adverse impacts on small entities as a group distinct from other entities and considering alternatives that may minimize the impacts while still achieving the stated objective of the action. When an agency publishes a proposed rule, unless it can provide a factual basis upon which to certify that no such adverse effects will accrue, it must prepare and make available for public review an Initial Regulatory Flexibility Analysis (IRFA) that describes the impact of the proposed rule on small entities. An IRFA for this action is included with this analysis in Appendix C.

I.5 Executive Order 12898 – Environmental Justice

EO 12898 focuses on environmental justice in relation to minority and low-income populations. The Environmental Protection Agency (EPA) defines environmental justice as the "fair treatment for people of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies." This executive order was spurred by the growing need to address the impacts of environmental pollution on particular segments of our society. This order (Environmental Justice, 59 Fed. Reg. 7629) requires each federal agency to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority and low-income populations." The EPA responded by developing an environmental justice strategy that focuses the agency's efforts in addressing these concerns. To determine whether environmental justice concerns exist, the demographics of the affected area should be examined to ascertain whether minority populations and low-income populations are present. If so, a determination must be made as to whether implementation of the alternatives may cause disproportionately high and adverse human health or environmental effects on these populations. Environmental justice concerns typically embody pollution and other environmental health issues, but the EPA has stated that addressing environmental justice concerns is consistent with NEPA; thus, all federal agencies are required to identify and address these issues. Each alternative in this analysis has been evaluated in terms of its effects related to environmental justice. The results are provided in Appendix C.

I.6 Executive Order 13175 - Tribal Coordination

E.O. 13175 is intended to ensure regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications. Alaska Native groups are recognized as Indian tribes under E.O. 13175. To meet the intent of E.O. 13175, NMFS encouraged Alaska Native participation in the numerous public meetings held during the development of the EIS. These meetings were held in various locations throughout Alaska, including rural settings, to ensure ample vetting to Alaska Native groups and to receive their input. Furthermore, the Council includes an Alaska Native representing the Community Development Program (a program specifically designed to benefit Alaska Natives) as a voting member. NMFS will continue to work with Alaska Native groups during implementation of the EFH provisions of Council FMPs.

I.7 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) establishes a federal responsibility to conserve marine mammals, with management responsibility for cetaceans (whales) and most pinnipeds (seals) vested with the Department of Commerce, NMFS. The Department of the Interior, U.S. Fish and Wildlife Service (USFWS), is responsible for all other marine mammals in Alaska, including sea otters, walrus, and polar bear. Congress found that certain species and population stocks of marine mammals are or may be in danger of depletion due to human activities. Congress also declared that marine mammals are resources of great international significance and should be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management. Species listed under the Endangered Species Act (ESA) that occur in the management area are discussed in Section 3.2.3 of the EIS. Marine mammals not listed under the ESA that may be present in the BSAI management area include cetaceans, [minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcinus orca*), Dall's porpoise (*Phocoenoides dalli*), harbor porpoise (*Phocoena phocoena*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), and the beaked whales (e.g., *Berardius bairdii* and *Mesoplodon* spp.)] as well as pinnipeds [Pacific harbor seal (*Phoca vitulina*), northern fur seal (*Callorhinus ursinus*), Pacific walrus (*Odobenus rosmarus*), spotted seal (*Phoca largha*), bearded seal (*Erignathus barbatus*), ringed sea (*Phoca hispida*) and ringed seal (*Phoca fasciata*)], and the sea otter (*Enhydra lutris*). The primary management objective of the MMPA is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The MMPA is intended to work in concert with the provisions of the ESA. The Secretary is required to give full consideration to all factors regarding regulations applicable to the "take" of marine mammals, including the conservation, development, and utilization of fishery resources, as well as the economic and technological feasibility of implementing the regulations. If a fishery affects a marine mammal population, then the potential impacts of the fishery must be analyzed in the appropriate environmental assessment or EIS, and the Council or NMFS may be asked to consider regulations to mitigate adverse impacts.

A review of the effects of the alternatives on marine mammals is provided in Chapter 4. For EFH description and HAPC identification alternatives, there are no known interactions between implementation of the alternatives under consideration and any ESA-listed species. However, evaluation of the alternatives to minimize the potential adverse effects of fishing on EFH suggests that some alternatives (Alternatives 5B and 6) may result in adverse impacts on some marine mammal species because of the potential for an increase in spatial and temporal concentration of fishing effort. In particular, concentration of the AI Atka mackerel fishery under these alternatives may result in negative effects on Steller sea lions by affecting localized prey availability. Additionally, concentration of fishing effort could result in increased "takes" of great whales by increasing the incidence of their collision with ships, should fishing occur in areas where whales aggregate.

I.8 Endangered Species Act

The ESA (16 U.S.C. § 1531-1544), amended in 1988, establishes a national program for the conservation of threatened and endangered species for fish, wildlife, and plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires that federal agencies consult with the USFWS and NMFS, as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of their designated critical habitat. Section 7(b) of the ESA requires the USFWS and NMFS to summarize consultations in biological opinions that detail how actions may affect threatened or endangered species and designated critical habitat.

As previously discussed, some of the alternatives (5B, 5C, and 6) to minimize the potential adverse effects of fishing on EFH may result in adverse impacts on some marine mammal species because of the potential for an increase in spatial and temporal concentration of fishing effort. In particular, concentration of the AI Atka mackerel fishery under these alternatives may result in negative effects on ESA-listed Steller sea lions by affecting localized prey availability. Additionally, concentration of fishing effort could result in increased takes of ESA-listed great whales by increasing the incidence of their collision with ships, should fishing occur in areas where whales aggregate. NMFS considered the effects of preferred Alternative 5C on listed whales and sea lions pursuant to Section 7 of the ESA and concluded that the proposed measures are not likely to adversely affect threatened or endangered species or critical habitat.

I.9 Coastal Zone Management Act

Implementation of each of the alternatives would be conducted in a manner consistent, to the maximum extent practicable, with the Alaska Coastal Management Program within the meaning of the Coastal Zone Management Act of 1972 and its implementing regulations.

Appendix J
Proposed HAPC Identification Process

Prepared by

North Pacific Fishery Management Council

April 2005

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ACRONYMS AND ABBREVIATIONS

Council	North Pacific Fishery Management Council
EFH	essential fish habitat
EIS	environmental impact statement
EEZ	exclusive economic zone
FMP	Fishery Management Plan
HAPCs	habitat areas of particular concern
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
SSC	Scientific and Statistical Committee

J.1 Introduction and Background

In June 1998, the North Pacific Fishery Management Council (Council) identified several habitat types as habitat areas of particular concern (HAPCs) within essential fish habitat (EFH) amendments 55/55/8/5/5. Habitat types, rather than specific areas, were identified as HAPCs because little information was available regarding specific habitat locations. These HAPC types included the following:

1. Areas with living substrates in shallow waters (e.g., eelgrass, kelp, and mussel beds)
2. Areas with living substrates in deep waters (e.g., sponges, coral, and anemones)
3. Freshwater areas used by anadromous fish (e.g., migration, spawning, and rearing areas)

The history of North Pacific Council HAPC designations is provided in Chapter 2 of the EFH environmental impact statement (EIS). In April 2001, the Council formed the EFH Committee to facilitate industry, conservation community, Council, and general public input into the EFH EIS process. The committee worked cooperatively with Council staff and the National Marine Fisheries Service (NMFS) to identify alternative HAPC criteria, as well as approaches that could be used to designate and manage HAPC areas. The Committee aided in formulating the HAPC designation alternatives referred to in Chapter 2 and developed recommendations for a HAPC process.

In October 2003, the Council chose a preliminary preferred alternative for a HAPC approach: HAPCs will be site-based, and the three HAPC types listed above will be rescinded.

For the initial 2003 HAPC process, the Council recommended that the proposals focus on sites within two specific priority areas:

1. Seamounts in the exclusive economic zone (EEZ), named on National Oceanic and Atmospheric Administration (NOAA) charts, that provide important habitat for managed species
2. Largely undisturbed, high-relief, long-lived hard coral beds, with particular emphasis on those located in the Aleutian Islands, which provide habitat for life stages of rockfish or other important managed species

Nominations were based on best available scientific information and included the following features:

1. Sites must have likely or documented presence of Fishery Management Plan (FMP) rockfish species.
2. Sites must be largely undisturbed and occur outside core fishing areas.

This appendix summarizes the process that will be used to identify HAPC sites in the future, consistent with the HAPC approach chosen through Action 2, Adopt an Approach for Identifying HAPCs, of this EIS. The Council may modify this HAPC process over time, as warranted.

J.2 HAPC Considerations and Priorities

The Council will call for HAPC nominations through a proposal process that will focus on specific sites consistent with HAPC priorities designated by the Council. The Council may designate HAPCs as habitat sites, and management measures, if needed, would be applied to a habitat feature or features in a specific geographic location. The feature(s), identified on a chart, would have to meet the considerations established in the regulations and would be developed to address identified problems for FMP species. They would have to meet clear, specific, adaptive management objectives. Evaluation and development of HAPC management measures, where management measures are appropriate, will be guided by the EFH Final Rule.

J.2.1 HAPC Considerations

HAPCs are those areas of special importance that may require additional protection from adverse effects. Regulations at 50 CFR 600.815(a)(8) provide the following:

> FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations:
>
> (i) The importance of the ecological function provided by the habitat.
> (ii) The extent to which the habitat is sensitive to human-induced environmental degradation.
> (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type.
> (iv) The rarity of the habitat type.

The Council will consider HAPCs that meet at least two of the four HAPC considerations above, and rarity will be a mandatory criterion of all HAPC proposals.

J.2.2 HAPC Priorities

The Council will set priorities at the onset of each HAPC proposal cycle.

J.3 Proposal Cycle

HAPC proposals may be solicited every 3 years or on a schedule established by the Council.

J.4 HAPC Process

The HAPC process will be initiated when the Council sets priorities, and a subsequent request for HAPC proposals is issued. Criteria to evaluate the HAPC proposals will be reviewed by the Council and the Scientific and Statistical Committee (SSC) prior to the request for proposals. Any member of the public may submit a HAPC proposal. Potential contributors may include fishery management agencies, other government agencies, scientific and educational institutions, non-governmental organizations, communities, and industry groups. A step-by-step outline is attached as Figure J-1.

J.4.1 Call for proposals

A call for proposals will be announced during a Council meeting, and will be published in the Federal Register, as well as advertised in the Council newsletter. Scientific and technical information on habitat distributions, gear effects, fishery distributions, and economic data should be made easily accessible for the public, simultaneous with issuing a call for proposals. For example NMFS' Alaska Region website has a number of valuable tools for assessing habitat distributions, understanding ecological importance, and assessing impacts. Information on EFH distribution, living substrate distribution, fishing effort, catch and bycatch data, gear effects, known or estimated recovery times of habitat types, prey species, and freshwater areas used by anadromous fish is provided in the EFH EIS. The public will be advised of the rating criteria with the call for proposals.

J.4.1.1 Contents of Proposals

The format for a HAPC proposal should include the following:

- Provide the name of the proposer, address, and affiliation.
- Provide a title for the HAPC proposal and a single, brief paragraph concisely describing the proposed action.
- Identify the habitat and FMP species that the HAPC proposal is intended to protect.
- State the purpose and need.
- Describe whether and how the proposed HAPC addresses the four considerations set out in the final EFH regulations.
- Define the specific objectives for this proposal.
- Propose solutions to achieve these objectives [How might the problem be solved?].
- Establish methods of measuring progress towards those objectives.
- Define expected benefits of the proposed HAPC; provide supporting information/data, if possible.
- Identify the fisheries, sectors, stakeholders, and communities to be affected by establishing the proposed HAPC [Who would benefit from the proposal; who would it harm?] and any information you can provide on socioeconomic costs.
- Provide a clear geographic delineation for the proposed HAPC (written latitude and longitude reference point and delineation on an appropriately scaled NOAA chart).
- Provide the best available information and sources of such information to support the objectives for the proposed HAPC (citations for common information or copies of uncommon information).

J.4.2 Initial Screening

Council staff will screen proposals to determine consistency with Council priorities, HAPC criteria, and general adequacy. Staff will present a preliminary report of the screening results to the Council. The Council will determine which of the proposals will be forwarded for the next review step: scientific, socioeconomic, and enforcement review.

J.4.3 Review Process

J.4.3.1 Scientific Review

The Council will refer selected proposals to the plan teams (Gulf of Alaska groundfish; Bering Sea groundfish; Bering Sea crab, scallop, and salmon). The teams will evaluate the proposals for ecological merit.

There will always be some level of scientific uncertainty in the design of proposed HAPCs and how they meet their stated goals and objectives. Some of this uncertainty may arise because the public will not have access to all relevant scientific information. Recognizing time and staff constraints, however, the staff cannot be expected to fill all the information gaps of proposals. The Council will have to recognize data limitations and uncertainties and weigh precautionary strategies for conserving and enhancing HAPCs while maintaining sustainable fisheries. The review panels may highlight available science and information gaps that may have been overlooked or are not available to the submitter of the HAPC proposal.

J.4.3.2 Socioeconomic Review

Proposals will be reviewed by Council or agency economists for socioeconomic impact. The Magnuson-Stevens Act states that EFH measures are to minimize impacts on EFH “to the extent practicable,” so socioeconomic considerations have to be balanced against expected ecological benefits at the earliest point in the development of measures. NMFS’ Final Rule for developing EFH plans states specifically that FMPs should “identify a range of potential new actions that could be taken to address adverse effects on EFH, include an analysis of the practicability of potential new actions, and adopt any new measures that are necessary and practicable” (50 CFR 600.815(a)(2)(ii)). In contrast to a process where the ecological benefits of EFH or HAPC measures are the singular initial focus and a later step is used to determine practicability, this approach would consider practicability simultaneously.

Proposals should also be rated as to whether they identify affected fishing communities and the potential effects on those communities, employment, and earnings in the fishing and processing sectors and the related infrastructure, to the extent that such information is readily available to the public. Management and enforcement will also provide input during the review to evaluate general management cost and enforceability of individual proposals.

J.4.3.3 Management and Enforcement Review

Proposals will be reviewed for management and enforceability.

J.4.4 Evaluation of Candidate HAPCs

The reviewers may rank the proposals by using a system like the matrix illustrated in Table J.1 and provide their recommendations to the Council. In the NPFMC Environmental Assessment of Habitat Areas of Particular Concern (NPFMC 2000), proposed HAPC types and areas were evaluated by using a ranking system that provided a relative score to the proposed HAPCs; they were weighed against the four considerations established in the EFH Final Rule. One additional column was added to the matrix to score the level of socioeconomic impact: the lower the impact, the higher the score. The Data Level column was split into two columns, Data Level and Data Certainty, to reflect not only the amount of data available, but also the scientific certainty of the information supporting the proposal. A written description should accompany the scoring so that it is clear what data, scientific literature, and professional judgments were used in determining the relative score.

Table J-1. Evaluation Matrix of Proposed HAPC Types and Areas, with Sample Proposals for Illustration Only

Proposed HAPC area	**Data Level**	**Data Certainty**	**Sensitivity**	**Exposure**	**Rarity**	**Ecological Importance**	**Socioeconomic impact level**
Seamounts and Pinnacles	1	1	Medium	Medium	High	Medium	Low
Ice Edge	3	1	Low	Low	Low	High	Low
Continental Shelf Break	3	2	Medium	Medium	Low	High	Medium
Biologically Consolidated Sediments	1	3	Low	Medium	Low	Unknown	Unknown

J.5 Council Action

J.5.1 Council Assessment of Proposal Reviews

Staff will provide the Council with a summary of the ecological, socioeconomic, and enforcement reviews.

J.5.2 Council Selection of HAPC Proposals for Analysis

The Council will select which proposal or proposals will go forward for analysis for possible HAPC designation. The Council may modify the proposed HAPC sites and management measures.

J.5.2.1 Potential Outcomes

Each proposal received and/or considered by the Council would have one of three possible outcomes:

1. The proposal could be accepted, and, following review, the concept from the proposal could be analyzed in a NEPA document for HAPC designation.
2. The proposal could be used to identify an area or topic requiring more research, which the Council would request from NMFS or another appropriate agency.
3. The proposal could be rejected.

J.5.3 Stakeholder Input

The Council may set up a stakeholder process, as appropriate, to obtain additional input on proposals.

J.5.4 Technical Review

The Council may obtain additional technical reviews as needed from scientific, socioeconomic, and management experts.

J.6 NEPA Analysis

Staff will prepare a National Environmental Policy Act (NEPA) analysis and other analyses necessary under applicable laws and Executive Orders.

J.6.1 Public Comment on NEPA Analysis

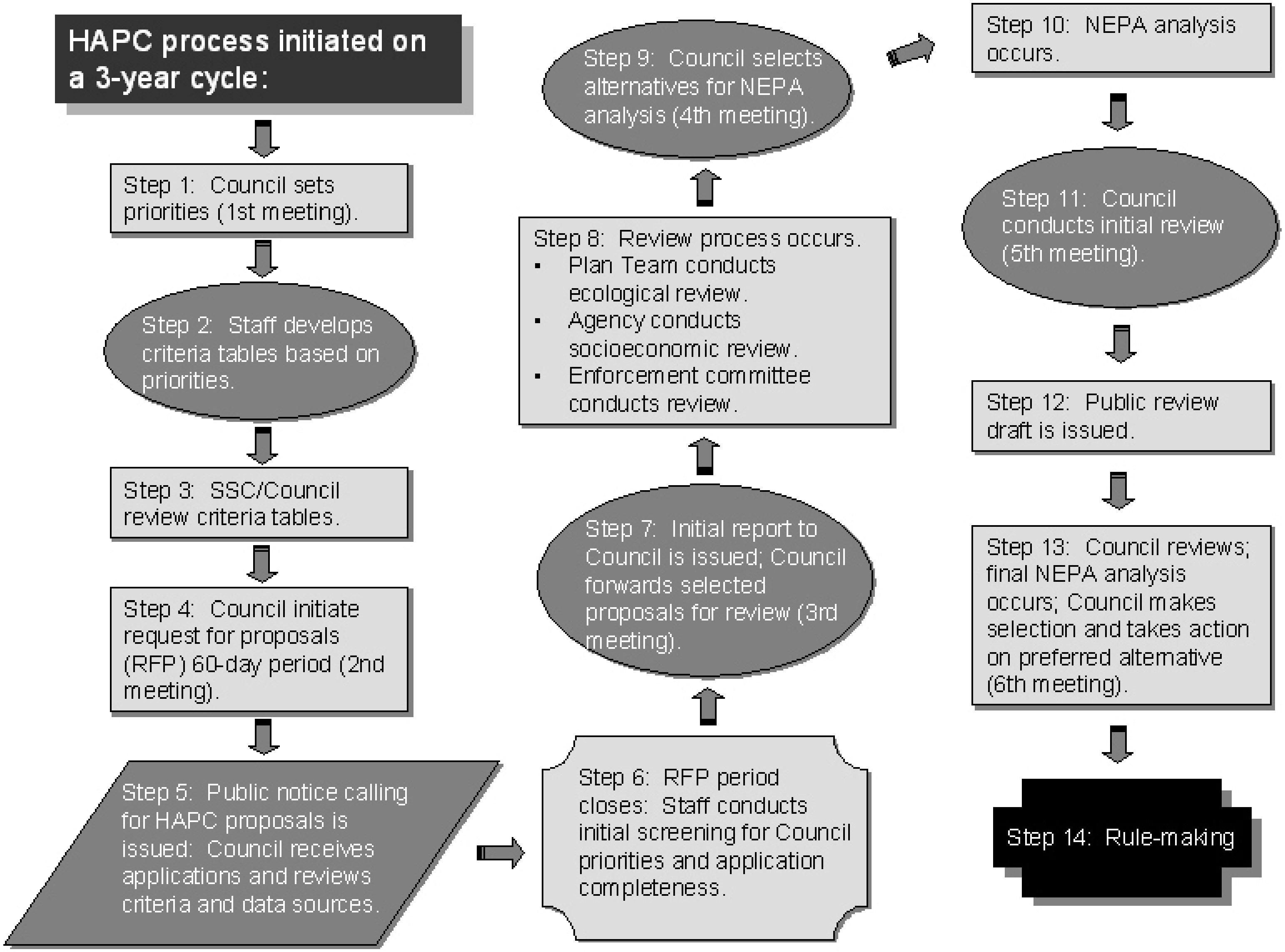
The Council will receive a summary of public comments and take final action on HAPC selections and management alternatives.

J.7 Periodic Review

The Council may periodically review the efficacy of existing HAPCs and allow for input on new scientific research.

LITERATURE CITED

NPFMC. 2000. Draft Environmental Assessment/Regulatory Impact Review. Habitat Areas of Particular Concern. North Pacific Fishery Management Council. Anchorage, AK.



HAPC process initiated on a 3-year cycle:

Step 1: Council sets priorities (1st meeting).

Step 2: Staff develops criteria tables based on priorities.

Step 3: SSC/Council review criteria tables.

Step 4: Council initiate request for proposals (RFP) 60-day period (2nd meeting).

Step 5: Public notice calling for HAPC proposals is issued: Council receives applications and reviews criteria and data sources.

Step 6: RFP period closes: Staff conducts initial screening for Council priorities and application completeness.

Step 7: Initial report to Council is issued; Council forwards selected proposals for review (3rd meeting).

Step 8: Review process occurs.
- Plan Team conducts ecological review.
- Agency conducts socioeconomic review.
- Enforcement committee conducts review.

Step 9: Council selects alternatives for NEPA analysis (4th meeting).

Step 10: NEPA analysis occurs.

Step 11: Council conducts initial review (5th meeting).

Step 12: Public review draft is issued.

Step 13: Council reviews; final NEPA analysis occurs; Council makes selection and takes action on preferred alternative (6th meeting).

Step 14: Rule-making

Appendix K
Research and Monitoring Approaches for Evaluation of EFH Fishing Impact Minimization Alternatives

Prepared by

National Marine Fisheries Service

April 2005

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ACRONYMS AND ABBREVIATIONS

AI	Aleutian Islands
Council	North Pacific Fishery Management Council
EA	environmental assessment
EBS	Eastern Bering Sea
EFH	essential fish habitat
EIS	environmental impact statement
FMP	fishery management plan
GOA	Gulf of Alaska
NMFS	National Marine Fisheries Service

In February 2003, the North Pacific Fishery Management Council (Council) directed that each essential fish habitat (EFH) fishing impact minimization alternative within the EFH environmental impact statement (EIS) include a research and monitoring component to help determine the efficacy of that alternative, should it be implemented, and to determine, to the extent practical, the effects of fishing on habitat. As directed by the Council, each alternative shall contain specific language as to the intent and objectives of its research component linked with the goals of the alternative. The final hypothesis-driven research design shall be developed when the preferred alternative is selected in a subsequent process that will include public and stakeholder input. All alternatives should contain benthic mapping to improve future management and meet research goals. In the proposed research components, research designers will attempt to map all closed and open areas as square blocks rather than as irregular shapes. The Council also noted that it supports full funding of the essential fish habitat research.

Based on the above direction from the Council, this appendix to the EIS describes the overall goals and objectives for research and monitoring for each EFH fishing impact minimization alternative. It does not discuss different research areas and/or specific experimental designs for each alternative. However, to the extent that goals and objectives for research and monitoring may differ based on the type of alternative being considered (e.g., the goals for evaluating a rotational management scheme might differ from the goals for evaluating permanent closures), this appendix to the EIS discusses those differences. The following sections describe preliminary research and monitoring approaches for each of the alternatives.

Once the Council selects a preferred alternative to minimize adverse effects of fishing on EFH, the National Marine Fisheries Service (NMFS) and Council staff will begin developing the necessary analyses to implement research and monitoring. This subsequent process will develop a hypothesis-driven research design and will include public and Council input to help select research areas. An environmental assessment (EA) will be used to evaluate options for the research and monitoring, and it will be accompanied by a Regulatory Impact Review and Regulatory Flexibility Act analysis of socioeconomic impacts. Implementation of the research and monitoring program will be contingent on the availability of sufficient funds.

K.1 Research Approach for EFH Fishing Impact Minimization Alternative 1

K.1.1 Objectives

No additional measures would be taken at this time to minimize the effects of fishing on EFH.

K.1.2 General Research Questions

Consideration of ecosystem health and the effect of fishing on EFH should focus on whether adverse impacts alter structure, function, and/or rates of ecosystem processes. Scientific assessments should address whether fishing activities reduce habitat suitability for marine resources and, thus, affect sustainable harvest levels. In particular, habitat-mediated effects on spawning, breeding, feeding, growth, and shelter of fishery management plan (FMP) species should be examined. This is a two-stage process that requires identification of specific effects attributable to fishing activities and subsequent interpretation of these effects to determine the positive/negative ecological implications.

K.1.3 Research Activities

Three experimental approaches are applicable to these general research questions, and suitable research sites are generally available in the Bering Sea (EBS), Gulf of Alaska (GOA), and Aleutian Islands (AI) areas.

(1) Compare conditions in heavily fished and lightly fished/unfished areas that are close to each other and otherwise similar. This approach allows an assessment of the long-term (chronic) effects of fishing activity on physical features of the seabed, as well as effects on the structure and function of associated benthic invertebrate communities. High-quality fishing effort data are required to identify appropriate experimental sites, which may or may not straddle closed area boundaries. Replicated biological sampling with grabs, trawls, and underwater video or submersible observations is needed to characterize relevant population and community-level attributes in the disturbed and undisturbed sites. Attributes include biomass, numbers of individuals, body size, species richness, species diversity, and the physiological states of biostructure, prey, and resident FMP species. Acoustical surveys with multibeam, side scan, or single-beam devices, coupled with grab and video groundtruthing, would be the basis for comparison of physical features such as sediment texture and bedforms. Very few sites are available under the status quo where heavily fished and lightly/unfished areas are located in close proximity over similar habitat. McConnaughey (2000) found significantly greater abundance and diversity and a less patchy distribution of sedentary benthic macrofauna within the Bristol Bay Crab and Halibut Protection Zone, compared to outside the zone. The Bristol Bay Crab and Halibut Protection Zone had been unfished since 1959. Stone (in press) did studies around the Kodiak crab closures (established ~1987), but found only subtle differences between the closed and the open areas.

(2) Compare conditions before and after experimental fishing to identify short-term (acute) effects on the benthos. If unfished controls are incorporated in the experimental design, recovery after disturbance(s) can also be examined with continued sampling. Replication with multiple (paired) sites is required to avoid spurious outcomes. These sites should have limited or, preferably, no prior fishing disturbance history in order to obtain a full measure of acute effects. Otherwise, longer-lived individuals or species will be under-represented in the samples, thereby biasing results. In addition to sampling methods and gear types described in (1) above, effective contrasts of conditions before and after fishing require highly accurate positioning of fishing and sampling gear within the disturbed (experimentally fished) and undisturbed (control) sites, especially when destructive sampling methods (e.g., research trawls) are used.

(3) Determine rates of disturbance with repetitive fishing of specific grounds. Incremental and cumulative catch rates can be used to measure the rates of depletion of benthic fauna, changes in community structure, and alteration of seabed properties as a function of fishing intensity. Similar to (2) above, these sites should have limited or, preferably, no prior fishing disturbance history in order to obtain a full measure of effects. Once again, careful positioning of fishing and sampling gear is required for meaningful results.

K.1.4 Research Time Frame

The time frame for completion of studies in the Alaska Region under Alternative 1 cannot be estimated until more systematic methods are developed and implemented, and the overall level of research effort increases. A preliminary research plan for studying the effects of fishing activities on benthic habitat in the Alaska Region was developed in 1999. Three classes of projects were identified: 1) effects of specific gear on specific habitat, 2) linkage of fishing-induced disturbance to population dynamics of commercial and non-commercial species, and 3) mitigation of effects through gear design. Application of research findings to date is generally limited by their experimental designs to the specific localities studied. Similarly, the geographic scope of efforts to map the distribution of distinct benthic habitat types has been limited. At the present rates, several hundred years may be required to gain a comprehensive understanding of fishing gear effects on specific benthic habitats and the distribution of these habitats in the EBS, GOA, and the AI.

K.2 Research Approach for EFH Fishing Impact Minimization Alternative 2

K.2.1 Objectives

Reduce impacts. Restrict the higher impact trawl fisheries (compared to other fishing gear) from a portion of the GOA slope, thus encouraging a switch to fixed gear and pelagic trawls.

Benthic habitat recovery. Allow benthic habitat within these areas to recover or remain relatively undisturbed.

K.2.2 Research Questions

Reduce impacts. Does the closure effectively restrict higher-impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gears in the closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear types?

Benthic habitat recovery. Did the habitat within these areas recover or remain unfished because of these closures? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas still fished without EFH protection?

K.2.3 Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. Lack of recent fishing effort in and adjacent to the proposed closure areas would indicate that the chosen closure areas would have little efficacy in achieving the objective of reducing impact. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. The relative effects of bottom trawl and alternative gears and, thus, the efficacy of the measure should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species with each gear. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on benthic habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Because the selected closure areas have received little fishing effort in recent years, determining whether any changes constitute recovery from fishing or just natural variability/shifts requires comparisons with both an area that is undisturbed by fishing and otherwise comparable, and an area that has been recently disturbed by fishing and is otherwise comparable. To ensure comparability, the areas should be close to each other. A reference site would have to remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance. Replication in these studies will depend on the essential similarity, or lack thereof, of the 11 designated areas.

Replicated biological sampling with grabs, trawls, and underwater ROV or submersible observations is needed to characterize relevant population and community-level attributes in the disturbed and undisturbed sites, such as biomass, numbers of individuals, body size, species richness, species diversity, and the physiological states of biostructure, prey, and resident FMP species. Acoustical surveys with multibeam, side scan, or single-beam devices, coupled with grab and video groundtruthing, would be the basis for comparison of physical features such as sediment texture and bedforms.

K.2.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period of time if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner.

K.3 Research Approach for EFH Fishing Impact Minimization Alternative 3

K.3.1 Objectives

Reduce impacts. Restrict the higher impact trawl fisheries (compared to other fishing gear) from a portion of the GOA slope, thus encouraging a switch to fixed gear and pelagic trawls.

Benthic habitat recovery. Allow benthic habitat within these areas to recover or remain relatively undisturbed.

K.3.2 Research Questions

Reduce impacts. Does the closure effectively restrict higher-impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gear types in the closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear types?

Benthic habitat recovery. Did the habitat within these areas recover or remain unfished because of these closures? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas that are still fished without EFH protection?

K.3.3 Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. Lack of recent fishing effort in and adjacent to the proposed closure areas would indicate the chosen closure areas would have little efficacy in achieving the objective of reducing impact. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. The relative effects of bottom trawl and alternative gear types and, thus, the efficacy of the measure should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis for comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species with each gear. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on benthic habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Because the selected closure areas have received little fishing effort in recent years, determining whether any changes constitute recovery from fishing or just natural variability/shifts requires comparison with both an area that is undisturbed by fishing and is otherwise comparable, and an area that has been recently disturbed by fishing and is otherwise comparable. To ensure comparability, the areas should be close to each other. A reference site would have to remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance. This alternative is primarily distinguished from Alternative 2 by the geographic extent of closures that would occur. Replication in these studies will depend on the existence and identification of similar experimental areas within this larger 200 to 1,000 m closure.

Replicated biological sampling with grabs, trawls, and underwater ROV or submersible observations is needed to characterize relevant population, and community-level attributes in the disturbed and undisturbed sites, such as biomass, numbers of individuals, body size, species richness, species diversity, and the physiological states of biostructure, prey, and resident FMP species. Acoustical surveys with multibeam, side-scan, or single-beam devices, coupled with grab and video groundtruthing, would be the basis for comparison of physical features such as sediment texture and bedforms.

K.3.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period of time if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner.

K.4 Research Approach for EFH Fishing Impact Minimization Alternative 4

K.4.1 Objectives

Bering Sea. (1) Limit fishing vessels to areas historically fished and prevent them from expanding into new areas. (2) Reduce the amount of fishing gear contact with the bottom through the use of discs and bobbins to lift up the net and sweeps. (3) Allow a portion of the habitat to recover to an “unaffected by bottom trawl fishing” status by using rotating closures.

Aleutian Islands. (1) Allow a portion of the benthic habitat to recover from the effects of bottom trawling.

Gulf of Alaska. (1) Restrict the higher impact trawl fisheries from a portion of the slope, thus encouraging a switch to fixed gear and pelagic trawls. (2) Allow benthic habitat within these areas to recover or remain relatively undisturbed.

K.4.2 Research Questions

Reduce impacts. Does the closure effectively restrict higher impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gear types in the closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear/footrope designs?

Benthic habitat recovery. Did the habitat within these areas recover or remain unfished because of these closures? Are 10-year closures in 25 percent of closed areas sufficient and optimum for complete recovery of disturbed benthic habitat? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas still fished without EFH protection?

K.4.3 Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. If recent fishing effort declined or ceased in and next to proposed closure areas, the areas would have little efficacy in achieving the objective of reducing impact. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. Effects of displaced fishing effort would have to be considered. The relative effects of bottom trawl and alternative gear/footrope designs and, thus, the efficacy of the measure should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear. The period of closures (10 years) and the instantaneous closed area fraction (25 percent) for rotating closures in the EBS should be evaluated experimentally with respect to severity of cumulative impacts over the period of active fishing and the relationship of the disturbance pattern to recruitment/recovery rates. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on benthic habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable. A reference site would have to be established and remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance.

K.4.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period of time if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner. Ideally several complete 40-year closure cycles would be used to evaluate the efficacy of the strategy.

K.5 Research Approach for EFH Fishing Impact Minimization Alternative 5A

K.5.1 Objectives

Bering Sea. (1) Limit fishing vessels to areas historically fished and prevent them from expanding into new areas. (2) Reduce the amount of fishing gear contact with the bottom through the use of discs and bobbins to lift up the net and sweeps. (3) Allow a portion of the habitat to recover to an “unaffected by bottom trawl fishing” status through the use of rotating closures.

Aleutian Islands. (1) Allow a portion of the benthic habitat to recover from the effects of bottom trawling.

Gulf of Alaska. (1) Restrict the higher impact trawl fisheries from a portion of the slope, thus encouraging a switch to fixed gear and pelagic trawls. (2) Allow benthic habitat within these areas to recover to a near “unaffected by fishing” condition.

K.5.2 Research Questions

Reduce impacts. Is bottom trawling kept from expanding into unfished areas of the EBS? Does the closure effectively restrict higher-impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gear types in the GOA closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear/footrope designs?

Benthic habitat recovery. Did the habitat within these areas recover or remain unfished because of these closures? Are 5-year closures in 33.3 percent of closed areas sufficient and optimum for complete recovery of disturbed benthic habitat? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas still fished without EFH protection?

K.5.3 Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. The effects of displaced fishing effort would have to be considered. The relative effects of bottom trawl and alternative gear/footrope designs, and, thus, the efficacy of the measure, should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear. The period of closures (5-year) and the instantaneous closed area fraction (33.3 percent) for rotating closures in the EBS should be evaluated experimentally with respect to severity of cumulative impacts over the period of active fishing and the relationship of the disturbance pattern to recruitment/recovery rates. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on benthic habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable. A reference site would have to remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance.

K.5.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period of time if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner. Ideally several complete 15-year closure cycles would be used to evaluate the efficacy of the strategy.

K.6 Research Approach for EFH Fishing Impact Minimization Alternative 5B

K.6.1 Objectives

Reduce impacts. (1) Limit fishing vessels to areas historically fished and prevent them from expanding into new areas. (2) Avoid increased effort in areas that remain open. (3) Reduce the bycatch of benthic epifauna. (4) Increase monitoring for enforcement. (5) Improve estimation of invertebrate bycatch. (6) Establish a scientific research program.

Benthic habitat recovery. Allow recovery of habitat in a large area with relatively low historic effort.

K.6.2 Research Questions

Reduce impacts. Is bottom trawling kept from expanding into unfished areas of the EBS? Does the closure effectively restrict higher-impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gears in the GOA closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear types? What are the research priorities? Are sponge and coral essential components of the habitat supporting FMP species?

Benthic habitat recovery. Did the habitat within these areas recover or remain unfished because of these closures? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas that are still fished without EFH protection?

K.6.3 Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. Effects of displaced fishing effort would have to be considered. The relative effects of bottom trawl and alternative gear/footrope designs and, thus, the efficacy of the measure should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on sponge and coral habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable. A reference site would have to remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance.

K.6.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period of time if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner.

K.7 Research Approach for EFH Fishing Impact Minimization Alternative 5C

K.7.1 Objectives

Reduce impacts. (1) Limit bottom trawling in the AI to areas historically fished and prevent expansion into new areas. (2) Limit bottom contact gear in specified coral garden habitat areas. (3) Restrict higher impact trawl fisheries from a portion of the GOA slope. (4) Increase monitoring for enforcement. (5) Establish a scientific research program.

Benthic habitat recovery. Allow recovery of habitat in a large area with relatively low historic effort.

K.7.2 Research Questions

Reduce impacts. Does the closure effectively restrict higher-impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gears in the GOA closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear types? What are the research priorities? Are fragile habitats in the AI affected by any fisheries that are not covered by the new EFH closures? Are sponge and coral essential components of the habitat supporting FMP species?

Benthic habitat recovery. Did the habitat within closed areas recover or remain unfished because of these closures? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas that are still fished without EFH protection?

K.7.3 Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. Effects of displaced fishing effort would have to be considered. The relative effects of bottom trawl and alternative gear/footrope designs and, thus, the efficacy of the measure should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear type. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on sponge and coral habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable. A reference site would have to remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance.

K.7.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner.

K.8 Research Approach for EFH Fishing Impact Minimization Alternative 6

K.8.1 Objectives

Reduce impacts. In all regions, eliminate all effects of fishing on EFH in 20 percent of the area historically fished.

Benthic habitat recovery. Allow protected areas to fully recover to an “unaffected by fishing” condition.

K.8.2 Research Questions

Reduce impacts. Does the closure effectively restrict higher impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gears in the closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear types?

Benthic habitat recovery. Did the habitat within these areas recover or remain unfished because of these closures? Do recovered habitats support more abundant and healthier FMP fish?

K.8.3 Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. The relative effects of bottom trawl and alternative gears and, thus, the efficacy of the measure should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on benthic habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable. A reference site would have to remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance. Replication in these studies will depend on the essential similarity, or lack thereof, of the designated areas.

K.8.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period of time if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner.

Appendix L

Responses to Public Comments on the Draft Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska

National Marine Fisheries Service
April 2005

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Introduction

The National Marine Fisheries Service (NMFS) received approximately 33,304 written comments on the Draft Environmental Impact Statement (EIS) for Essential Fish Habitat (EFH) Identification and Conservation in Alaska, and held public meetings in Seattle, Anchorage, and Juneau to provide opportunities for verbal testimony. Commenters included fishing and seafood industry groups, individual fishermen, environmental groups, non-fishing industry groups, federal agencies, state agencies, and numerous private citizens. The comments and responses discussed below are arranged by topic, with summaries of the comments followed by the applicable responses. Comments are paraphrased and similar comments are combined in some cases to facilitate concise and consistent responses.

Comments in Favor of Habitat Conservation

Comments: A number of commenters expressed general support for habitat conservation. Some environmental groups and individuals stated that the loss of corals and other sensitive habitats due to bottom trawling could be irreversible. Many commenters made the general recommendation that NMFS and the Council should take action to conserve EFH before long term damage occurs, and many specifically called for action to reduce the effects of fishing on EFH.

Response: NMFS agrees that habitat conservation is an essential component of sustainable fishery management. NMFS also agrees that bottom trawling and other fishing activities can have lasting effects to fragile habitats that are slow to recover, such as cold water corals. The analysis of the effects of fishing on EFH in Appendix B acknowledges considerable scientific uncertainty regarding the consequences of habitat alteration for the sustained productivity of managed species. Nevertheless, the analysis finds no indication that current fishing activities alter the capacity of EFH to support healthy populations of managed species over the long term. Despite this conclusion, NMFS recommended and the Council agreed that specific additional management measures may be warranted as a precaution to avoid additional disturbance to certain sensitive sea floor habitats. The preferred alternative for Action 3 (minimizing the effects of fishing on EFH) includes extensive new bottom trawl closures designed to protect relatively undisturbed habitats in the Aleutian Islands; new closures to all bottom contact fishing in six areas of the Aleutian Islands to protect coral garden habitats, which are especially diverse and vulnerable; and new closures to bottom trawling in ten areas on the Gulf of Alaska slope to reduce the effects of fishing on rocky areas that may support coral. Additionally, the Council adopted a process to consider identifying and managing Habitat Areas of Particular Concern (HAPCs), and the Council intends to adopt specific new HAPCs and management measures using that process.

Comments on the Description and Identification of EFH

Comment: Two fishing industry associations commented that the draft EIS presents an adequate range of options for describing and identifying EFH.

Response: NMFS agrees.

Comment: Many commenters supported the Council's preliminary preferred alternative, Alternative 3 - Revised General Distribution. Several non-fishing industry commenters and a state agency preferred Alternative 6 - EEZ Only because, in their view, nearshore and freshwater habitats are already protected under other authorities. One commenter endorsed Alternative 5 - Ecoregion Strategy to ensure holistic management.

Response: NMFS does not agree that EFH descriptions should be limited to the EEZ. The Magnuson-Stevens Act requires every fishery management plan to describe and identify EFH for the fishery, and defines EFH to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Many species of fish managed by the Council rely upon nearshore habitats, such as adult and juvenile Atka mackerel, Pacific cod, and numerous sole species. Pacific salmon depend upon freshwater habitats for migration, spawning, and rearing. Limiting EFH descriptions to the EEZ would not comply with the Magnuson-Stevens Act.

As discussed in Section 4.5.1, Alternative 5 would result in larger EFH designations but may be less beneficial for managed species because it would be harder to distinguish EFH from all potential habitats. Also, NMFS does not have sufficient scientific data regarding the relationships between species and their habitats to manage North Pacific Ocean fisheries effectively using a pure ecosystem approach.

Comment: A conservation group stated that a broad interpretation of "essential" is appropriate given the high degree of scientific uncertainty regarding fish populations and their habitat requirements.

Response: Based on the statutory definition of EFH, NMFS agrees that a broad interpretation is appropriate. Nevertheless, some of the EIS alternatives would narrow the existing EFH descriptions based upon more recent scientific information and improved analytical techniques for identifying the habitats most commonly used by managed species.

Comment: One commenter stated that NMFS should clarify whether each alternative is consistent with the final EFH regulations, and specifically whether EFH should be described when information is not available.

Response: Section 4.5.1.3 discusses the consistency of the alternatives with the EFH regulations. The regulations at 50 CFR 600.815(a)(1)(iii)(B) state that EFH should not be designated if there is no information on a given species or life stage and habitat usage cannot be inferred from other means. In the alternatives for describing EFH, where information is not available for a particular species or life stage, and cannot reasonably be inferred from other sources, EFH was not described.

Comment: Two fishing industry commenters suggested that NMFS include seamounts in the EFH descriptions to facilitate their identification as HAPCs.

Response: NMFS agrees and has modified the final EIS accordingly. Seamounts are unique habitat features that support managed species in isolated areas of the abyssal plain, and scientific information is available to describe seamount habitats in waters off Alaska. The revised EFH descriptions in Alternatives 3 and 6 identify 16 specific seamounts in the EEZ as EFH for shortraker/rougheye rockfish, thornyhead, sablefish, sculpin, squid, and chum, pink, and sockeye salmon. Alternatives 3 and 6 also identify one of these seamounts, Bowers, as EFH for golden king crab and tanner crab.

Comment: A federal agency suggested that Chapter 2 use coho salmon rather than Chinook as an example for illustrating the difference between the alternatives for describing and identifying EFH.

Response: NMFS disagrees. In Chapter 2, NMFS chose a single representative species from each FMP to illustrate the different alternatives for describing and identifying EFH. NMFS used Chinook salmon as the example for the salmon FMP due to their distribution within marine, estuarine, and freshwater habitats as well as their importance to the fishery. EFH descriptions by alternative for all FMP species by life stage, including coho salmon, are presented in Appendix D.

Comment: A federal agency asked NMFS to indicate whether the Chukchi and Beaufort Seas are within the scope of EFH under the alternatives.

Response: The Chukchi and Beaufort Seas are listed in the West Area within the fishery management unit description in the FMP for the Salmon Fisheries in the EEZ Off the Coast of Alaska. Therefore, the EIS includes EFH descriptions for salmon in those areas for each alternative.

Comment: Several non-fishing industry commenters and a state agency expressed concern that the description and identification of EFH is overly broad, and that identifying EFH in state waters is an inappropriate expansion and does not acknowledge the state's sovereignty and regulatory authority. The commenters expressed concern that EFH designations may result in the loss of resource development opportunity and economic benefit without any additional gain in habitat protection.

Response: The identification of EFH in state waters does not supersede the regulations, rights, interests, or jurisdictions that pertain to the state. Many species targeted by federal fisheries spend part of their life cycle in state waters, and EFH for these species (e.g., salmon) may be affected by various human activities. The Magnuson-Stevens Act requires Councils to describe and identify EFH for all life stages of managed species, with no limitations placed on the geographic location of EFH. The habitat benefits afforded by EFH designation stem from the additional information made available to regulatory agencies and others regarding the habitat requirements of managed species and the techniques for reducing adverse effects.

Comments: A corporation involved in inland transportation commented that the draft EIS does not adequately address the effects of EFH description and identification on non-fishing activities.

Response: Section 4.1 of the EIS evaluates the effects of EFH description and identification on non-fishing industries or other proponents of activities that may be subject to interagency consultations or recommendations to avoid and minimize adverse effects to EFH. The analysis acknowledges that certain alternatives, including the preferred alternative, may have an indirect negative effect on costs for industries and other entities that sponsor non-fishing activities with the potential to harm fish habitats. The analysis notes that permitting or funding agencies may ask applicants to provide information about effects to EFH, and may condition or deny permits or funding to protect EFH based on recommendations from NMFS or the Council. Federal or state action agencies make such decisions at their discretion. Neither NMFS nor the Council have the authority to regulate or impose costs on non-fishing industries.

Comments on the Approach for Identifying HAPCs

Comments: Numerous fishing and seafood industry commenters as well as a federal resource agency supported the Council's preliminary preferred alternative: the site-based approach for identifying HAPCs. These commenters noted that the site-based approach would enable the Council to focus habitat conservation measures on more specific locations with identified problems. Several non-fishing industries and related groups, as well as a state agency, supported the site-based approach but wanted NMFS to limit HAPCs to the Exclusive Economic Zone, arguing that state laws provide adequate habitat protection in state waters. Several marine conservation groups and a federal land management agency supported the type/site based approach, whereby the council would first identify the types of habitat within which HAPCs may be located, and then would identify specific sites as HAPCs. The commenters stated that the type/site based approach would provide more flexibility than other alternatives while enabling the Council to move toward management of more specific HAPCs. One of these groups recommended that the Council adopt a new alternative that would retain the existing broad HAPCs based on habitat types (living substrates in shallow and deep waters, and freshwater areas that support anadromous salmon), and also enable the Council to add new site-based HAPCs.

Response: NMFS and the Council determined that the existing HAPCs for all living substrates in shallow water, all living substrates in deep water, and all freshwater areas that support anadromous salmon are so broad and general that they are not particularly useful for management purposes. NMFS and the Council recognize that the habitat types included in the existing HAPCs are extremely important for Council managed species, but switching to a site-based approach for HAPCs would yield a more effective tool for habitat conservation and management. The Council therefore decided to select Alternative 3, the site-based approach for identifying HAPCs, as its preferred alternative.

The Council decided not to limit HAPCs to the Exclusive Economic Zone because many Council managed species rely on habitats in state waters for spawning, breeding, feeding, and growth to maturity, and some of those habitats meet the four regulatory considerations to be identified as HAPCs (50 CFR 600.815(a)(8)). Before identifying any HAPCs in state waters, the Council and NMFS will coordinate with applicable state agencies and the state Board of Fisheries to ensure that HAPC designations complement state management programs.

The Council elected not to add a new alternative that would retain the existing HAPCs plus allow the identification of site-based HAPCs, because the EIS already analyzes a wide range of alternative approaches for identifying HAPCs. Alternative 2 would retain the existing HAPCs, and Alternative 3 would move to a site-based approach, so the suggested new alternative would combine those two options. The environmental consequences of those two alternatives are evaluated in Section 4.2 of the EIS. Although the draft EIS did not specifically evaluate a hybrid alternative, the draft analysis provided sufficient information to enable the Council to consider the possibility, and the Council decided not to support such an alternative.

Comment: A federal land management agency commented that retaining the existing HAPCs would provide the greatest protection to salmon in freshwater areas.

Response: The existing HAPC for salmon encompasses a larger area of salmon EFH than HAPCs the Council might identify under other alternatives, but larger HAPCs do not necessarily equate to a higher degree of habitat protection. HAPCs offer a means for the Council to highlight priority areas within EFH for conservation and management. The existing salmon HAPC does not distinguish any portion of freshwater salmon EFH as being especially important or vulnerable. Also, HAPC designation does not convey any direct protections for the habitat. Any such protection in freshwater areas would stem from EFH consultations between NMFS and federal agencies regarding actions that may adversely affect salmon EFH.

Comment: A federal environmental agency expressed concern that Alternatives 3, 4, and 5 would rescind the existing HAPCs in favor of more discrete approaches, and hence certain habitats that are vulnerable to disturbance from fishing may not receive adequate attention until some future time when the Council may identify those specific areas as HAPCs. The commenter recommended that Alternatives 3, 4, and 5 include a mechanism for identifying current HAPC areas that are effective and protecting those areas from the adverse effects of fishing.

Response: The existing HAPCs have been in effect since January 1999 (64 FR 20216; April 26, 1999). Based on NMFS's experience, the existing HAPCs have not proven to be a very effective tool for distinguishing valuable and/or vulnerable portions of EFH due to their broad nature. Hence, the Council favors rescinding the existing HAPC designations in favor of an approach that would more effectively prioritize portions of EFH for conservation and management.

The Magnuson-Stevens Act requires the Council and NMFS to minimize to the extent practicable the adverse effects of fishing on all of EFH, and not only within HAPCs. The EFH regulations at 50 CFR 600.815(a)(2)(ii) state that "Amendments to the FMP or to its implementing regulations must ensure that the FMP continues to minimize to the extent practicable adverse effects on EFH caused by fishing." Thus, legal mechanisms already exist to ensure that the Council will consider and minimize the effects of fishing on EFH, even in the absence of HAPC designations. Nevertheless, the Council elected to proceed with a process for identifying new HAPC areas and associated management measures on a 3-year cycle (see Appendix J). The Council will use that process to determine which areas warrant designation as HAPCs and developing additional fishery management measures.

Comments: Several commenters addressed the process of identifying new HAPCs in the future. One of these commenters noted that proposed HAPCs could be rejected, presumably based on public comments or analyses of the effects of HAPC designation. Another commenter said that mitigation measures associated with HAPCs should be based upon a demonstrated need as well as demonstrated benefits. An association of non-fishing industries stated that HAPCs should not be identified based on recommendations from anti-development groups seeking to use HAPCs to stop specific projects. Other groups commented that the selection of site specific HAPCs should be based on peer reviewed science, and that proposals not meeting specific criteria for HAPCs should be rejected. Several commenters thought the EIS should clarify that the HAPC process described in Appendix J may need to be modified in the future.

Response: NMFS agrees with the commenters that proposed HAPCs should be evaluated based on information specific to each proposal. Proposed HAPCs should be rejected if they do not address one or more of the four regulatory considerations at 50 CFR 600.815(a)(8) or if the potential benefits of HAPC designation do not outweigh the negative effects. HAPC designation, like all fishery management measures, must be based upon the best available scientific information, although such information is not necessarily limited to peer reviewed literature. NMFS agrees that Appendix J should clarify that the HAPC process used by the Council may change over time, and has revised Appendix J accordingly.

Comment: A conservation group stated that measures to protect the Council's current HAPC priorities, seamounts and relatively undisturbed corals, will not necessarily minimize bottom trawl impacts. The commenter stated that bottom trawls are the gear with the greatest impact on sensitive habitats, and that the Council is considering habitat protection measures for sites where bottom trawling does not occur.

Response: NMFS agrees that bottom trawling can disturb certain sensitive habitats. Through the EFH EIS the Council is considering the effects of fishing (including bottom trawling) on all EFH areas in Council jurisdiction, and determining which alternative is the preferred approach to minimize adverse effects to the extent practicable. The Council is considering additional habitat protection measures via the HAPC process and a separate Environmental Assessment, including measures to protect seamounts and corals. The Council's emphasis on protecting relatively undisturbed seamounts and corals is based upon its desire to safeguard these undisturbed habitats from potential future impacts.

Comment: A conservation group objected to the Council's decision to make rarity of the habitat a mandatory criterion for all HAPC proposals, and stated that all four regulatory considerations for HAPCs (50 CFR 600.815(a)(8)) are equally important.

Response: As NMFS stated in the preamble to the final EFH regulations, "Councils may designate HAPCs based on one or more of the four specified considerations, because any one of the considerations may provide sufficient basis for distinguishing a subset of EFH from the remainder of EFH" (67 FR 2358; January 17, 2002). However, Councils also have the flexibility to focus on one or more of the considerations, such as rarity.

Comment: A conservation group recommended modifying Appendix J so that after HAPC proposals are evaluated by the Council's Plan Teams, the authors of a proposal have an opportunity to revise and resubmit the proposal before the Council selects proposals for analysis.

Response: The Council chose not to provide an explicit opportunity for the authors of an HAPC proposal to resubmit the proposal following Plan Team review. However, proposal authors and other members of the public may submit written comments or provide verbal testimony to the Council to influence the Council's decision regarding which proposals warrant detailed analysis.

Comment: A federal agency with responsibility for mineral resources stated that it should be consulted regarding any HAPC proposals because HAPCs may fall within areas under its regulatory authority.

Response: NMFS disagrees that specific consultation is necessary, because HAPCs have no direct effect on other agencies. The Magnuson-Stevens Act requires federal agencies to consult with NMFS regarding any action that may adversely affect EFH. The identification of HAPCs does not alter that requirement nor establish any restrictions on mineral development or other non-fishing activities. However, the consequences of all HAPC proposals will be evaluated with ample opportunity for public comment under the Magnuson-Stevens Act and other applicable laws, so federal agencies and other interested parties may identify any concerns through those processes.

Comments on the Effects of Fishing on EFH

Comments: Numerous commenters including conservation groups, private citizens, and some fishermen and fishing industry groups asserted that bottom trawling harms sea floor habitats. The commenters stated that bottom trawling reduces habitat complexity and species diversity, alters the benthic community structure, and causes lasting damage to sensitive habitats that are slow to recover, such as corals.

Response: NMFS agrees that bottom trawling and other fishing activities can have lasting effects on benthic habitats and communities. Although the analysis of effects of fishing on EFH in Appendix B acknowledges considerable scientific uncertainty regarding the consequences of habitat alteration for the sustained productivity of managed species, based on available information the analysis finds no indication that current fishing activities in waters off Alaska alter the capacity of EFH to support healthy populations of managed species over the long term.

Comment: Several commenters cited the benefits of area closures as a valuable habitat protection tool.

Response: NMFS agrees that area closures may serve as a valuable habitat protection tool. A number of existing year-round area closures exist in the BSAI and GOA to protect habitat from potential negative effects of fishing. Many of the alternatives described in the EIS for minimizing the effects of fishing on EFH include new trawl closure areas.

Comment: One commenter challenged the implication that Steller sea lion closures provide a significant benefit to EFH because they do not prohibit all bottom trawling from occurring inside protected areas.

Response: NMFS agrees that the Steller sea lion closures do not provide complete protection of EFH within their boundaries, but the closures do provide a significant benefit for the habitat. These closures constrain both fisheries that exert the vast majority of bottom trawl effort in the Aleutians (Pacific cod trawl and Atka mackerel trawl). Table B.2-9 shows that these fisheries account for 91 percent of the effects on living substrate in the Aleutian Islands shallow habitat. The Long Term Effects Index (LEI) charts in Appendix B show that effects in the closed areas, even for the ultra-slow recovering hard coral category, are essentially eliminated. However, given the potential for very slow recovery of the habitat features represented by the hard coral category, any shifting of these closures should consider the potential for long term effects on those features.

Comments: Numerous commenters including conservation groups, private citizens, and some fishermen and fishing industry groups asserted that NMFS and the Council have not implemented sufficient measures to mitigate the adverse effects of fishing on EFH. Many of these commenters cited the need for new precautionary management measures to avoid long lasting or irreparable harm to fragile habitats. Several commenters said the draft EIS did not sufficiently discuss the relevance of the scientific uncertainty that is acknowledged in the evaluation of the effects of fishing on EFH, and failed to incorporate that uncertainty into the decisions reached.

Response: Under the Magnuson-Stevens Act EFH regulations, Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, based on an evaluation of the effects of fishing on EFH (50 CFR 600.815(a)(2)(ii)). The evaluation contained in Appendix B notes that there are long-term effects of fishing on benthic habitat features off Alaska, and acknowledges that considerable scientific uncertainty remains regarding the consequences of such habitat changes for the sustained productivity of managed species. Nevertheless, the analysis concludes based on the best available information that the effects of fishing on EFH are minimal because the analysis finds no indication that continued fishing activities at the current rate and intensity alter the capacity of EFH to support healthy populations of managed species over the long term.

Subsequent to publication of the draft EIS, NMFS contracted with the Center for Independent Experts to conduct an independent peer review of the Appendix B evaluation of the effects of fishing on EFH. The review was conducted by a panel of six scientists with expertise in benthic ecology, fisheries oceanography, fishery biology, fisheries assessment, fishing gear technology, and biophysical modeling. The reviewers concluded that the model developed for Appendix B by the NMFS Alaska Fisheries Science Center is a reasonable approach to determine the effects of fishing on ocean habitat features, and recommended a number of improvements to the way agency scientists assessed the influence of habitat disturbance on fish stocks. In particular, the reviewers criticized the use of stock abundance in Appendix B to assess the possible influence of habitat degradation on fish stocks. They recommended supplementing the analysis with additional information to attempt to validate the model and provide other indicators of potential consequences of habitat alteration for managed species of fish. The reviewers also urged fishery managers to use a precautionary approach because of large uncertainties in scientific knowledge of the links between fish and their habitat.

For the final EIS, NMFS conducted additional analyses to verify model predictions and reevaluated the potential consequences of habitat disturbance for managed stocks. The additional information included in Appendix B for the final EIS documents stock distribution and abundance over time and discusses additional ways to help detect potential habitat-related changes in the successful reproduction, feeding, and growth to maturity of managed species. The additional information clarifies the reasons why analysts made their decisions. In several cases, analysts concluded that effects of habitat degradation were unknown because of the uncertainty regarding the effects of habitat disturbance on elements of the life history of managed species. The commenters highlight a key policy issue for the Council: given the uncertain effects of fishing-induced habitat disturbance for the productivity of managed species, and the tangible economic and socioeconomic costs of new restrictions on fishing, how much precaution is warranted? Given the Council's overall precautionary management approach, including a variety of existing measures that protect large areas of habitat and limit harvests to very conservative levels, are additional restrictions appropriate?

Based upon the final EIS and the views of public commenters, the Council decided to support substantial new fishery restrictions in the Aleutian Islands and the Gulf of Alaska as precautionary measures to reduce the potential effects of fishing on EFH. The Council recognized the EIS conclusion that the effects of fishing on EFH are minimal based on the best available scientific information, yet the Council acknowledged the considerable scientific uncertainty embedded in that conclusion, as highlighted in Appendix B and echoed by the Center for Independent Experts review. The Council considered a wide range of management options for reducing the effects of fishing on EFH and selected a precautionary alternative that incorporates measures that enhance protection of the most vulnerable habitats while minimizing costs for the fishing industry.

Comments: A longline fishermen's association stated that NMFS should take additional steps to mitigate the effects of the Gulf of Alaska rockfish trawl fishery. The same commenter stated that protecting benthic habitat from the effects of bottom trawling would be a positive step to maintain and restore ecosystem health.

Response: The preferred alternative for Action 3 includes new closures to bottom trawling in ten specific areas of the Gulf of Alaska slope. The Council selected these closures specifically to reduce the potential effects of the rockfish trawl fishery on sensitive habitat features.

Comments: Several conservation groups commented that the draft EIS misleads the public about the real effects of fishing on EFH. These commenters thought the analysis was designed to ensure a conclusion that fishing has no adverse effects; justifies a decision already made by the Council; draws arbitrary conclusions; mischaracterizes other management actions; and contradicts previous agency findings about the effects of fishing on habitat. Some of the commenters stated that NMFS's conclusions about the effects of fishing ignore the results of NMFS's own model, contradict national and international scientific consensus and literature, substitute the Magnuson-Stevens Act's overfishing provisions for its EFH provisions, and reject a precautionary approach. In contrast, a fishing industry commenter stated that the Council used the best science available to measure fishing impacts. Another commenter stated that Appendix B uses a reasonable approach for determining whether fishing effects on EFH are more than minimal and not temporary.

Response: NMFS disagrees with the criticisms of the analysis. The Appendix B analysis constitutes a reasonable approach using the best available scientific information. The EIS evaluates the effects of fishing on habitat using a quantitative mathematical model developed for this analysis. After considering the available tools and methodologies for assessing effects of fishing on habitat, the Council and its Scientific and Statistical Committee concluded that the model incorporates the best available scientific information and provides a good approach to understanding the impacts of fishing activities on habitat. Although the model indicates that there are long-term effects of fishing on benthic habitat features, the effects on EFH are minimal because, based on past trends and current observations, NMFS finds no indication that continued fishing activities at the current rate and intensity alter the capacity of EFH to support healthy populations of managed species over the long term.

Appendix B evaluates impacts to habitat and impacts to managed fish species. The model results are an integral part of the analysis, providing a consistent estimation of the relative effects of fishing for different habitat features at a fine spatial scale. NMFS conducted three types of analyses to assess whether habitat impacts would be likely to lead to more than minimal and temporary impacts on growth to maturity, reproductive success, or distribution of managed fish species. First, analysts reviewed the available information on egg, larvae, juvenile, and adult life stages to describe associations between their assigned species and a particular habitat type (Table B.3-1 of Appendix B). Next, analysts reviewed the LEI scores within the intersection of species distributions and habitat types, and weighted habitat impacts by how much of the species distribution was associated with a given habitat type (Table B-3.3 of Appendix B). The third step was an evaluation of the likelihood that present levels of habitat impact would lead to more than minimal and temporary impacts on the spawning, breeding, feeding, or growth to maturity of managed species.

The Appendix B analysis acknowledges that Council-managed fishing affects habitat. Specifically, Council-managed fishing results in persistent reductions in the availability of certain benthic habitat features, including corals and other living structure. Nevertheless, the analysis finds no indication that these changes to portions of EFH alter the overall capacity of EFH to support sustainable fisheries. In that respect the analysis is consistent with the general consensus reflected in the national and international scientific literature: fishing can cause lasting adverse effects to certain types of habitat, but because the linkages between fish species and their habitat are so poorly understood, the consequences of those habitat changes for managed fish stocks are uncertain.

The analysis considered stock status as an indicator of whether habitat impacts are unsustainable, but did not substitute overfishing thresholds for an evaluation of effects on EFH. NMFS stock assessments attempt to track direct effects of fishing on population dynamics. If habitat impacts are contributing to natural mortality of fish, and the time trend in these impacts is constant, then they might go undetected as part of natural mortality in the model. However, if habitat impacts increase or decrease production, they would appear as anomalies in recruitment or growth. Likewise, if habitat impacts alter the distribution of fish, evidence might be apparent in fishery catch rates or surveys. The information added to Appendix B for the final EIS includes data that allow for an evaluation of the spatial and temporal pattern of commercial fishing, fish condition in various habitats, and the spatial and temporal pattern of fish distribution. This information was useful in detecting potential meso-scale responses of fish to habitat impacts. However, the scale of the available data is not sufficient to evaluate short term (e.g., over days or weeks) or localized (e.g., regions less than a kilometer) responses of fish stocks. Very little research has been focused on the linkages between habitat impacts and fish production, especially at early and juvenile life stages.

The EIS acknowledges considerable scientific uncertainty concerning the effects of fishing on EFH and the consequences of habitat alteration for managed species. As discussed above, an independent peer review supported the model underlying the analysis, and offered recommendations to improve the way agency scientists assessed the consequences of habitat disturbance on fish stocks. NMFS conducted several new analyses in response to these recommendations, including a validation exercise to compare model predictions to empirical data; an attempt to estimate length-weight anomalies by substrate type for species that use different habitats; a more explicit consideration of spatial distribution, recruitment trends, and biomass relative to biological reference points; a CPUE analysis to check for evidence of serial depletion that may be linked to areas with high LEIs; and an analysis of growth patterns in different habitat types for certain species. The final EIS incorporates the best available scientific information regarding the effects of fishing on EFH in waters off Alaska. As more information becomes available in the future, NMFS may be able to conduct additional analyses to improve understanding of the effects of fishing on EFH in Alaska. The EFH regulations at 50 CFR 600.815(a)(10) note that NMFS and the Council should review the EFH components of FMPs at least once every 5 years.

Comment: One commenter stated that the EIS did not adequately consider the effects of fishing on sensitive habitat features, particularly living substrates such as corals and sponges. The commenter indicated that bottom trawling is having a significant adverse effect on key species that comprise EFH, most notably corals and sponges.

Response: The draft EIS considered the effects of fishing on animals that provide living structure as well as three other categories of habitat features considered potentially important to managed fish species. Particularly long-lived animals that provide habitat structure were considered separately as the "hard coral" feature. The effects of fishing model estimated the persistent effects on these features to the smallest spatial scale that was feasible. As envisioned by the EFH regulations, the analysis focused on the extent to which fishing affects the capacity of EFH to support managed species, as evidenced by the ability of a species to support a sustainable fishery and the species' contribution to a healthy ecosystem. The areas used by each species and their habitat needs were provided in the EFH descriptions and supporting information in Appendices D and F. An expert on each managed species or species group considered these and other sources of information on species welfare to evaluate whether the habitat effects of fishing would alter EFH in a way that is more than minimal and temporary. None of the evaluators found habitat effects that exceeded this threshold.

Comment: One commenter provided a literature citation on the longevity of sponges, which indicated a slower recovery rate than was used in the model. The commenter also noted that the recovery rates for living substrates on the eastern Bering Sea shelf did not include values reflecting ultra-slow recovering organisms, such as hard corals.

Response: The citation provides information that was not considered in the recovery parameters for the effects of fishing model, indicating that sponges on hard substrates in a temperate fjord were very long lived. Considering this information, it may be more appropriate to consider such sponges as belonging to the class of ultra-slow recovering living structure, which was represented in the analysis by the hard corals. NMFS modified the EIS accordingly.

The parameters used in the fishing effects model draw a distinction between habitat features on hard substrates (rock and boulders) and those on soft (gravel, sand, and mud). The slowest recovering living structure organisms (e.g., hard corals requiring immobile attachments) are associated with hard substrates, while features associated with softer, more mobile substrates were considered to have quicker recovery rates. The eastern Bering Sea shelf was the only area for which relatively comprehensive substrate data were available (Smith and McConnaughey 1999). These data indicate that hard substrates are very rare in this region; most occur in shallow water areas near the Pribilof Islands and the Alaska Peninsula that are subject to little or no fishing effort. Therefore, the analysis only used the soft substrate recovery rates for this region. While coral has been recorded in surveys of this area, it principally consists of soft coral species such as *Gersimia* sp., which are more adapted to soft substrates and, based on available information, are not as slow to recover as the hard corals.

Comments: Several conservation groups commented that habitat removal, with possibly irreversible consequences, would continue under the Council's preliminary preferred alternative. A fishermen's association commented that the recovery time for most benthic habitat, and particularly living habitat such as corals, is so long that impacts would be irreversible by the time an associated fish species falls below the Minimum Stock Size Threshold (MSST). Other commenters noted that there may be a significant lag time between habitat damage and any resulting declines in fish productivity that can be observed via stock status relative to MSST.

Response: NMFS agrees that fishing activities would continue to remove habitat features under the status quo management regime, and that the recovery time for some habitats is very long. The fishery evaluation model projected habitat effects for the 95 and 75 percent distributions of salmon, crab, target groundfish species, and forage species. The analysis noted these effects in terms of projected reductions of features (epifauna prey, infauna prey, living structure, non-living structure, and hard corals) within defined habitat substrates (e.g., Bering Sea sand, Bering Sea mud, Aleutian Islands shallow, Aleutian Islands deep). Table B.3-3 shows results of these projections, termed LEIs. The analysis then assessed whether these impacts to EFH are more than minimal and temporary, i.e., whether adverse effects to EFH are sufficient to impair the ability of EFH to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. The analysis was not designed to assess in the abstract whether impacts on coral or other specific habitats are minimal and temporary, but rather whether such effects are consequential for managed species. NMFS found that the current level of impact to EFH is minimal for most target species and unknown for many species taken incidentally in the catch.

To address the potential lag time between habitat disturbance and any resulting effects on productivity, NMFS considered whether the level of impact would affect future stock status. In longer lived species, this type of forecast is needed because impacts on reproductive success could take several years to manifest themselves at the population level. NMFS stock assessment scientists examined the time series of reproductive success (recruitment), spawning biomass, and growth.

NMFS included a better description of the basis for the impact ratings in Appendix B to the final EIS. NMFS stock assessment scientists reevaluated the consequences of habitat disturbance for each stock using a revised set of instructions that directed analysts to consider more explicitly all of the available information that could help determine whether there is evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature. NMFS undertook the reevaluation in response to public comments as well as an outside peer review conducted by the Center for Independent Experts. Analysts followed seven steps. First, they reviewed and updated information from the draft EIS regarding habitat associations for each stock. Second, they reviewed maps of the areas with high LEI scores to assess overlap with distribution of each stock. Third, they reviewed and updated information from the draft EIS regarding the relationship between habitat impacts and reproduction of the species. Fourth, they reviewed and updated information from the draft EIS regarding the relationship between habitat impacts and growth to maturity for each species. Fifth, they reviewed and updated information from the draft EIS regarding the relationship between habitat impacts and feeding success for the species. Sixth, they assessed whether available information on the stock status and trends indicates any potential influence of habitat disturbance due to fishing. For this step the analysts considered not only whether habitat impacts may adversely affect the ability of the stock to remain above MSST, but also whether the temporal or spatial pattern of habitat disturbance on stock abundance is sufficient to adversely affect the ability of the stock to product MSY over the long term. (For most stocks in Alaska, available data do not provide reliable estimates of MSY, so a proxy is used). Finally, analysts summarized the results of the previous six steps based on the overall weight of available evidence, and assigned an overall rating as to whether the effects of fishing are both more than minimal and not temporary, or either minimal or temporary, or unknown.

Comments: Several conservation groups stated that the EFH EIS should have taken the same approach as the programmatic supplemental EIS for the groundfish fisheries by designing the analysis to avoid a Type II error. Conservation groups as well as fishing industry groups asked for clarification of a related statement on page 4-401 of the draft EIS: "Reducing the probability of making a Type II error is more precautionary and is more responsive to both EFH mandates and the public comment received on the 2001 draft PSEIS." A fishing industry alliance asked NMFS to modify Section 4.5.4 to describe more accurately the differences between the purposes of the two EISs and the corresponding reasons for differences between the analyses.

Response: In scientific studies, a Type II error occurs when a false hypothesis fails to be rejected. In the context of the EFH EIS, a Type II error would occur if the analysis examines whether fishing has minimal adverse effects on habitat and does not reveal more than minimal effects, yet in reality such effects are occurring. In other words, if the EIS analysis finds no indication that fishing is causing more than minimal adverse effects, but in actuality the analysis is wrong, a Type II error will have occurred. Scientific studies typically test a null hypothesis (e.g., fishing has no effect on habitat) rigorously and only reject the null hypothesis if there is a low statistical probability if its being true. To reduce the possibility of a Type II error, the results of an analysis can be interpreted with a high degree of precaution.

The potential for Type II error in impacts analyses involving natural resources is an important consideration because of the large number of factors influencing living populations. In the present case the status of commercially targeted species in Alaska is well documented and uncertainty in stock trends is presented in annual SAFE documents. With the exception of selected crab stocks, stock conditions are sufficient to support sustainable fisheries. This information, coupled with the absence of evidence of a an impact on growth or a change in habitat usage to avoid heavily fished areas, was an integral part of the analysts' evaluations. The results of the analysis do not preclude the Council and NMFS from insuring against the possibility of a Type II error by protecting additional habitat based on the large number of species for which time trends in reproduction, growth, and distribution are not known.

The sentence cited by the commenters incorrectly implied that the EFH provisions of the Magnuson-Stevens Act include explicit direction to use a high degree of precaution when assessing the effects of fishing on habitat. Neither the Magnuson-Stevens Act nor the EFH regulations address the degree of precaution that is appropriate for the analysis. Instead, the general guidance from National Standard 2 applies: conservation and management measures must be based upon the best scientific information available. Thus, given the scientific uncertainties, the Council must make a policy determination regarding the level of precaution that is appropriate.

The preferred alternative for Action 3 includes substantial new fishery restrictions in the Aleutian Islands and the Gulf of Alaska to reduce the potential effects of fishing on EFH. The Council endorsed these measures expressly for the purpose of being precautionary, given the amount of scientific uncertainty regarding the effects of habitat disturbance for managed species.

NMFS agrees that the final EIS should explain more clearly its relationship to the programmatic supplemental EIS for the groundfish fisheries, and has modified Section 4.5.4 accordingly.

Comments: A conservation group stated that the draft EIS includes an incorrect assumption that rationalization programs will, by definition, result in additional habitat conservation. The commenter stated that any benefits for EFH need to be articulated in the design of a rationalization program, including measurable objectives for habitat protection as well as spatial management to protect certain habitat features. A fishing industry group commented that rationalization should be considered in the future as a tool for reducing the effects of fishing on EFH and allowing vessels the opportunity to experiment with pelagic gear. Another fishing industry group said rationalization will reduce habitat impacts and increase the safety and efficiency of fisheries.

Response: NMFS agrees with the commenters that rationalization can be beneficial for EFH under certain circumstances. If rationalization programs are intended to meet multiple objectives, including habitat conservation objectives, the associated management measures should be designed carefully to meet the intended purposes. In general, rationalization reduces fishing effort and excess capacity, which increases catch per unit effort and decreases the opportunity for interactions between fishing gear and fish habitat.

Comments: Several conservation groups commented that Figure ES-1, titled Areas Closed Year-round to Bottom Trawling, is misleading. The commenters said this figure either should show only areas closed year round to all bottom trawling, or acknowledge that it represents only closures to some fisheries, and bottom trawling in other fisheries is still permitted in these areas.

Response: NMFS agrees that limited state-managed bottom trawling occurs in some of the depicted areas. Beam trawling for shrimp is allowed in southeast Alaska, Prince William Sound, and the Kodiak area, although effort is extremely low. NMFS modified Figure ES-1 for the final EIS accordingly.

Comments: A few commenters provided lists of literature citations related to the effects of fishing on EFH and asked NMFS to incorporate those studies into the analysis.

Response: NMFS reviewed these lists of citations, which contained a broad sampling of studies from the literature regarding the effects of fishing on habitat. The EIS cites review articles to represent general findings in this field and concentrates on describing and using those studies most relevant to Alaska fisheries. Many of the listed citations were included in those review articles, were similar to articles (many by the same authors) that were cited in the draft EIS or were not available when the draft EIS was prepared. The final EIS incorporates those that provide relevant information that was not covered by references already cited.

Comments on the Evaluation of the Effects of Fishing on EFH

Comments: A state agency commented that the Appendix B results are filtered through a screen of professional opinions based on apparent productivity of the species and a qualitative assessment of the likelihood of the species remaining above MSST when that reference point is known.

Response: NMFS agrees. In most cases, impacts analyses were assigned to individuals responsible for conducting annual stock assessments to ensure that decisions would be made by individuals who were familiar with the stock and the data available for the species. Each stock assessment author was asked to consider the LEI maps in conjunction with information on the past, present, and expected future status of their assigned stock to determine whether potential impacts were more than minimal and not temporary. Stock assessment authors were not given a time trend in the degree of habitat impact. For the draft EIS, NMFS was unable to map LEIs on 5-year time periods to track temporal shifts in habitat impact. A proxy for this product appears in the revised version of Appendix B for the final EIS based on a time series of trawl effort in the three management regions. In all three regions the LEIs depend on the amount of effort that occurs within 5 km x 5 km blocks, where time series of pelagic and non-pelagic trawl effort are available.

Comments: A fishing industry alliance commented that the analysis could be improved by a more systematic representation of the available information for each species.

Response: NMFS agrees. The past and present status of the stocks was evaluated using survey, fishery, and stock assessment information. Most assessment authors include plots of catch distribution and survey biomass in their annual stock assessments. Time series of recruitment, spawning biomass, and total biomass were available for species that are assessed using age- or size-based statistical age structured models. In some cases, authors had information on interannual variations in size-at-age or weight-at-age by area. Information on spatial distributions, recruitment trends, and biomass relative to biological reference points is included in Appendix B to the final EIS.

Comment: One commenter objected to an assertion in Appendix B that refers to patchiness of coral habitats and indicates that fishing activity would likely avoid coral due to potential net damage. The commenter said that no evidence supports this behavior, and LEI values for coral are underestimated. The commenter cited data from R. Stone showing that 87 percent of adult FMP species were found to be associated with coral, and said fishing would likely occur in these areas.

Response: NMFS agrees that LEIs may be underestimated if the distributions of habitat features and the targeted species are correlated, as may be the case for living substrates in hard bottom areas. However, the LEIs also may overestimate the impact because the analysis assumes that hard corals occur everywhere in the prescribed depth ranges, which in unlikely. The principal point of the paragraph cited by the commenter was a source of LEI overestimation where fishing is constrained to a more limited distribution than that represented by the model's assumption of random fishing distribution within 5 km x 5 km blocks. Hence, more effort is expended at sites where some habitat features have already been removed, resulting in less total removals than a broader fishing distribution. While the distribution of the targeted fish is generally more concentrated than random in hard bottom areas, fishers must consider the added constraint of avoiding structures that damage fishing gear. This additional constraint has not been carefully studied and cited by the scientific community, but NMFS does not agree that no evidence supports it. The fisheries descriptions (Sections 3.4.1.2.2.7 and .8) of the Aleutian Islands rockfish and Atka mackerel fisheries describe fishing "adjacent to areas with large potential for hangs" as well as numerous adjustments to gear and fishing methods to reduce net damage, such as lifting trawls from the bottom when rough areas are encountered during a tow. These statements derived from public meetings with fishermen (held during development of the EIS) for the purpose of describing their gear and fishing techniques. NMFS also has considerable direct experience with the prevalence of very rough substrates in the Aleutian Islands. The NMFS bottom trawl survey of the Aleutian Islands is severely constrained by difficulty in locating trawlable bottom, frequent hanging of the trawl on bottom obstructions, and damage to trawl nets. In summary, fishermen need to balance the desire to fish in areas where target species are abundant (including areas of high coral abundance) against the potential to damage their fishing gear. Further study and analysis is necessary to determine which of these two factors is the stronger driving force in present fisheries distribution and which most affects the accuracy of LEI estimates.

Comment: One commenter asserted that the model should assume a one-to-one linkage between several FMP species and corals and sponges.

Response: While some data show associations between FMP species and corals and sponges, the causal mechanism for these associations remains unclear. For example, Kreiger and Wing (2002) found that 85 percent of large rockfish observed from a submersible at 11 sites in the Gulf of Alaska were found on large boulders with corals, and hypothesized that the abundance of shrimp (a prey species) near corals may result in this association. Additionally, rockfish were found in only 81 of the 599 coral colonies observed, leaving open the question of whether the association of rockfish with corals is mediated by other, currently unknown, habitat factors. Kreiger and Wing (2002) conclude that more research is needed to describe the underlying mechanisms of species associations with rockfish. Therefore, assuming a one-to-one linkage between habitat and feeding, spawning/breeding, and/or growth to maturity for FMP species would not be appropriate.

Reference:
Kreiger, K.J. and B.L. Wing. 2002. Megafauna associations with deepwater corals (*Primnoa* spp.) in the Gulf of Alaska. Hydrobiologica 471:83-90.

Comment: Several commenters disagreed with the conclusion that bottom trawling has no adverse effect on Atka mackerel habitat. One commenter suggested that reanalysis with information from subsection 4.3.2.2.1.4, p.4-59, may justify rating the impact as "adverse." The commenter noted that Appendix B, Table B.3-3 indicates that living structure, non-living structure, and hard corals will be reduced by 20, 13, and 40 percent, respectively, and stated that these are significant changes to Atka mackerel habitat. The commenter said that videos collected by NOAA demonstrate that Atka mackerel use habitat with these features, and the analysis should specifically address the effects of habitat supply. The commenter said the age-structured population model used did not address impacts on habitat, and it is not a valid tool for assessing effects on the quality or quantity of habitat.

Response: The analysis does not claim that fishing has no adverse effect on Atka mackerel habitat; it finds that effects to the Atka mackerel population are minimal based on the projected reductions of habitat features (epifauna prey, infauna prey, living structure, non-living structure, and hard corals) within defined substrates (e.g., Aleutian Islands shallow, Aleutian Islands deep). While NMFS has data that show associations between Atka mackerel and various habitat features, the weight of evidence is unclear regarding the type of linkages that may exist between habitat and feeding, spawning/breeding, and/or growth to maturity for Atka mackerel. As such, the information is not adequate to assess the direct impacts to Atka mackerel of particular percentage reductions in the living structure, non-living structure, and hard coral habitat features. Given the data gaps, NMFS considered indirect evidence of impacts on habitat through a broader perspective of the health of the Atka mackerel population. The age-structured population model is a valid tool to assess the effects of the quality and quantity of habitat on target groundfish, and is based on the best available information. The age-structured model projections in the groundfish programmatic supplemental EIS showed that the effects of fishing did not jeopardize the ability of the Atka mackerel stock to maintain itself at or above its MSST. Furthermore, no evidence suggests low productivity, recruitment failures, or fishery collapse for Atka mackerel. To the contrary, the Aleutian Islands Atka mackerel stock appears to be robust and productive, and has sustained good recruitment with several average and above average year classes. Most recently, two back-to-back strong year classes are contributing to the population (1998 and 1999 year classes). Therefore, NMFS found no data to justify an adverse rating for Atka mackerel, and rated the impact of the status quo fishery on Atka mackerel EFH "minimal and temporary."

Comment: On commenter asserted that the omission of several literature sources on the connections between corals and sponges and target fish resulted in incorrect conclusions about whether impacts listed in Table B-3.3 were minimal.

Response: As discussed above for Atka mackerel, NMFS has data that show associations between FMP species and corals and sponges, but is not aware of any evidence that shows specific habitat linkages to feeding, spawning/breeding, and/or growth to maturity for FMP species. For rockfish, the evaluation of the effects of fishing on EFH considered the potential association between rockfish and living and non-living substrates as well as the use and projected reductions in habitat. For example, for shortraker and rougheye rockfish, which are species associated with particular living and non-living benthic structures, the evaluation regarding growth to maturity was rated as "unknown" because insufficient information exists to assess whether the adverse effects of displaced boulders and damaged corals would be more than minimal. For other rockfish species, the ratings of minimal and temporary reflect not an omission of the relevant literature, but rather the lack of strong associations with benthic habitat in terms of prey species or habitat use, the level of projected impacts on the benthic habitats, and, where available, the population-level responses such as recruitment time-series.

Comment: One commenter said evidence suggests Atka mackerel nest in deeper habitat (>100 m), contradicting the idea that bottom trawling does not overlap with nesting grounds, and cited pages B-37 and 4-59 in the draft EIS.

Response: NMFS agrees. The draft EIS assumed that the directed Atka mackerel fishery has "…little or no overlap with Atka mackerel nesting grounds." Indirect evidence from cannibalized eggs (Yang 1999) and archival tags (Nichol and Somerton 2002) suggest that there may be nests deeper than 100 m. The archival tagging study by Nichol and Somerton (2002) documents the capture of brightly colored males in spawning condition in a single tow. Two of the males captured in this tow displayed what was interpreted as apparent nest-guarding behavior (extended period of bottom tending during the spawning season). Based on this information, the authors assumed that the location of the tow was a spawning site. The bottom depth recorded for these fish was 115 to 117 m. The final EIS addresses this evidence and acknowledges the possibility for overlap of the fishery with Atka mackerel nesting grounds.

References:
Nichol D.G., Somerton D.A. 2002. Diurnal vertical migration of the Atka mackerel *Pleurogrammus monopterygius* as shown by archival tags. Mar Ecol Prog Ser 239: 193-207.

Yang, M-S. 1999. The trophic role of Atka mackerel *Pleurogrammus monopterygius*, in the Aleutian Islands area. U.S. Fish. Bull. 97(4)1047-1057.

Comment: One commenter suggested that the Appendix B evaluation of effects for sablefish should include additional text regarding anthropogenic effects and other effects on survivorship. The commenter recommended including reference to coastal development and its effects on juvenile sablefish habitat, as well as reduced survivorship of sablefish due to bycatch. Additionally, the commenter suggested adding new text regarding juvenile sablefish distribution relative to habitat on the continental shelf.

Response: NMFS agrees that potential habitat effects that are unrelated to fishing (e.g., coastal development) should be included, and NMFS updated Appendix B accordingly. NMFS disagrees with the comment that juvenile sablefish bycatch should be included in this section, because mortality from bycatch is unrelated to habitat concerns. NMFS agrees with adding the new information regarding juvenile sablefish distribution on the continental shelf. Most years juvenile sablefish are not common on the Bering Sea shelf. However, sablefish were abundant on the Bering Sea shelf during a period of strong year classes. Juvenile sablefish may use the area only when they are abundant. Strong year classes provide much of the productivity (biomass and yield) of the sablefish population. Thus habitat effects on the eastern Bering Sea shelf have the potential to affect juvenile sablefish and the productivity of the sablefish stock.

Comment: One commenter opposed NMFS's position that snow crab and blue crab are at low numbers due to climatic changes in the ocean.

Response: As summer water temperatures have risen in the period since 1979, and particularly in the past 5 years, red king crab have nearly replaced blue king crab in the Pribilof Islands management district of the EBS despite the closure of all trawling since 1995 and extremely conservative management of commercial king crabbing including closures during eleven of the past 20 years (1988-1992, 1999-2004).

Declines in the St. Matthew island area have also occurred and that fishery has been closed from 1998 onward. Declines and changes in distribution of blue king crab in the Pribilof Islands area have been closely correlated with warmer bottom temperatures during the annual NMFS survey. They are also correlated with increased prevalence of finfish predators and competitors which in turn may reflect climatic changes. Neither decline is associated with bottom trawling, which was never prevalent and then prohibited in both the Pribilof Island District and in state waters of the St. Matthew area.

The distribution of snow crab is strongly associated with cold waters of the EBS mid-shelf. Unlike blue king crab, snow crab are not associated with rocky bottoms but rather with mud-sand bottoms that occur over most of the Bering Sea. Consequently, the snow crab habitat of the EBS is extremely large and covers most of the area where summer bottom temperatures are less than 5 degrees C. Year to year changes in prevalence and distribution are correlated with shifts in the distribution of cold water in the summer months. Bottom trawling occurs on the mud-sand-silt bottoms that are inhabited by snow and Tanner crabs but there is little epifauna to be disturbed on these bottoms. The critical habitat is the substrate itself where juveniles and adults burrow and feed. Both species are further protected by quotas on bycatch which tend to limit total bottom trawl effort. There can be synergistic effects of various bycatch quotas, for example the bycatch quota on halibut is usually reached before that of snow and Tanner crab and hence limits trawling in many areas. Bering sea snow crab increased in abundance in the 1980s to a high in 1992, and has since declined. The distribution of snow crab has shifted northward over time, with current centers of abundance north of the Pribilof Islands up to St. Matthews Island. The shift in distribution appears to be due to environmental conditions and to catch occurring mostly from the southern portion of the range.

Comments: A conservation group stated that the draft EIS did not adequately consider the effect of trawling on crab populations. The commenter faulted the draft EIS for not stating that the presently low population levels of red king crab may have been caused by bottom trawling in the important “hatching grounds” or “primary brood stock refuge,” nor that continued trawling in those areas may be suppressing the population from rebounding to historic levels. The commenter said the EIS also must address the effects of bottom trawling on other crab populations in the Gulf of Alaska and Bering Sea, such as mature female snow crab. A state agency noted that for the EBS, the red king crab evaluation reflects the current status of crab but does not reflect information on the historic distribution of red king crab females, which as recently as the 1970s were common north of Unimak Island in areas trawled for cod and flatfish (e.g., Figures 3.4-20 and 22).

Response: As stated above, changes in crab distribution and abundance appear to be attributable to changes in water temperature, not the effect of fishing gear on crab habitat. Nevertheless, many areas considered critical to crab populations in the continental shelf waters of Alaska are closed to bottom trawling and dredging. These areas were closed because they were the known habitats of adult female and juvenile crabs, and because of a perception that the habitat was important since it produced crabs so consistently. Other areas where crabs may have been found in the past but are not currently important in their distribution are protected by bycatch caps, and no known disruptions to the habitat would preclude recolonization.

The area north of Unimak Island which some refer to as the “primary brood stock refuge” is currently protected by various caps on bycatch of king crabs, Tanner crab, and snow crab. It was very important in the distribution of red king crab females during periods of high abundance in the mid to late 1970s, but was not particularly important prior to that time and has not been important since. In contrast, the crab habitat areas that currently are closed to trawling have been important for crabs in every year for which there are records. Additionally, the area north of Unimak was not very important for red king crabs during the years that produced the peak abundance in the mid to late 1970s. That period of high abundance coincided with anomalously cold waters in the outer Bristol Bay area, which may have affected crab distribution. Finally, the biomass of cod and flounders in the Bering Sea has increased sharply since the 1970s and may inhibit restoring red king crabs to former levels of abundance. The abundance of red king crabs in the late 1970s was anomalously high and should not be viewed as a realistic goal for restoring the population.

The distribution of female snow crab is vast and much of it occurs in areas where there is very sparse bottom trawling. Due to changing water temperatures, as discussed above, the areas where female snow crabs are prevalent is not constant. Under these circumstances, a bycatch cap is effective because it discourages trawling in the areas that are most important at any given point in time. Available information does not indicate any known attributes of snow crab habitat that are critical to protect from disturbance by trawling.

Comment: One commenter asked why NMFS did not consider bycatch and discards in Alaska's groundfish fisheries in the analysis of reduced prey on the habitat quality of FMP species.

Response: NMFS collects and analyzes food habits information to track factors impacting foraging behavior of selected groundfish. Commercial fisheries tend to target adult fish. Piscivorous fishes tend to consume juvenile fish (age-0 or age-1). The bycatch of young fish in trawling operations is small relative to the abundance of fish remaining on the grounds. The groundfish FMPs include a retention cap on bycatch of forage species in commercial trawls. The final EIS includes text to describe these existing mitigation activities.

Comment: One commenter asserted that loss of habitat features must be calculated on the same time scale as the source of the stock size. The commenter said that results of calculations from Equations 4, 5, and 6 from the fishing effects model should be made available to the public so they can determine how close the current habitat losses are to equilibrium. The commenter said the EIS should include the trajectory of habitat loss through time and show how each alternative would change the trajectory for each habitat feature.

Response: Historical fishing effort data would be needed to determine how close the current habitat losses are to equilibrium. The hypothetical average equilibrium values of habitat loss (LEIs) are shown for each alternative in Table 4.3-1. LEI as presented in the EIS is the hypothetical long term habitat loss given that fishing continues as estimated for 1998-2002. Showing trajectories would require knowing the current amount of habitat by habitat type, which is unknown. In the absence of such data, trajectories of habitat loss would have to be based on unknown current habitat levels and uncertain assumptions about habitat distribution and the model parameters for recovery and sensitivity. NMFS determined that given the data gaps, conducting such an involved and voluminous analysis would not be appropriate.

Comment: One commenter highlighted that fishing data used in the model were from 1998-2002 and asserted that if effort changes from that pattern, the LEI values will be inaccurate and likely underestimated.

Response: The LEI was defined for this analysis as the equilibrium value that would result from fishing indefinitely at the rate estimated for the years 1998 to 2002. NMFS used these years to represent the current state of the fishery and to reflect some of the year-to-year movements of fishing effort. If future effort patterns are different such that effort is increased in areas unfished or lightly fished during 1998-2002, LEIs would likely increase, particularly for habitat features that recover slowly.

Comment: One commenter suggested that frequency histograms of the effort distribution for each fishery listed in Table B.2-3 be included in the Appendix B.

Response: NMFS agrees. Frequency histograms of effort distribution would provide more information for readers to assess the frequency of different levels of fishing intensity. All such plots for all fisheries may not provide useful additional information, but NMFS included in the final EIS examples of such histograms to allow readers to make such assessments.

Comment: One commenter argued that the draft EIS tends to accept modeled estimates of habitat benefits from additional closed areas, but tends to discount model results pertaining to the benefits of proposed gear modifications.

Response: Estimating the effects of both closures and gear modifications requires a number of assumptions, but there were significant differences in the data available to evaluate each of these concepts. Fishing distribution data and the effects of fishing model allowed many of the parameters related to the effects of the closures to be quantified, but no such data were available to flesh out the most basic assumptions for the effects of the gear modifications. Both evaluations relied on assumptions with considerable uncertainty, yet the available data provided a better basis for assessing the closures than the gear modifications.

Comment: One commenter claimed that the assumption in the draft EIS that the distribution of corals and sponges on the seafloor is uniform is contradicted by catch-per-unit-effort (CPUE) data, which can be used to calculate relative abundance of habitat types. The commenter said these data should be used to weight each block-specific LEI value to calculate the aggregate LEI value for each habitat feature by region.

Response: The analysis did not assume that the distribution of corals and sponges is uniform. For summed habitat LEIs, the analysis assumed distribution is random within blocks and within general topographic (slope versus shelf) and substrate types. Insufficient CPUE and topographic data were available to provide a higher resolution breakdown of LEIs.

Comment: A state agency noted that the results of the fishing effects model serve as an important basis for the evaluation of the importance of effects of fishing on habitat, and emphasized the caution noted in Appendix B, page 23: "Both the developing state of the model and the limited quality of available data to estimate input parameters prevent this from providing a clear view of habitat effects. While output detail may provide an illusion of precision, the results are actually subject to considerable uncertainty." The commenter observed that impacts are summed up over very large areas, equivalent to large percentages of habitat used by a species, such that local effects, even if they were to be severe, typically end up as small percentages.

Response: NMFS agrees that there are local habitat reductions (LEIs) that are much larger than the average values for large habitat areas. The distribution and range of LEIs within those areas are not evident when only the average is shown. Therefore, Appendix B provides charts of LEI values, representing the spatial variation at the smallest feasible scale (5 x 5 km). NMFS agrees that caution is warranted insofar as the LEI concept provides only a framework and a preliminary comparison of fisheries and management alternatives for different areas. Due to the lack of information, the current application assumes equal habitat abundance and value over large areas or habitat types. The LEI values provide a relative index of the vulnerability of different habitat features, but do not account for spatial variation in the abundance or function of such features. As more information on habitat distribution and value is obtained, the LEI approach will become more useful.

Comment: One commenter suggested an alternative model to be used with the LEI analysis. This model indicates a high risk of future overfishing for populations that are harvested at the MSY determined by conventional models.

Response: The commenter's model assumes a direct relationship between catch and the reduction of carrying capacity of the target species. The relationship involves a linkage between fishing effort and habitat reduction, which may be a relatively simple linkage and not hard to envisage. However, the model also requires is a linkage between habitat reduction and carrying capacity. Such a linkage could occur in a number of ways, likely through intermediate linkages or interactions, but very little research exists to substantiate the connection between habitat and carrying capacity. The commenter's model condenses a complex relationship of many basic interactions into a simple relationship represented by a single parameter. While a relationship between habitat and carrying capacity likely exists, there is likely a high degree of stochasticity (variability) associated with it. NMFS determined that using such a model for the analysis of the effects of fishing on EFH would not be appropriate without either a sufficient time series of catch and abundance data that fits the model, or research results that demonstrate how habitat affects at least some of the necessary linkages (such as food abundance, predator-prey relationships, interspecies competition, spawning success, etc.). The commenter's model may be useful in comparing policy decisions, but its use for the EFH EIS would imply an understanding and substantiation of the ecological effects of fishing that does not currently exist.

Comment: One commenter suggested using observer data to assess the quality and quantity of effects of fishing on corals and sponges. The commenter said that locations with high LEI values correspond to areas with recorded coral bycatch in the Aleutian Islands, but said the areas with the highest bycatch do not match the LEI score maps.

Response: The effect and recovery model was used to evaluate the effects of fishing on corals and sponges. The model predicts an estimate of the proportional reduction in a habitat feature (e.g., corals or sponges) relative to an unfished state, if a fishery were continued at current intensity or distribution. NMFS determined that the model was the best tool available for the assessment. The model considers the intensity of fishing effort, sensitivity of habitat features, recovery rates of habitat features, and distribution of fishing effort. The analysis incorporated a range of plausible values for sensitivity and recovery rates of corals and sponges. The observer data provide estimates of the bycatch of corals and sponges, but are not particularly useful for analyzing fishing impacts. These data document that corals and sponges are taken incidently in various fisheries, but do not provide a quantitative estimate of the relative abundance and distribution of corals and sponges, nor the proportional reduction in coral and sponge habitat relative to unfished levels.

Comment: One commenter discussed whether the effects of fishing should be viewed on a global versus a local scale. The commenter opined that the guidelines for evaluating the effect of fishing on EFH take a global view. The commenter said that consideration of localized effects to EFH would be appropriate for a managed species if it were possible to identify a limited range of available habitat that is vital to the survival of the managed species and vulnerable to the effects of fishing. The commenter said that even if concentrated fishing effort causes localized habitat impacts, the important question is whether productivity of the managed species is substantially reduced due to the concentration of fishing, i.e., whether species abundance remains sustainable. The commenter noted that no empirical evidence suggests that harvests of managed species in Alaskan waters are not sustainable. Other commenters took the opposing view and criticized NMFS for focusing only on aggregate LEI values instead of using each block as the unit of analysis. These commenters maintained that site-specific effects were subsumed inappropriately into the larger scale analysis. One commenter said that ignoring local impacts could be significant for non-migratory species such as rockfish.

Response: Results of the fishing effects analysis were provided to the expert evaluators for each managed species aggregated on scales ranging from the entire general distribution of the species to charts showing effects for each 5 km by 5 km grid cell, allowing evaluators to consider whatever scale and locations they found important to the welfare of their species. While values aggregated on larger scales were useful in summarizing evaluations, consideration of local effects was available if specific sites were considered very important to a species. However, the final evaluations of whether the effects of fishing on EFH are more than minimal and not temporary were made at the population / ecosystem scale because the regulatory definition of EFH notes that habitat "necessary" for fish means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem (50 CFR 600.10). Therefore, the consequences of fishing's effects on EFH ultimately were evaluated across fished populations and ecosystems. Site-specific effects were considered relative to their importance to the species on these larger scales.

Comments: A number of commenters discussed the propriety of considering effects on the productivity of managed species when evaluating the effects of fishing on EFH. Commenters affiliated with the fishing industry stated that productivity is central to the goals of the Magnuson-Stevens Act and provides the context for assessing potential benefits to EFH of any of the mitigation measures. Thus, if productivity is not adversely affected, no mitigation is necessary. Commenters affiliated with conservation groups stated that assessing impacts relative to stock productivity is improper. Some of these commenters said that limiting the scope of inquiry to an assessment of whether stocks are overfished is contrary to the requirements of the Magnuson-Stevens Act. Some said waiting for evidence that habitat disturbance causes fish stocks to decline raises the burden of proof beyond that which is attainable. One conservation group said that the analysis should consider additional factors besides whether fishing affects the ability of the managed species to support a sustainable fishery and a healthy ecosystem.

Response: The preamble to the final EFH regulations discusses the threshold that requires Councils to minimize adverse effects of fishing on EFH. Action to minimize adverse effects of fishing "is warranted to regulate fishing activities that reduce the capacity of EFH to support managed species, not fishing activities that result in inconsequential changes to the habitat." Nevertheless, the preamble continues by stating that "[i]t is not appropriate to require definitive proof of a link between fishing impacts to EFH and reduced stock productivity before Councils can take action to minimize adverse fishing impacts to EFH to the extent practicable. Such a requirement would raise the threshold for action above that set by the Magnuson-Stevens Act" (67 FR 2354; January 17, 2002). The EIS appropriately considers the productivity of managed species to assess whether habitat disturbance caused by fishing reduces the capacity of EFH to support those species. Likewise, the analysis appropriately considers whether fishing changes the ability of habitat "to support a sustainable fishery and the managed species' contribution to a healthy ecosystem," which is what makes a particular habitat "necessary" to fish in the context of the definition of EFH (see the regulatory definition of EFH at 50 CFR 600.10). The analysis completed for the draft EIS considered whether fishing affects the ability of the stocks to remain above their MSSTs into the future, and was not limited to an assessment of whether stocks are overfished. The analysis also considered other information besides stock status relative to MSST, such as any published literature regarding the habitat requirements of managed species, and the opinions of NMFS experts in the biology and stock structure of the various species. For the final EIS, NMFS reevaluated the effects of fishing on EFH and examined more broadly whether stock status and trends indicate any potential influence of habitat disturbance due to fishing. The analysis considered whether credible evidence exists (i.e., not whether definitive proof exists) to support a conclusion that disturbance to EFH caused by fishing reduces the capacity of EFH to support managed species, and found no indication of such effects that are more than minimal. Nevertheless, even though the available information does not identify adverse effects of fishing that are more than minimal and temporary in nature, that finding does not necessarily mean that no such effects exist.

Comments: Several commenters questioned using MSST as an element for evaluating present sustainability of managed fisheries.

Response: As discussed above, MSST was one of several factors considered in the analysis. The following discussion explains why NMFS used stock forecasts relative to MSST as a reference point for the draft EIS. Given the apparent confusion from some commenters over how NMFS considered stock status in this analysis, for the final EIS NMFS modified Appendix B to address whether stock status and trends indicate any potential influence of habitat disturbance due to fishing. Such effects on stock status could be detected relative to MSST, Bmsy, or any other benchmark. For the final EIS, NMFS analysts assessed for each stock whether the temporal or spatial pattern of habitat disturbance on stock abundance is sufficient to adversely affect the ability of the stock to produce MSY over the long term.

Harvests of BSAI and GOA Groundfish stocks are limited by a number of stringent management measures. For a given stock or stock complex (except for the GOA “other species” complex, which is managed using slightly different rules), the total allowable catch (TAC) is always set less than or equal to the acceptable biological catch (ABC), which is always set less than or equal to the maximum permissible ABC (maxABC), which is always set substantially below the overfishing level (OFL), except in the limiting case where OFL is zero, in which case maxABC, ABC, and TAC are also zero.

The maxABC and OFL are prescribed by formulae called harvest control rules. Six pairs (“tiers”) of maxABC and OFL control rules are specified by the BSAI and GOA Groundfish FMPs, corresponding to six levels of data availability. The parameters (“reference points”) used in the tier system vary from tier to tier, but a common theme throughout the system is that the maxABC control rule is always proportionally less than the OFL control rule, except in the limiting case where OFL is zero, in which case maxABC is also zero.

Presently, nearly all major stocks and stock complexes are managed under Tier 3. The level of data availability corresponding to Tier 3 is such that reliable estimates of MSY-related reference points do not exist. Instead, reference points in the Tier 3 control rules are based on relative spawning per recruit (SPR). Relative SPR is the ratio between lifetime egg production of two hypothetical cohorts, one of which is fished and one of which is not. The cohort that is fished produces fewer eggs over the course of its lifetime than the cohort that is not, because the process of fishing removes some fish from the cohort and these removed fish are no longer able to contribute to egg production. Thus, relative SPR is a number that ranges between 0 (obtained in the case of extremely intense fishing) and 1 (obtained in the case of no fishing), and is often displayed as a percentage. For example, $F_{35\%}$ is the fishing mortality rate that reduces the lifetime egg production of a cohort to 35 percent of what it would be in the absence of fishing, $F_{40\%}$ is the fishing mortality rate that reduces the lifetime egg production of a cohort to 40 percent of what it would be in the absence of fishing, and so forth. For a given stock, $F_{35\%}$ will always be higher than $F_{40\%}$, because more fishing is required to reduce lifetime egg production to 35 percent of the unfished level than is required to reduce lifetime egg production to 40 percent of the unfished level. In terms of biomass, SPR-based reference points represent the long-term average biomass that would result if the average strength of future cohorts were equal to the historic average and all future cohorts were fished at the corresponding SPR-based fishing mortality rate. For example, $B_{35\%}$ represents the long-term average biomass that would result if the average strength of future cohorts were equal to the historic average and all future cohorts were fished at $F_{35\%}$.

The control rules for Tier 3 are shown in Figure 1. In Tier 3, the proxies for B_{MSY} and F_{MSY} are $B_{35\%}$ and $F_{35\%}$, respectively. The fishing mortality rate corresponding to OFL can never exceed $F_{35\%}$ and the fishing mortality rate corresponding to maxABC can never exceed $F_{40\%}$. In the event that stock size declines below $B_{40\%}$, both the OFL and maxABC fishing mortality rates decline linearly with stock size. These mandated reductions in fishing mortality begin as soon as a stock declines below $B_{40\%}$, well before the stock reaches its MSY proxy level of $B_{35\%}$. In the unlikely event that a stock falls to a size less than 5 percent of its MSY proxy level, both OFL and maxABC (and therefore ABC and TAC) are set equal to zero. As Figure 1 implies, the fishing mortality rates corresponding to all ABCs and TACs are less than the MSY proxy fishing mortality rate of $F_{35\%}$. As a practical manner, many Tier 3 stocks are harvested at rates that are only small fractions of $F_{35\%}$, even though their biomass levels are well above $B_{40\%}$.

In the terminology of the National Standard Guidelines, the fishing mortality rate corresponding to OFL represents the “maximum fishing mortality threshold” (MFMT). The MFMT plays a key role in determining the MSST, which is defined in the National Standard Guidelines (§600.310(d)(2)(ii)) as follows: “To the extent possible, the stock size threshold should equal whichever of the following is greater: one-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the maximum fishing mortality threshold specified under paragraph (d)(2)(ii) of this section.”

The MSST does not represent the point at which fishing mortality rates begin to be reduced. In Tier 3, the point at which fishing mortality rates begin to be reduced is $B_{40\%}$, well above the MSY proxy stock size of $B_{35\%}$ and far above MSST. MSST represents the point at which the reductions in fishing mortality already mandated by the tier system are required to be reexamined and adjusted if they are found to result in an insufficient rate of rebuilding.

The draft EIS used MSST to represent the lower bound of the range of sustainability. A stock is determined to be above its MSST only if it is above the biomass that produces MSY (Bmsy) or is expected to rebuild to Bmsy within 10 years. To ensure that the test for recovery errs on the conservative side, rebuilding rates are computed using the assumption that the stock will be harvested at the overfishing level throughout the rebuilding period, although actual harvesting rates in the BSAI and GOA groundfish fisheries invariably are much lower. Assessing stock status relative to MSST ensures that the stock is either above or reasonably close to the MSY level, so this test is more rigorous than a test for “sustainability” per se.

The draft EIS Appendix B analysis assessed whether the effects of fishing alter the ability of a stock to sustain itself above MSST (i.e., not whether the stock is currently below MSST). The answer to that question would be yes if there are downward trends in the stock status sufficient to drive the population below its MSST, and if those trends are related to poor recruitment. Such trends should be evident long before the stock reaches its MSST. Hence, considering the ability of a stock to remain above MSST is not an insensitive measure of the response of the stock to habitat perturbations. NMFS did not identify any such downward trends in stock status that could reasonably be attributed to habitat factors.

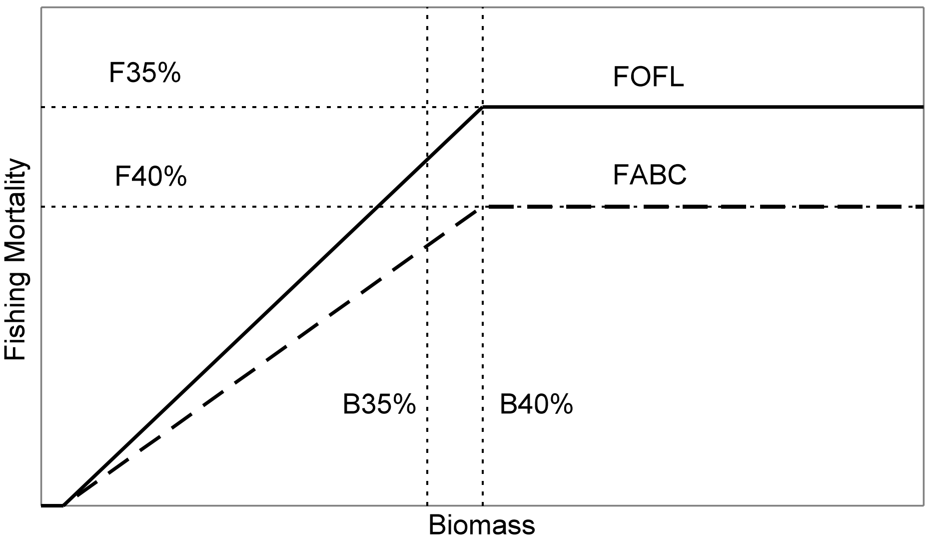

Figure 1. Tier 3 harvest control rules. The fishing mortality rate corresponding to OFL is shown by the solid segmented line and the fishing mortality rate corresponding to maxABC is shown by the dashed segmented line.

Comment: One commenter recommended changing the biomass threshold for habitat health to Bmsy or a proxy for Bmsy.

Response: The draft EIS Appendix B analysis used MSST to assess whether the current status of habitat is sufficient to sustain managed fish species, not to evaluate habitat health. The MSST test evaluates whether the current stock condition is capable of rebuilding to Bmsy or a proxy ($B_{35\%}$) in 10 years if the stock is fished at a level greater than status quo Fmsy or $F_{35\%}$. Several indicators of stock status could have been considered for this analysis. NMFS selected MSST because it has been accepted by the Council and NMFS as a reasonable process of evaluating the status of a stock. The Bmsy or $B_{35\%}$ is an integral part of the test, as it is the target level for rebuilding over a 10-year time horizon. NMFS did not select a Bmsy or $B_{35\%}$ threshold for current stock size because stocks are likely to fluctuate above and below the target biomass level. An advantage of the biomass forecasts is that they provide an estimate of the range of likely biomass levels in the next decade. In the case of the BSAI groundfish stocks, the mean spawning stock biomass level is expected to be above the Bmsy or $B_{35\%}$ level in 2013 under status quo harvest policies. As discussed above, for the final EIS NMFS used a more general approach and assessed whether stock status and trends indicate any potential influence of habitat disturbance due to fishing, rather than expressly evaluating such effects relative to the ability of the stock to remain above its MSST.

Comment: One commenter stated that if population trends vary in proportion to fishery impacts on habitat, the MSST standard for sustainability could be thought of as a coarse measure of habitat health.

Response: NMFS agrees. While developing Appendix B, analysts evaluated available information to assess whether fish populations vary as a function of habitat condition. The first part of this analysis involved determining whether there was evidence of a functional relationship between spatial or temporal trends in habitat impact and the spatial distribution or temporal trends in fish production. Stock assessment authors reviewed time series of production indices and maps of fish distribution to assess whether there were trends in the population that raised concerns. If a decline in recruitment or growth coincided with an increase in habitat impact, or if shifts in distribution coincided with maps of high habitat impact, the authors were encouraged to identify potential links in their evaluations. Authors were not encouraged to raise concerns based solely on evidence of a declining population trend; a link to spatial or temporal trends in habitat impacts was required. The authors were cautioned to differentiate between shifts due to targeted fishing or incidental catch and shifts potentially caused by a change in habitat. The results found no indication that current levels of habitat impact negatively affect the ability of the stocks to support sustainable fisheries for target species.

Comment: Some commenters said that the species-by-species productivity approach NMFS undertook to evaluate fishery effects on habitat failed to adequately address documented habitat impacts, species declines, and ecosystem functions. Another commenter said that whether or not a higher biomass threshold than MSST is used as an indicator of potential effects of habitat disturbance for managed species, the rigor of the inference that fishing impacts on EFH are minimal is strengthened by cumulative indicators of fishery impact: healthy stocks, low levels of fishing effort, low habitat sensitivity to fishing, and fairly rapid recovery rates from the effects of fishing.

Response: NMFS disagrees with the criticisms. The functional relationship between habitat and fish productivity or fish distribution is not documented for most target species in Alaska. In the absence of direct functional relationships, NMFS stock assessment scientists based their evaluations on a review of temporal trends in abundance, temporal trends in recruitment, and spatial and temporal trends in distribution relative to available information regarding spatial or temporal trends in habitat impacts. NMFS analysts examined the available data to determine whether fish population trends varied in response to fishery impacts on habitat. They used indices of past, present, and future stock status to evaluate the sustainability of managed fish species given current levels of habitat impact. This type of analysis is used commonly in retrospective analyses of impacts of climate or oceanographic factors on the distribution or production of marine fish (Francis et al. 1998, Anderson and Piatt 1999, Hunt et al. 2001). In Appendix B, retrospective analyses searched for evidence that habitat impacts influence the productivity of managed species. The conceptual foundation for this technique is that if fish populations were tightly coupled to habitat, and the habitat was severely degraded, then impact of degraded habitat condition would be detectable at the population level.

Moreover, MSST does not represent the point at which fishing mortality rates begin to be reduced. In Tier 3 stock assessments, the point at which fishing mortality rates begin to be reduced is $B_{40\%}$, well above the MSY proxy stock size of $B_{35\%}$ and far above MSST. MSST represents the point at which the reductions in fishing mortality already mandated by the tier system are required to be reexamined and adjusted if they are found to result in an insufficient rate of rebuilding. Thus, NMFS agrees with the comment that cumulative indicators of fishery impacts over time are very useful and appropriate for this analysis.

References:

Francis, R. C., Hare, S. R. , Hollowed, A. B., Wooster, W. S., 1998. Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific", Fisheries Oceanog. 7: 1-21.

Hunt, G.L., P. Stabeno, G. Walters, E. Sinclair, R.D. Brodeur, J.M. Napp, and N.A. Bond. 2002. Climate change and control of the southeastern Bering Sea pelagic ecosystem. Deep-Sea Research II 49:5821-5853.

Anderson, P. J., and J. F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Mar. Ecol. Prog. Ser. 189:117-123.

Comment: One commenter suggested that references to projected stock biomass from the draft programmatic groundfish EIS should be replaced with the specific stock biomass values used to judge stock sustainability.

Response: NMFS agrees and has incorporated this information into the final EIS.

Comments on the Alternatives for Minimizing the Effects of Fishing on EFH

Comments: Many commenters addressed the adequacy of the range of alternatives for minimizing the effects of fishing on EFH. Some fishing industry commenters stated that the range of alternatives meets the requirements of NEPA and the Magnuson-Stevens Act and should not be expanded. Some conservation group commenters stated that the draft EIS failed to consider all reasonable alternatives or to take a hard look at the environmental impacts of the alternatives, but these comments did not include specific suggestions for new alternatives or analyses. However, the commenters criticized some of the alternatives for applying only to a certain region, such as the Gulf of Alaska, and for focusing on lightly fished or unfished areas rather than areas with heavy fishing activity. Some conservation groups stated that the draft EIS should have included multiple alternatives containing combinations of fishing equipment restrictions, time/area closures, and harvest limits. Some of these groups also cited the failure to include research closures among the alternatives. One comment letter stated that the alternatives failed to focus on the fisheries identified by NMFS's fishing effects model as having the most significant effect on EFH, and the draft EIS improperly rejected as impracticable an alternative that would reduce total allowable catch to reduce fishing effort.

Response: NMFS and the Council developed the alternatives in the draft EIS through an extensive public process that included numerous public meetings and opportunities for comment. Section 2.5 discusses many additional alternatives that were considered but not carried forward for detailed analysis, and explains the reasons for rejecting those alternatives. The suite of alternatives was developed specifically to address the fisheries identified by NMFS's fishing effects model as having the greatest potential impact on EFH. The alternatives start with status quo measures, which include many measures that benefit habitat. Each alternative adds progressively more restrictive measures in addition to the status quo, starting with the fisheries and habitat areas identified in the model as having the greatest potential disturbance to EFH. Each alternative includes fishing equipment restrictions, time/area closures, and harvest limits, insofar as these types of measures are a part of the status quo management regime. The range of alternatives also includes new fishing equipment restrictions, time/area closures, and harvest limits (i.e., in addition to status quo), although not all of these types of new measures are included in each alternative.

Comments: A conservation group recommended that the final EIS evaluate a revised version of the Aleutian Islands component of Alternative 5B. The revisions incorporate three differences from Alternative 5B in the draft EIS: prohibit bottom contact fishing in six identified coral garden sites, modify eight specific open areas (making some larger and some smaller), and eliminate the proposed reduction in total allowable catch (TAC) for Pacific cod. Another conservation group commented that the TAC reduction for Pacific cod is not a vital component of Alternative 5B and that the conservation benefits can be attained without it.

Response: The final EIS includes the suggested revisions in a new option for Alternative 5B. The Council also voted to include a third option for Alternative 5B wherein the open area are identified based on a spatial analysis of areas that have supported the highest catch rates, with specific modifications based on data analysis and input from Aleutian Islands trawl fishermen. This option would have no TAC reductions or bycatch caps. The new alternatives are described in more detail in Section 2.3.3 of the final EIS.

Comments: A fisherman commented that for the Aleutian Islands component of Alternative 5B, open areas should be identified using all observer data, VMS data, and logbook information from fishermen. The commenter said that open areas should be displayed on 1:300,000 scale nautical charts to help stakeholders interpret the proposal.

Response: As discussed above, for the final EIS the Council added two new options for the Aleutian Islands component of Alternative 5B to identify open areas that are important to the industry while closing relatively undisturbed habitats. The Council also directed staff to display all of the Alternative 5B options for the Aleutian Islands on 1:300,000 scale charts and make them available to the public.

Comments: A fisherman objected to the following portions of Alternative 5B: TAC reductions, bycatch caps for corals and sponges, and open areas that do not include all trawling grounds currently or recently used by the industry. The commenter stated that some specific areas in the Aleutians that are fished were excluded from the identified open areas in Alternative 5B. The commenter also said the components of Alternative 5B should be independent such that the Council could adopt the Aleutian Island portion but reject the Bering Sea and Gulf of Alaska portions, or accept only parts of the Aleutian Islands measures and reject others.

Response: As discussed above, for the final EIS the Council added two new options, including one that omits TAC reductions and bycatch caps. The two new options revise the open areas to better reflect important fishing grounds as compared to the version of Alternative 5B that was included in the draft EIS.

Final Council and NMFS decisions regarding preferred alternatives must be based upon the analysis in the final EIS, such that the decision makers are aware of the effects of selected management measures, including costs and benefits, before making a final decision. The administrative record must include sufficient information to enable decision makers to make informed judgments about the effects of the combinations of management measures selected.

Comments: A conservation group said NMFS should consider two additional options for the Bering Sea component of Alternative 5B. First, permanently close to all trawling one third of each of the five proposed Bering Sea rotational management areas, selected to provide maximum benefits for mature female snow crab. Second, use a rotational approach that leaves only one third of each of the five blocks open for 5 years so that after 15 years all areas would have been closed for 10 years rather than the 5 years proposed in Alternative 5B.

Response: The Council and its EFH Committee considered a variety of options when designing the Bering Sea rotational management approach included in Alternative 5B. The Council decided against permanent closures because it wanted to retain flexibility for the industry to fish in different areas over time in response to shifts in stock distribution and abundance. The Council selected the particular time periods for the proposed rotational management areas based on considerations for the time estimated for partial habitat recovery in closed areas, balanced against the need to provide flexibility for the industry as discussed above.

Comments: Several comments addressed how the alternatives for minimizing the effects of fishing on EFH may affect communities and existing fishing effort. An environmental group noted that most of the alternatives focus on areas with little fishing effort and where habitat could be protected with the least economic impact. Several conservation groups recommended that NMFS work with local communities to minimize impacts and to identify areas to close to bottom trawling. Other commenters thought NMFS should adopt new management measures to protect EFH from the impacts of industrial fisheries.

Response: The Council and its EFH Committee devoted considerable effort to developing the alternatives in a manner that would meet conservation objectives while minimizing impacts to the fishing industry and communities. Unfortunately, the joint stipulation that established the schedule for the EIS limited the time available to the Council to work with affected communities and industry sectors to refine some of the alternatives and reduce potential impacts, most notably for Alternative 6.

Comments: Most commenters expressed an opinion regarding a preferred alternative for minimizing the effects of fishing on EFH. Many fishing industry commenters supported the Council's preliminary preferred alternative: status quo management measures (Alternative 1). These commenters generally thought the Council employs a sufficiently precautionary management policy and that no further action to protect habitat is needed because there is no clear indication that existing fishing practices are reducing the productivity of managed stocks. Conservation groups, private citizens, and some fishing industry commenters supported Alternative 5B. These commenters generally thought additional protection is warranted to reduce the effects of bottom trawling and protect corals, particularly in the Aleutian Islands, and expressed opposition to the Council's preliminary preferred alternative. One conservation group cited the benefits of Alternative 5B for reducing habitat impacts along the Gulf of Alaska slope, the northwest portion of the Eastern Bering Sea (including Opilio crab habitat), and the Aleutian Islands shelf and slope. Another conservation group endorsed the marine reserves concept that led to Alternative 6, and stated that at a minimum the Council should adopt Alternative 5B. A fixed gear fishing group endorsed Alternative 3 and cited the need to reduce the effects of bottom trawling on the upper slope in the Gulf of Alaska. The same commenter stated that Alternative 5B would provide significant habitat protection, but would impose significant costs on the industry. A federal environmental agency recommended that the final EIS endorse a preferred alternative that is more protective than the status quo.

Response: The Council selected Alternative 5C, Expanded Closures in the Aleutian Islands and Gulf of Alaska, as its preferred alternative for minimizing the effects of fishing on EFH. The Council endorsed Alternative 5C for a number of reasons. The Council recognized that, based on the best available scientific information, the EIS concludes that the effects of fishing on EFH are minimal because the analysis finds no indication that continued fishing activities at the current rate and intensity would alter the capacity of EFH to support healthy populations of managed species over the long term. Nevertheless, the Council acknowledged that considerable scientific uncertainty remains regarding the consequences of habitat alteration for the sustained productivity of managed species. The Council also noted recent information from a variety of sources about the existence, fragility, and potential ecological significance of cold water corals and other epifauna, particularly in the Aleutian Islands area, and the Council noted considerable public support for adopting precautionary measures to protect such habitats while maintaining important fisheries. The Council considered a wide range of management options for reducing the potential effects of fishing on EFH, and it selected an alternative that incorporates measures that enhance protection for the most vulnerable habitats while minimizing costs for the fishing industry.

Alternative 5C incorporates measures from other alternatives that focus on the areas that support (or are most likely to support) corals and other fragile sea floor habitats that may be especially slow to recover following disturbance. For the Aleutian Islands, Alternative 5C includes a variation of the open area approach from Alternative 5B, resulting in extensive closures to bottom trawling to protect relatively undisturbed habitats. Additionally, Alternative 5C prohibits all bottom contact fishing within six coral garden areas, providing a higher level of protection for those especially diverse and fragile habitats. For the Gulf of Alaska, Alternative 5C includes closures to bottom trawling in ten areas on the Gulf of Alaska slope to reduce the effects of fisheries with higher scores in the evaluation of the effects of fishing on EFH (Appendix B). Alternative 5C does not include new management measures for the Bering Sea because available information indicates that the Bering Sea does not support the kind of hard bottom habitats that sustain extensive corals and other particularly sensitive benthic invertebrates. However, under this alternative the Council would initiate a subsequent analysis specifically to consider potential new habitat conservation measures for the Bering Sea, including the management options identified in this EIS and other options.

Alternative 5C also incorporates many existing measures that protect habitat, such as the Bristol Bay closure area, Pribilof Islands habitat conservation area, Southeast Alaska trawl closure, Sitka Pinnacle marine reserve, red king crab savings area, Kodiak king crab protection zones, and Steller sea lion measures. The Council also initiated a HAPC process to consider additional habitat protection measures in the future (see Appendix J).

Although most fishing industry commenters endorsed Alternative 1 in their comments on the draft EIS, many of these commenters provided written or verbal testimony to the Council in February 2005 supporting Alternative 5C as the preferred alternative. These commenters generally agreed that the measures included in Alternative 5C are reasonable and precautionary steps to provide additional habitat protection. Similarly, although most commenters who supported additional habitat protection endorsed Alternative 5B, the majority focused on the Aleutian Islands, and the preferred Alternative 5C incorporates a variation of the Aleutian Islands component of Alternative 5B.

Comment: A fishing industry alliance and some of its supporters expressed concern about the proposal in Section 4.5.3.3 of the draft EIS to prohibit bottom trawl fisheries in lower slope/basin areas deeper than 1,000 m. The commenters stated that this proposal does not seem designed to address identifiable adverse effects of fishing and thus does not address the Council's problem statement.

Response: The potential bottom trawl closure in waters deeper than 1,000 m was included in the practicability analysis in the draft EIS to illustrate one low cost option for protecting habitats from potential future disturbance. The Council did not direct staff to evaluate this option as a stand alone alternative for the final EIS.

Comments: A private citizen stated that Alternative 6 was designed to fail because it did not properly account for economic, socioeconomic, and cultural considerations. The commenter made a number of procedural and substantive suggestions for reworking Alternative 6 to make it more practicable. A conservation group commented that the analysis highlighted the negative aspects of Alternative 6 over the positive benefits to habitat. The commenter stated that NMFS and the Council should either change Alternative 6 to make it more practicable or add a new marine reserve alternative. The commenter also thought Alternative 6 should incorporate an effort limitation component.

Response: The Council added Alternative 6 to the analysis in response to requests from a conservation group for a marine reserves alternative and a recommendation from NMFS to broaden the overall range of alternatives. Unfortunately, Alternative 6 evolved rather late in the development of the alternatives and, as mentioned above, stipulated constraints on the time frame for the EIS limited the Council's ability to refine Alternative 6 and reduce potential impacts. The Council decided not to include new effort limitations in Alternative 6 because the Council already limits overall fishing effort, and the Council was concerned that additional effort limitations may not be necessary and would greatly increase the costs of Alternative 6, which are already quite high.

Comment: One commenter asked for an explanation of the Council's rationale behind the proposal in Alternative 6 to close 20 percent of fishable waters in Alternative 6, as opposed to a greater or smaller portion of available habitat.

Response: As noted in Section 2.3.3.7, the Council was not aware of any definitive study to estimate marine reserve area requirements relative to the goals of protecting habitat or minimizing the effects of fishing on habitat. In the absence of a scientifically accepted proportion of the available habitat, the Council chose 20 percent based upon public comment that cited a consensus in some circles that 20 percent is a reasonable figure to use when designing marine reserves.

Comments on the Analysis of Economic and Socioeconomic Costs

Comment: One commenter questioned the basic premise for the analysis that "eliminating 20 percent of fishing grounds in each region would require additional running time to reach open areas and to return to port to deliver catch (or product)" from page 4-261 of the draft EIS and page C.3.8.2 of Appendix C.

Response: Appendix C and Chapter 4 of the EIS contain an assessment of anticipated economic and socioeconomic impacts from adoption and implementation of the Council's proposed action alternatives. While primarily qualitative, the analytical descriptions of the expected impacts (e.g., increased running time) and their distribution among the various fishing sectors (e.g., disproportionately burdensome for smaller catcher vessels (CVs) delivering catch to shoreside plants for processing) are consistent with empirical findings associated with other fishery management area closures (e.g., Steller sea lion no-transit zones) and also reflect information gleaned from public testimony on the range of EFH alternatives submitted to the Council.

Comment: One commenter said that in Section 2.3.1, Regional Fishery Dependence Profiles, the discussion on vessel ownership should be expanded to note substantial ownership of mobile groundfish processing (motherships and catcher-processors) by western Alaska communities. The commenter said the at-sea sector is a significant component of Alaska's groundfish fisheries and reference to ownership by Community Development Quota (CDQ) groups based in Alaskan communities should be included.

Response: NMFS agrees that analyzing CDQ ownership of mothership, catcher/processor, and shoreside processing capacity would enhance the RIR's treatment of regional and community dependence and investment in the processing sectors of the fishing industry. A section addressing CDQ ownership of mobile, as well as shorebased, processing capacity in the North Pacific commercial fisheries has been added to Appendix C, Section 2.3-6.

Comment: Add a discussion and cost estimate of a mechanical system or observer coverage level to determine whether a vessel was engaged in fishing in any of the proposed closed areas.

Response: Estimates of these costs are already contained in the RIR. For example, the expected increase in U.S. Coast Guard and NMFS enforcement costs is presented in Section 3.1.2.7, Management and Enforcement Costs. Cost estimates associated with VMS mechanical systems, designed to track fishing vessel location, are presented in the same section. Increased observer coverage is presented as a possible alternative to VMS, as well as a measure that may be combined with VMS. While the RIR specifically cites average historical observer costs, based on empirical experience with both state and federal observer programs, it is not possible to quantify the costs that may accrue under the various alternatives due to indeterminate requirements for expanded observer coverage. Nonetheless, the RIR highlights the potential substantial economic, logistical, and operational impacts expanded observer coverage requirements would impose on the industry, observer providers, NMFS Observer and In-season Management Programs, and the individuals employed as observers.

Comment: Discuss costs, practicability, and safety tradeoffs associated with no entry designations.

Response: Supplemental text addressing the economic and operational costs, practicability, and safety implications of closures and no transit zones has been added to Appendix C, Sections C.3.1.2.3 and C.3.1.2.4.

Comment: Economic impacts of mitigation alternatives should be revised to assess more accurately the impacts on gross revenues and operating costs, and should be better tailored to determine impacts to specific participants and communities.

Response: NMFS disagrees. The draft EIS characterized the economic impacts of the fishing impact mitigation measures to the fullest extent practicable, given available data and federal and state of Alaska confidentiality constraints. Estimates of fishing gross revenues are derived by taking reported landings, using NMFS's blend data, obtained from state fish ticket files and onboard observer data, by various categorical combinations (e.g., vessel size, gear type, area, target species, operating mode), then combining those data with an estimated ex-vessel price, developed by using the Alaska Commercial Fishery Entry Commission's price deck, Council database analysis, and NMFS REFM Division data analysis. These constitute the official record of landings and the best available price data for these fisheries. At the processor level, fish ticket data, weekly processor reports, state and federal observer reports, and the Comprehensive Annual Operators Report database have all been used to derive catch, production, and first wholesale gross revenue estimates. These, too, constitute the best available data on this segment of the industry.

NMFS used these data, combined with GIS models developed to characterize the spatial limits of each proposed alternative, to estimate the gross revenues at risk, by fishery, fleet component (e.g., gear type, vessel size, operational mode), region, and (where appropriate) community. These represent the most accurate assessment of gross revenue impacts that currently available data and fishing pattern models allow. A more accurate assessment of economic impacts on operational costs is severely constrained by lack of empirical cost data for the affected fishing sectors. The same data limitations (e.g., fixed and variable costs, prices, net revenues), combined with state of Alaska and federal confidentiality rules, preclude a more precise tailoring of the analysis to determine impacts to specific participants.

Comment: A fishing industry alliance said Appendix C assumes fishing consumes habitat in economic terms, while NMFS finds there is no adverse effects on EFH in regulatory terms. Appendix C and Chapter 4 speculate that reducing habitat consumption will produce greater long-term benefits and, thus start with a second presumption not supported by the analysis. Appendix C also offers an internally contradictory perspective on the issue of whether the alternatives create benefits.

Response: NMFS disagrees. The economic theory of production is based on the functional relationship between use (consumption) of input factors and outputs. Just as farm production is characterized by combining inputs, such as labor, land, water, etc., to yield a harvestable output, commercial fishing uses production inputs to derive a harvest. As in other forms of commercial production, the producer need not own, or even pay for, every input employed. The producer consumes those free inputs, just like owners and purchasers in the marketplace. In the farming example, if water is drawn from a commonly shared underground aquifer, the farmer consumes that input at no (or little) cost. This results in the producer externalizing the costs of using this particular input. It is, nonetheless, a necessary input consumed in the production process. Likewise, prohibited species are taken unavoidably in some fisheries, so for example halibut may be considered an input in rock sole roe production. To the extent that marine habitat disturbance accrues as part of commercial fisheries (e.g., bottom contact by non-pelagic trawl gear), that habitat is being consumed as an input to production, even though the associated cost of its use is external to the producer's incurred cash outlays. The use of this concept from production economics is appropriate in this context.

NMFS also disagrees with the assertion that Appendix C offers an internally contradictory perspective on whether the alternatives create benefits. The comment apparently considers only benefits for commercial fisheries. As discussed in the RIR, several other non-commercial sources of benefits may be attributable to the EFH mitigation alternatives, including passive-use values, non-market consumptive use values, and nonmonetary benefits associated with maintenance of ecological equilibrium and biodiversity.

Comment: The EIS provided no adequate quantitative analysis of expected economic benefits of increased fisheries productivity as the result of trawl closures. Estimates of revenue changes associated with each alternative should include the value of increased productivity of FMP species as a result of changes in habitat impacts such as reductions in coral sponge bycatch or LEI value.

Response: Quantitative analysis of expected economic benefits from increased fisheries productivity depends upon quantitative biological evidence of the size, composition, and timing of such productivity gains, and that type of information is not available. As the draft EIS indicates (Executive Summary, page ES-8): "Limited information is available to describe the effects on productivity of managed species from habitat alteration caused by fishing. Likewise, there are no proven techniques for quantifying the benefits to target species that may accrue as a result of adopting any of the alternatives to minimize the effects of fishing on EFH (although many studies worldwide have documented the results of implementing various closed areas). In summary, although short-term costs to the industry are relatively easy to identify, the long-term economic and socioeconomic benefits that may accrue from habitat conservation measures are harder to predict with much precision. Nevertheless, the EIS uses the best information available to summarize the effects of fishing on EFH and the consequences of the alternatives."

The EIS contains an evaluation of the effects of fishing on general classes of habitat features and the broad connections to be drawn between these features and the life histories of some managed species. The level of effects on the stocks or potential yields of these species cannot be estimated with current knowledge. An expectation of substantial recoveries due to mitigation measures would require species with clear habitat limitations and poor stock condition. Because such data are lacking, no quantitative measures of sustained or increased yield in production or biomass of FMP species are available.

Comment: Appendix C's commentary on the six mitigation alternatives fails to provide any method of balancing or measuring benefits versus costs and provides no metric to measure benefits or to compare benefits to costs.

Response: NMFS disagrees. To the fullest extent practicable, given the limitations of empirical data, Appendix C provides quantitative estimates (in dollars) of the potential benefits and costs attributable to the action alternatives. For other economic and socioeconomic impacts, data are insufficient to support precise dollar estimates. In such instances, the analysis relied on economic theory, as well as previous experience under similar regulatory circumstances, to characterize the expected nature, magnitude, direction, and distribution of potential impacts, consistent with Executive Order 12866 and other applicable standards for regulatory impact analyses.

Executive Order 12866 states, in part, that "…costs and benefits are, herein, understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nonetheless essential to consider." The Executive Order continues: "…in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits [including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity]…"

NMFS's Guidelines for Economic Analysis of Fishery Management Actions (revised August 16, 2000) state "Economists may use several analytical options to meet the spirit and requirements of E.O.12866, the RFA, and other applicable laws. The appropriate options depend on the circumstances to be analyzed, available data, the accumulated knowledge of the fishery and of other potentially affected entities, and on the nature of the regulatory action." Elsewhere, the guidelines state ". . . the analyst is expected to make a reasonable effort to organize the relevant information and supporting analyses, [but] …at a minimum, the RIR and RFA should include a good qualitative discussion of the economic effects of the selected alternatives. Quantification of these effects is desirable, but the analyst needs to weigh such quantification against the significance of the issue and available studies and resources. Generally, a good qualitative discussion of the expected effects would be better than poor quantitative analyses." Appendix C was prepared consistent with these standards.

Owing to the qualitative nature of the estimates of impacts for a number of benefits and costs, the relative importance (i.e., weighting) of each in the benefit/cost calculation is subjective. Decision makers should consider all available sources of information, including the benefit/cost analysis, and apply relative weights as appropriate.

Comment: Appendix C makes no attempt to analyze other closures and restrictions that apply in the North Pacific, which makes a shift of effort from one area to another difficult.

Response: NMFS disagrees. Appendix C incorporates relevant analysis concerning existing regulatory restrictions and anticipated fishing industry responses to proposed alternatives. All of the fishing effort redeployment and revenue-at-risk analyses explicitly incorporate existing closures and other restrictions. In addition, Appendix C considers measures in some of the alternatives that would reduce regulatory barriers to mobility between areas and/or fishing gear groups (e.g., allowing fishermen to switch gear type).

Comment: Appendix C makes a determination of fishable area so it can compare the amount of area that would be closed to the amount of area that would be available. The method for determining areas to be fishable is not stated.

Response: No method for determining an area to be fishable is defined in Appendix C because such methodology is not used in the analysis. The analysis relies on the record of reported locations where catches have occurred over the entire range of fishing grounds. A plot of the locations of all reported/observed catches was overlain on the areas where fishing would be restricted under each alternative. The catch (and associated value) in the remaining open areas was then summed, yielding an expected catch and value estimate for each alternative. The arithmetic difference between the status quo catches and values for the management area and the estimated catches and value within the proposed management areas represents the catch and revenue at risk, as characterized in the economic impacts analysis. This methodology effectively incorporated all other closures and restrictions, because it included only areas with reported/observed catches.

The analysis is predicated on the spatial distribution of catches that were recorded inside the proposed management areas and those recorded outside, without making any assumptions about fishable areas. The implicit presumption was that if fishermen used these locations and reported catches, these must be fishable areas. Following that logic, areas in which no historic activity was reported were not attributed to the remaining open area category, for purposes of describing redeployment opportunities.

Comment: Chapter 4 states that Alternatives 2 through 5 can be expected to have positive effects in terms of benthic biodiversity and habitat complexity while at the same time imposing relatively minimal socioeconomic effects on the sectors that catch and process fish as well as communities and related businesses. Appendix C, however, comes to a distinctly different conclusion.

Response: NMFS disagrees. Chapter 4 acknowledges significant uncertainty, but find that one may expect Alternatives 2 through 5 to result in some positive effects for benthic biodiversity and habitat complexity, and unknown net economic and socioeconomic effects on the fishing sector. The chapter also indicates that adverse impacts (economic costs, as well as other negative socioeconomic effects) would be expected to accrue to the fishing and processing sectors, at least in the short run. Consistent with the information presented in Appendix C, Chapter 4 emphasizes the uncertainty that surrounds the economic and social impact estimates. Chapter 4 states that Alternative 2 would have unknown net effects on revenues for the fishing industry. In the short term, certain sectors could experience decreased revenues because of measures resulting from the Magnuson-Stevens Act requirement to reduce adverse effects of fishing on EFH. In the long term, if reducing the effects of fishing on sensitive habitats leads those habitats to produce greater numbers of fish, fishing industry revenues could increase.

Comment: A resource development association objected to the absence of a quantitative analysis of the costs that may be incurred by NMFS, other federal agencies, and permit applicants to conduct interagency consultations regarding federal actions that may adversely affect EFH. The commenter provided suggestions for analyses to include in the RIR/IRFA (Appendix C) to evaluate costs for EFH consultations on non-fishing activities.

Response: The Regulatory Flexibility Act requires federal agencies to prepare an initial and final regulatory flexibility analysis for a rulemaking unless the agency can certify that the rule will not have a significant economic impact on a substantial number of small entities. The EFH EIS includes such an analysis for those portions of the action that will affect small entities, i.e., proposed fishery management measures. EFH consultations and recommendations under Section 305(b) of the Magnuson-Stevens Act do not have direct economic effects on applicants for permits for non-fishing activities. EFH consultations regarding federal permits, licenses, or funding could lead the responsible federal agency to restrict or limit the proposed action, which may result in indirect costs for the entity seeking the authorization or funding. However, EFH conservation recommendations are advisory and not binding. Any resulting requirements on non-fishing entities would be imposed at the discretion of the responsible federal agency, and it would be speculative to evaluate such costs in conjunction with this action.

Comment: For the at-sea sector, the analysis concludes that Seattle has too much economic activity and too many people relative to the estimated impacts, hence there are no effects on communities. In reality, the affected people are the catcher-processor owners and their employees who operate dozens of fishing and marine dependent service businesses, mostly out of Seattle's Ballard/Fishermen's Terminal area. These businesses cannot readily redirect their investments into the high-tech oriented economy of Seattle, and their employees have fishing industry training and skills that are largely not transferable. The Ballard/Fishermen's Terminal community is not so large as to not feel the impacts of the EFH alternatives.

Response: NMFS acknowledges the potential for substantial hardships to individual companies and their employees as a result of implementation of several of the alternatives. NMFS disagrees, however, that a clearly identifiable community exists within the Seattle metropolitan region for which such impacts may be isolated and estimated. As noted in the draft EIS, potential impacts to the catcher-processor sector and associated communities vary by alternative. Under Alternatives 1 (Status Quo) and 4, impacts to the catcher-processor sector would be negligible. Under Alternatives 2 and 3, revenue at risk to catcher-processors would be in the 1 to 2 percent range of the total gross revenue of involved vessels, and no impacts would be anticipated for any communities as a result of ties to this sector. Under Alternatives 5A and 5B, revenue at risk for affected catcher-processors (primarily head and gut vessels) would be in the 3 to 5 percent range of the total catch valuation for those operations. Alone, a 3 to 5 percent impact would typically be considered less than significant. Further, some revenue at risk probably could be made up by redirecting fishing effort from closed to open areas. The draft EIS indicates that some operations may be harder hit than others, although a 3 to 5 percent reduction in total gross receipts would not likely result in significant impacts at the sector level. In terms of linking those impacts back to a particular community, much of the support activity for this sector occurs in the Seattle area where most of the involved vessels are based. If a 3 to 5 percent reduction in total gross receipts would result in a proportional reduction in demand for local support services, this would probably not result in a significant impact to the Seattle support service sector, even if the support sector were exclusively dependent upon this particular catcher-processor fleet segment. Given that whatever negative impacts would occur to the fleet might not be evenly distributed among individual operations, however, particular support service businesses might be hit harder than others.

In general, however, neither Alternative 5A nor 5B would result in an overall reduction of harvest quota. The same aggregate volume of fish likely would be harvested under either of these alternatives, and the demand for support services would be roughly equal to demand under status quo conditions. While there may be some redistribution of catch among different fleet sectors, NMFS finds no indication that there would be a net reduction in demand for support services from Seattle.

The draft EIS indicates that Alternative 6 would have significant negative impacts to communities and shoreside industries. Seattle would experience a wide range of negative impacts under this alternative because that it is the most heavily engaged of any community in the at-risk fisheries in terms of catcher vessel, catcher-processor, and mothership participation. Furthermore, Seattle is the predominant center of shoreside processor ownership and the business and operational headquarters for most of these firms. The draft EIS concludes that, given the size and diversity of the local economy, however, Seattle itself cannot be considered a community that depends of the affected fisheries, despite the fact that Seattle based businesses would be affected. In this sense, the current fisheries are dependent upon Seattle, but Seattle is not dependent on these fisheries.

In terms of specific links of catcher-processors to Seattle, a wider range of catcher-processors would experience negative impacts under Alternative 6 than under any of the other alternatives. Under Alternative 6, negative impacts would also be felt by the largest groundfish catcher-processors in the region, the BSAI pollock and cod oriented vessels, as well as among catcher-processors harvesting non-groundfish species. These operations are largely concentrated in Seattle. According to earlier reports (e.g., regional and sector profiles, http://www.fakr.noaa.gov/npfmc/misc_pub/misc_pub.htm), however, they are not exclusively associated with a particular neighborhood in the community. Similarly, commercial fishing related suppliers and offices are spread along both sides of the Salmon Bay-Lake Washington Ship Canal, around Lake Union, along 15th Avenue West through Queen Anne, and along the shores of Elliot Bay, bordered by the Ballard, Fremont, Queen Anne, Magnolia, and Interbay neighborhoods. Ballard was a definable fishing community historically, but with respect to the Alaska groundfish fishery, today the area does not appear to be a clearly definable community within the larger community of Seattle. A loss of investment or employment may be significant at the individual, operational, and, possibly, sector levels under Alternative 6, but from a community dependency perspective, no significant community-level impacts would be anticipated for greater Seattle, given the size of the community and its economy relative to the scale of the affected portions of the fishing industry and the total revenues at risk.

Comment: A fisherman noted that under the status quo, the vast majority of the bottom in the Aleutian Islands is not impacted by bottom trawls. The commenter said that analysis of passive use values should tell the public the actual present impact as well as changes with protection measures.

Response: NMFS agrees that most of the Aleutian Islands bottom habitat is not impacted by trawling, and added such a statement to Appendix C. NMFS disagrees with the assertion that the passive use value analysis in the EIS should predict actual present impact, as well as changes with protection measures, because no such baseline study exists.

Comment: A fishing industry alliance said that the draft EIS includes inappropriate assumptions about the industry's ability to make up GOA slope rockfish revenues by fishing in areas not part of the slope or by using alternative gear. The commenter said the methodology could greatly underestimate the amount of catch attributable to the GOA slope area that would no longer be open to bottom trawling, because the entire harvest for any particular statistical area actually could have come from the portion of the area that is greater than 200m deep. To evaluate effects on each sector, a more meaningful context would report the percentage of annual revenue at stake for affected vessels in proportion to the gross annual revenues for each proposed alternative.

Response: NMFS recognizes the limitation cited in the comment, but disagrees that a potentially less biased approach is available. Rather than risk underestimating the potential catch and revenues at risk, the analysis was designed to be inclusive by estimating the proportion of catch in any given haul that came from within the closure area versus outside of it. The catch and revenue at risk calculations do not include hauls where haulbacks are reported to have occurred in waters less than 200m deep (outside of the proposed closure area). For haulbacks that occur within the closure area, the analysts acknowledge that potential imprecision resulting from trawling across the 200m contour during a tow could overstate the size of the potential loss associated with that tow.

NMFS disagrees with the comment regarding the use of catch mitigation assumptions that underestimate the losses attributable to the GOA slope closures. The analysis did not assume that fishing would occur in areas other than the GOA slope, nor did it attempt a formal spatial analysis of redeployment of effort and resultant catch. Rather, Appendix C qualitatively assessed catch and revenue at risk in the proposed closure areas versus those that might occur in the remaining open areas, based on historic fishing activity, anecdotal information, and expert advice. The analysis assessed the fleet's ability to mitigate at risk losses based on sector structure and fishing patterns, as well as available fishing areas. Sections C3.3.2.1, C3.4.2.1, C3.5.2.1, C3.6.2.1, and C3.7.2.1 provide the rationale for each conclusion. The potential for catcher vessels and catcher-processors to mitigate losses are discussed differentially, where possible, and the ability of the sector to use the gear type allowed by the alternative is discussed (see C3.4.2.1). In addition, each discussion of the mitigation potential for revenue at risk is explicitly qualified. For example, affected fishermen themselves probably do not yet know exactly how they would adjust to such a new management environment. Some or all of the revenue at risk may be recovered by fishing in adjacent open areas or with allowable gear types, but this outcome is not assured.

Regarding revenue comparisons, the argument has some merit. NMFS considered using the approach suggested in the comment, but determined that it was not appropriate. The analysis compares, by alternative, estimated revenue at risk for affected vessels with status quo revenue attributable to the entire fleet component. Table 3.3-2 in Appendix C indicates that virtually all effects of the proposed GOA slope measures would accrue to GOA rockfish target fishery catcher vessels and catcher-processors operating in the central Gulf and using non-pelagic trawl gear.

The status quo catch and revenue constitute the baseline against which the alternatives can be measured and contrasted. As such, the methodology cannot restrict the status quo calculations to only those vessels in a fleet component that are directly affected by the proposed closure, as suggested in the comment. Doing so would not yield a consistent metric across alternatives with which to compare the effects of each alternative.

Disparate effects on a small number of vessels within a category may have been masked by not doing an individual vessel revenue analysis for every operation. However, data on the operational costs, structure, ownership, and affiliation of vessels are not available, making it impossible to identify and define the dimensions of the fishing firm being impacted, attribute foregone catch and associated revenues, or compare the relative impact of revenues at risk for an alternative to the entity's total revenue flow. Moreover, data confidentiality constraints effectively preclude reporting analytical findings of at-risk catch and revenues, as compared to total revenues, on a vessel-by-vessel basis for any category with fewer than four entities, requiring aggregation of data that would largely reinstate the masking of disproportionate individual effects.

Comment: A fishing industry association stated that using ADF&G fish ticket information to determine catch from less than and greater than 200m greatly underestimates the amount of catch attributable to the GOA slope area that would be closed to bottom trawling. The commenter said the catcher-processor first wholesale value should be used to reflect shoreside value, and the entire value of sablefish and shortraker/rougheye should be assumed at risk. The commenter noted that the catcher vessels and catcher-processors compete for rockfish catch shares, so if travel time to and from grounds increases, the shorebased sector may lose catch share. The commenter stated that slope rockfish is very important to Kodiak, and the finding of no community impact is inaccurate.

Response: NMFS disagrees that using ADF&G fish ticket information to distinguish location of catch in the GOA slope rockfish fishery greatly understates the impacts on bottom trawling. NMFS also disagrees that the proposed slope rockfish bottom trawl closure areas would eliminate bottom trawl catch of sablefish and/or slope rockfish. Based on the best available stock biomass and species distribution information, as well as catch location data, substantial areas that have supported commercial catches of slope rockfish and sablefish would be unaffected by adoption of the closed areas. Appendix C plots the location of the rockfish and other harvests from Kodiak-based catcher vessels, confirming that these boats have historically fished for rockfish, including slope rockfish, in many areas not affected by the 200 to 1,000 m closure area. Much of the at-risk catch would be recoverable in these unaffected areas, and some diminished deep water bycatch of sablefish may accompany this effort redeployment.

The slope bottom trawl gross ex-vessel revenues represent a fairly small percentage of overall groundfish revenues for these catcher vessels. Several vessels rely relatively more heavily on rockfish, and particularly rockfish harvests affected by the proposed closure, compared to most of the GOA slope rockfish trawl sector. These operators (approximately 10) could be relatively more severely adversely impacted by the EFH measures if they could not mitigate any of their revenue at risk. Historically, directed rockfish revenues have been generated in a number of areas not impacted by the GOA slope bottom trawl EFH measures, and these areas may reasonably be expected to provide some mitigation opportunities through redeployment of effort.

NMFS agrees with the comment regarding the potential shorebased sector catch share losses that may accompany some area closures. If the remaining open areas require significantly longer running time to and from port, catcher vessels that must deliver to shore plants may lose fishing time to catcher-processors that can stay on the grounds throughout the opening. As a result, sector catch shares could be altered, as discussed in Appendix C.

NMFS disagrees that slope rockfish are "very important to Kodiak." Preliminary analyses pertaining to community dependency showed the status quo value of the directed slope rockfish fishery in the GOA to be approximately $2.2 million for catcher vessels. Of this amount, about $1.5 million in ex-vessel gross revenue value accruing to participants in this sector of the slope rockfish fishery was derived from sablefish and Pacific cod bycatch, implying that the rockfish catch is not the major component of the gross earnings in this fishery. Even assuming that all of the sablefish and Pacific cod bycatch revenue is placed at risk, the upper bound total GOA catcher vessel revenue at risk under the slope bottom trawl closures is approximately 74 percent. While this effect is significant for the slope bottom trawl catcher vessel sector, it represents about 4 percent of the $37 million total ex-vessel value of groundfish delivered to Kodiak annually, and approximately 2 percent of the $76 million ex-vessel value of all catches delivered to Kodiak shorebased processors (Appendix C, Table 2.3-9).

Appendix C indicates that the GOA slope rockfish closures may place at risk between 0 and 2 percent of the total ex-vessel value of all fish delivered to Kodiak for processing. To the extent that some vessels depend more heavily on the slope rockfish fishery than others, the closures could have detrimental impacts on a subset of the catcher vessel fleet. For the approximately10 vessels that appear to rely heavily on slope bottom trawling for rockfish, if mitigation opportunities provided in the action (e.g., remaining open areas, exemption for gear switching) do not successfully offset lost catch, the operations may incur substantial economic hardship.

Depending on the success of catcher vessels in recouping at-risk catches, a reduction in rockfish and associated bycatch landings could have some impact for processors, and potentially substantial impacts for the few processors that specialize in rockfish products. However, revenue from rockfish landings and bycatch in this fishery represents a rather minor overall community effect in Kodiak compared with all other catcher vessel landings. Overall, processor activities and impacts from the loss of unmitigated rockfish and associated bycatch landings are not likely to be significant at a community or regional level.

Comments on the Practicability Analysis

<u>Comments</u>: A fishing industry alliance questioned the analysis of the practicability of the alternatives to minimize the effects of fishing on EFH. The commenter felt that such an analysis is unnecessary and inappropriate in the absence of a clear determination that fishing is causing adverse effects that must be minimized under the Magnuson-Stevens Act. The commenter said that the practicability analysis did not effectively balance costs and benefits, included no metric for measuring benefits, and did not have a clear methodology for determining practicability.

<u>Response</u>: NMFS disagrees. Although the EIS finds no indication that Council-managed fishing activities have more than minimal and temporary adverse effects on EFH, the analysis indicates that there are persistent effects of fishing on benthic habitat features off Alaska, and highlights considerable scientific uncertainty regarding the consequences of such habitat changes for the sustained productivity of managed species. Faced with that uncertainty, the Council must choose a preferred alternative. The Council may choose the status quo, or it may choose to be more precautionary by selecting another alternative. The practicability analysis provides information to assist the Council in balancing relative

costs and benefits of the alternatives so the Council can avoid selecting an option that may not be practicable.

The EFH regulations at 50 CFR 600.815(a)(2)(iii) provide considerations for Councils to determine whether it is practicable to minimize an adverse effect from fishing. As stated in Section 4.5.3.3 of the EIS, NMFS has not adopted a preferred methodology as national guidance for conducting the practicability analysis. Due to limitations in the available data, the approach used in the EIS mixes quantitative and qualitative factors to assess relative (rather than absolute) benefits of the alternatives. Readers can compare these relative benefits to the estimated costs of each alternative in terms of revenue at risk, and use that comparison to judge the practicability of the alternatives.

Comments: A number of fishing industry commenters stated that the EIS should reconcile potential effects of the proposed management measures with a demonstrated need for mitigation measures based on an assessment of whether the impacts of fishing are more than minimal and temporary, and a demonstrated benefit of the proposed new measures.

Response: NMFS agrees that the EIS must consider the practicability of options for minimizing the effects of fishing on EFH. In accordance with 50 CFR 600.815(a)(2)(iii), the EIS includes a practicability analysis that considers the nature and extent of the adverse effects of fishing on EFH and the long and short term costs and benefits of potential management measures to EFH, associated fisheries, and the nation.

Other Comments on the Analysis of Alternatives for Minimizing the Effects of Fishing

Comments: A fishing industry alliance commented that the EIS should not assume that proposed habitat conservation measures necessarily will lead to more robust fisheries. The commenter asserted that the analysis should only infer fishery benefits from habitat conservation if several facts can be documented: a particular habitat performs an essential function for a managed species; fishing is having adverse effects on that habitat; and the adverse effects are more than minimal and temporary.

Response: NMFS agrees that habitat conservation measures must remedy some particular damage or threat to habitat functions before one can expect to see increased productivity or more stable fish stocks that are attributable to the management measures. However, in most cases the available scientific information regarding habitat function is not sufficient to establish such linkages conclusively. The analysis therefore incorporates professional judgment, and in some cases infers benefits that can reasonably be anticipated from the proposed management measures. Importantly, the Magnuson-Stevens Act does not require a definitive link between habitat conservation and resulting increased fish stock productivity before the Council may adopt new measures to protect habitat.

Comments: Several fishing industry commenters recommended reorganizing a portion of the Section 4.3 analysis of the consequences of the alternatives for minimizing the effects of fishing on EFH. They suggested discussing “productivity benefits” separately from “passive use.” They also suggested evaluating effects on passive use under a different heading than “Effects on the Fishing Fleet.” Finally, they suggested including productivity effects in Tables ES-6 and ES-7.

Response: NMFS agrees that clarification is warranted. In the final EIS, effects on passive use values are discussed under a separate heading from effects on the fishing fleet, and the text refers to potential productivity benefits in the context of a possible influence on passive use values. NMFS did not add a new category for productivity effects in Tables ES-6 and ES-7 because those tables already discuss effects on the target species of groundfish, crabs, scallops, and salmon, including effects on stock biomass, reproduction, feeding, and growth to maturity.

Comments: A fishing industry alliance and some of its supporters recommended providing more justification for the purported benefits of some of the alternatives for habitat complexity, diversity, and ecosystems, or else removing all suggestions that such benefits will accrue from the alternative.

Response: The final EIS includes revisions to provide additional justification where possible. However, NMFS disagrees that qualitative descriptions of anticipated benefits should be removed from the EIS. Under National Standard 2, all conservation and management measures must be based upon the best available information. In some cases, such as those cited by the commenter, qualitative professional judgment is the best available information for analyzing the pros and cons of various factors that must be evaluated to understand the environmental consequences of proposed management measures.

Comments: A fishing industry alliance questioned the expectation in the draft EIS that the proposed measures restricting Gulf of Alaska trawl fisheries will result in net habitat benefits. The commenter stated that in the absence of restrictions, fishing tends to occur in areas with the highest catch per unit effort, so alternatives that would shift effort to new and relatively unfished areas would result in additional fishing-induced disturbance to habitat as compared to the status quo. The commenter stated that shifting fishing effort to areas with lower catch per unit effort is incongruous with the intent of the Magnuson-Stevens Act.

Response: NMFS agrees that effort displacement can result in new effects to habitat in areas that presently are relatively unfished. However, an assessment of net benefits for habitat requires considering the potential impacts that would be avoided as well as the potential new impacts that may occur. The draft EIS finds that Alternatives 3, 5A, and 5B all would result in positive effects for habitat complexity and benthic biodiversity in the Gulf of Alaska because LEI values would be reduced substantially on sensitive hard substrates. Estimated increased effects on adjacent deep shelf habitats from fishing redistribution would be small proportional increases to LEIs that already are small.

Comments: A fishing industry alliance and some of its supporters questioned the expectation in the draft EIS that the proposed measures restricting Aleutian Islands trawl fisheries will result in net habitat benefits. The commenters stated that within the proposed Alternative 5B open areas, fishing occurs in a patchy fashion because fishermen tend to avoid unfishable bottom and return to areas they have towed in the past. The commenters said that within the proposed open areas fishing may shift to new sites, and thus the potential habitat benefits cited in the draft EIS may be overstated in Chapter 4 (although the commenter noted that Appendix C acknowledges this potential for Alternative 5B to push fishing into new areas).

Response: As stated above, NMFS agrees that effort displacement can result in new effects to habitat in areas that presently are relatively unfished. Chapter 4 of the final EIS acknowledges that within the proposed open areas in Alternative 5B, fishing effort is not uniform and could shift to areas that are not fished regularly under current conditions. However, for the same reasons cited by the commenters, NMFS expects that most fishing effort in the open areas will remain where it has historically occurred.

Comment: A fishing industry alliance cited the analysis of the effects on ecosystem diversity for Alternative 2 for minimizing the effects of fishing on EFH. The commenter criticized the analysis for stating that the alternative would have no effect on structural habitat diversity in the Aleutian Islands where most hard corals are found. The commenter noted that reference to the Aleutian Islands is irrelevant because the alternative only addresses fishing in the Gulf of Alaska.

Response: NMFS agrees. Section 4.3.3.6 of the final EIS omits the reference to the Aleutian Islands.

Comment: A federal environmental agency commented that the draft EIS does not provide enough specifics regarding the types of enforcement measures that would be needed to make the proposed actions effective.

Response: Section 4.3 of the EIS discusses the effects of the management alternatives on enforcement programs, including the aspects of each alternative that would facilitate or complicate enforcement. The NMFS Office of Law Enforcement and the U.S. Coast Guard participated in the evaluation of the management alternatives, and would use all available enforcement assets to enforce the Council's preferred alternative, including a variety of ships, aircraft, and vessel monitoring systems. Enforcement of new measures to protect EFH would occur in tandem with enforcement of other fishery management regulations throughout the EEZ, using the same techniques and resources that are used currently.

Comment: A fishing vessel owner and a fishing industry alliance asked for the EIS to discuss observer coverage needed to determine whether a vessel is fishing in the proposed closed areas, and stated that the EIS should discuss the costs, practicability, and safety issues associated with "no entry" designations.

Response: Observer programs are conducted by NMFS for the groundfish fishery and by ADF&G for the crab and scallop fisheries. Appendix C explains that the fishing industry contracts directly with authorized observers and pays for their services based upon observer coverage levels specified in regulation. Appendix C acknowledges that some of the alternatives for minimizing the effects of fishing on EFH would increase fishing and running time, so the cost of providing observer coverage would increase proportionately. None of the alternatives include "no entry" designations (akin to the existing "no transit zones" to protect Steller sea lions in some areas), so the EIS does not discuss such measures.

Comments: A federal minerals management agency noted that the draft EIS does not use explicit significance thresholds and said that the analysis should indicate the magnitude of potential environmental consequences on different resources. The commenter also thought the EIS should clarify that the no action alternatives each have effects and the magnitude of those effects are presented in relation to the effects of the other alternatives.

Response: NMFS elected not to use significance thresholds to evaluate each effect upon a resource. Instead, the EIS identifies whether each effect is positive, neutral, negative, or unknown and provides supporting text to describe the magnitude and intensity of anticipated effects. The text also explains that the no action alternatives have effects. As discussed in Section 4.0, the no action alternatives for identifying EFH and establishing an approach to identify HAPCs differ from the status quo because the Council and NMFS have already identified EFH and HAPCs, and thus choosing no action would mean rescinding the existing designations. In the alternatives for minimizing the effect of fishing on EFH, no action and status quo are treated synonymously.

Comments: A fishing industry alliance and some of its supporters criticized the ratings of effects (positive, neutral, negative, or unknown) for the alternatives to minimize the adverse effects of fishing on EFH, as well as the supporting rationale for those ratings. The commenters stated that the summary tables did not provide a clear basis for comparisons between alternatives, and thought many more effects should have been rated "unknown."

Response: NMFS agrees that the summary tables alone do not provide all of the information needed to compare alternatives. As discussed in the draft EIS, the analysis was hampered by incomplete information, so many of the different categories of potential effects of the alternatives were evaluated qualitatively, with supporting rationales to help explain the context and intensity of the anticipated effects. Where NMFS had sufficient information to determine that the probable effects would be positive or negative, the draft EIS rated the particular effects accordingly.

Comments: A federal minerals management agency suggested that the analysis should assess the effects of Council managed fisheries on other biological resources such as sharks and skates, and should address the effects of invasive species introductions on EFH. The commenter also said the EIS should analyze the effects of the proposed actions on sea turtles.

Response: An analysis of the effects of Council managed fisheries on sharks and skates is beyond the scope of this EIS, as is an analysis of the effects of invasive species introductions on EFH. Sea turtles occur in Alaska waters very infrequently. Chapter 3 of the final EIS acknowledges that sea turtle species occasionally visit Alaska waters, but NMFS does not expect any of the alternatives to affect them.

Comments: A conservation group questioned the conclusion that Alternative 5B for minimizing the effects of fishing on EFH may result in increased interactions with Steller sea lions and whales, and asked NMFS to reevaluate that finding.

Response: NMFS reevaluated the potential effects of Alternative 5B for Steller sea lions and whales, and the findings in the draft EIS remain valid. The principal concern for these marine mammals is displacement of Pacific cod and Atka mackerel fishing activity out of the proposed Aleutian Islands closed areas, presumably concentrating this activity in the remaining open areas where there may be increased potential for conflicts between fishing activities and ESA-listed marine mammals. The potential for adverse effects exists with or without the proposed TAC reductions.

The western stock of Steller sea lions has declined considerably, and is listed as endangered under the ESA. The “fishable” areas that would remain open under any of the Alternative 5B management options are fairly small, especially when combined with other existing closed areas. Fisheries for Pacific cod and Atka mackerel would be concentrated spatially into remaining open areas, including areas near important sea lion habitats. Furthermore, with TAC reductions under two of the Alternative 5B management options, there could be a “race for fish” during open seasons, with a fixed numbers of vessels competing for a smaller TAC, concentrating fishing activity temporally.

Concentrated fishing activity during winter months when sea lions forage further from shore (outside existing sea lion closed areas) could increase the potential for conflicts from competition for prey, disturbance, or entanglement or other injury. In the past, rookeries in the western Aleutian Islands have experienced greater declines than others; fishery encounters with these groups of sea lions would be of additional concern. A similar concern exists for ESA-listed whales that may forage in the Aleutian Islands region or move through migratory corridors where more concentrated fishing activity may occur.

NMFS will complete a consultation under Section 7 of the ESA if the Council selects Alternative 5B as its preferred alternative. However, NMFS does not expect the adverse effects for sea lions and whales to be substantial because the redistribution of fishing effort under Alternative 5B would be small under any of the three management options. Alternative 5B was designed to allow fishing to continue in areas with the highest historical catch rates, and to preclude fishing in new areas.

Comments: A federal minerals management agency asked NMFS to clarify that areas subject to bottom trawling closures would not have any direct implications to oil and gas related activities.

Response: NMFS agrees. However, if areas are closed to fishing to protect sensitive habitat features, NMFS would encourage agencies with appropriate jurisdiction to consider whether restrictions may also be warranted to protect the same habitat features from disturbance by non-fishing activities.

Comments on the Cumulative Effects Analysis

Comments: Several conservation groups criticized the cumulative effects analysis and stated that it indicated an adverse effect on habitat and ecosystems only if the effect of an alternative would be additive to an existing adverse trend or cause an adverse trend. The commenters said this approach misleads the public into thinking impacts are not significant if they are already occurring.

Response: NMFS disagrees. Section 4.4 of the EIS notes that active foreign and domestic trawl fisheries over time may have had negative effects on habitat, and Appendix B includes a detailed evaluation of the effects of fishing activities on EFH. NMFS prepared the EIS precisely because existing fishery management as modified by the proposed actions could have significant effects on the environment.

Comments in Favor of Interagency EFH Consultations Regarding Non-fishing Activities

Comments: Some commeters cited the effects of non-fishing activities on EFH. The commenters stated that non-fishing threats to EFH should be considered thoroughly, and supported the Magnuson-Stevens Act requirements for interagency consultations to minimize adverse effects to EFH.

Response: NMFS agrees that non-fishing activities should be designed to avoid or minimize adverse effects to EFH. Such activities are regulated under a variety of federal and state laws to reduce potential environmental impacts, including impacts to fish habitat. Interagency EFH consultations ensure that environmental reviews specifically address potential effects to the habitats that are necessary to managed species for spawning, breeding, feeding, and growth to maturity. Appendix G includes a comprehensive review of non-fishing activities that may adversely affect EFH.

Comments: Two commenters stated that due to recent legal and policy changes within the State of Alaska, the State is no longer capable of protecting EFH in inland waters. The commenters said NMFS clearly has the authority to do so because anadromous fish affect commerce throughout the nation. Another commenter stated that adverse impacts still occur even when other regulations are followed and that it is not unusual for adverse effects to be overlooked or discounted.

Response: Many species targeted by federal fisheries spend part of their life cycle in state waters, and EFH for these species (e.g., salmon) may be affected by various human activities. NMFS strives to work with all entities, including state agencies, to provide effective management of living marine resources that cross jurisdictional boundaries.

The Magnuson-Stevens Act requires Councils to describe and identify EFH for all life stages of managed species, with no limitations placed on the geographic location of EFH. Therefore, EFH may be identified in state and/or federal waters depending on the biological requirements of the species. The Magnuson-Stevens Act also requires NMFS to provide EFH Conservation Recommendations to state and federal agencies regarding actions that would adversely affect EFH, including actions in state waters. NMFS provides technical advice to regulatory agencies to avoid or minimize effects to EFH, but NMFS's EFH Conservation Recommendations are non-binding.

Comments on the Coordination, Consultation, and Recommendation Procedures

Comments: Several commenters were concerned that the EFH consultation process duplicates regulatory efforts and adds unnecessary layers, thereby increasing costs, creating permit delays, and resulting in lost revenue. The commenters stated that NMFS does not have responsibility for protecting salmon or other fish habitat within Alaskan waters.

Response: NMFS agrees that existing federal statutes such as the Fish and Wildlife Coordination Act (FWCA), Endangered Species Act (ESA), and National Environmental Policy Act (NEPA) require consultation or coordination with NMFS and other federal agencies, and the need for federal agencies to evaluate the effects of their actions on fish and fish habitat is not a new requirement imposed by the Magnuson-Stevens Act. However, Congress indicated through the EFH provisions of the Magnuson-Stevens Act that existing environmental reviews are not adequate for the conservation and management of fishery resources of the United States. Direct and indirect habitat losses have been and continue to be a threat to the long-term sustainability of many fisheries. The EFH provisions enable NMFS to work cooperatively with other agencies to avoid and/or minimize adverse effects to EFH, thereby promoting the conservation of living marine resources. In addition, the EFH regulations for the consultation process (50 CFR 600.920) encourage NMFS and other agencies to use existing environmental procedures to fulfill the EFH consultation requirements, minimizing the possibility of increased costs or permit delays.

Comments: A number of commenters said that the EFH consultation process should complement rather than duplicate the existing regulatory framework for other agencies to protect fish habitat in Alaska's coastal and marine waters, and that EFH consultation should go no further than monitoring compliance with existing laws and regulations. One commenter said that consultation under the Magnuson-Stevens Act should be restricted to fishing related activities.

Response: NMFS agrees that other laws also have environmental review requirements; however, no other federal mandate specifically evaluates potential adverse affects on habitats for federally managed fish species. Section 2(b)(7) of the Magnuson-Stevens Act states that one of Congress' purposes was to "promote the protection of essential fish habitat in the review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect such habitat." Therefore, an important purpose of EFH consultations is to provide information to action agencies to ensure consideration of potential impacts to EFH. The information provided during EFH consultation complements the information provided through other required reviews and consultations.

Comment: A resource development interest group commented that the consultation process took NMFS's focus away from EFH conservation efforts in the EEZ and duplicates ESA requirements for listed fish populations.

Response: NMFS disagrees. The EFH consultation process strengthens NMFS's ability to reduce and mitigate degradation and loss of habitat that may result in subsequent impacts to populations of fish. Maintaining the health and productivity of managed species enhances current and future opportunities for the sustainable use of these resources, as well as the health and biodiversity of their ecosystems. No species managed by the Council are listed under the ESA. By promoting the conservation of habitat via the EFH consultation process, NMFS hopes to avoid the future need to list fish species under the ESA.

Comment: One commenter was unclear as to whether federally funded programs that are administered or delegated to state authorities were subject to consultation, and if so, when that consultation occurs.

Response: The EFH regulations at 50 CFR 600.920(a)(1) require consultation on federal programs delegated to non-federal entities at the time of delegation for those programs that result in activities that may adversely affect EFH. For programs that were delegated prior to the approval of EFH designations by the Secretary, EFH consultation is required when the delegation is reviewed, renewed, or revised.

Comments: Several comments questioned NMFS's ability to keep up with the additional workload caused by EFH consultations, and stated that EFH consultations have resulted in absurd recommendations including monitoring programs and restrictions on dredging operations that had no scientific basis.

Response: The EFH regulations include numerous provisions to make consultations efficient and effective, such as the use of existing environmental review procedures, General Concurrences, programmatic consultations, and options for using compressed schedules for abbreviated or expanded consultation. NMFS designed these approaches for EFH consultation to implement the EFH provisions in an efficient manner and minimize additional workload. NMFS Alaska Region has taken advantage of these mechanisms and strives to provide EFH Conservation Recommendations to action agencies within the normal public or agency comment period.

NMFS uses the best scientific information available to support its EFH conservation recommendations. In areas where site specific information is not available, monitoring may be appropriate to identify ways to avoid, minimize, or offset adverse effects on EFH. Also, since EFH conservation recommendations are non-binding, they do not impose restrictions on proposed actions, and the agency responsible for the action chooses whether to require measures such as permit conditions or monitoring.

Comment: One commenter stated that agencies should not be required to reply in writing to NMFS's conservation recommendations as a result of the consultation process because of increased cost and permitting delays.

Response: Section 305(b)(4)(B) of the Magnuson-Stevens Act requires federal agencies to provide a detailed response in writing within 30 days after receiving EFH conservation recommendations from NMFS. NMFS has no authority to alter this statutory requirement, and is unaware of any resulting increased costs or permitting delays for applicants.

Comments: Several commenters noted that although compensatory mitigation is referred to in several sections of Appendix G, it is not defined or explained, and stated that these references should be clarified to explain that compensatory mitigation is that required under Section 404 [of the Clean Water Act]. The commenters said that compensatory mitigation should not be recommended for a minor loss of fish habitat in an area that is not habitat limited.

Response: NMFS agrees that Appendix G should clarify the authority for requiring compensatory mitigation, and has revised the text accordingly. Section 404 of the Clean Water Act requires developers to go through a sequencing process prior to the Corps of Engineers issuing a permit for the discharge of dredged or fill material into waters or wetlands. If impacts cannot be avoided or minimized, compensatory mitigation provides a way to offset unavoidable habitat loss.

Comment: One commenter suggested developing a collaborative working relationship between NMFS and the Alaska Board of Forestry, recognizing that the Alaska Forest Resources and Practices Act is the standard for compliance with federal coastal zone management and Clean Water Act requirements in Alaska.

Response: NMFS agrees, and will work with the Board of Forestry if NMFS identifies EFH concerns with any specific state managed forest practices.

General Comments on the Description of Non-fishing Effects in Appendix G

Comments: Commenters affiliated with non-fishing industries stated that NMFS exceeded its authority and area of expertise in describing potential impacts from non-fishing activities, and as a result the ensuing conservation recommendations are too restrictive or unnecessary and might conflict with recommendations from other agencies. Many of these commenters said that Appendix G should include a list of all state and federal habitat regulations, permitting requirements, best management practices, standards, procedures, and conservation recommendations that pertain to each of the non-fishing activities described therein. The commenters said that these existing measures provide sufficient oversight and therefore there is little benefit in NMFS identifying conservation recommendations for non-fishing activities. Two commenters encouraged NMFS and the Council to consider additional public review of Appendix G after language is added to more accurately portray current processes, agency oversight, and regulatory requirements used by industry.

Response: NMFS disagrees. Section 303(a)(7) of the Magnuson-Stevens Act requires FMPs to identify measures for actions other than fishing to promote the conservation and enhancement of EFH. NMFS has extensive experience reviewing non-fishing activities and recommending conservation measures. NMFS has commented on thousands of potential non-fishing impacts to fish habitat under the FWCA, NEPA, and other statutes since the agency was established in 1970.

Appendix G acknowledges that non-fishing activities are subject to a variety of regulations and restrictions under federal, state, and local laws designed to limit environmental impacts and that many of these existing requirements help to avoid or minimize adverse effects to aquatic habitats, including EFH. Listing all applicable laws and management practices in Appendix G is unnecessary. NMFS recognizes that the conservation recommendations in Appendix G are rather general and may overlap with certain existing standards for specific development activities. Nevertheless, the recommendations highlight practices that can help to avoid and minimize adverse effects and promote the conservation and enhancement of EFH.

During EFH consultations between NMFS and other agencies, NMFS strives to provide reasonable and scientifically based recommendations that account for restrictions imposed under various state and federal laws by agencies with appropriate regulatory jurisdiction. NMFS will not recommend that state or federal agencies take actions beyond their statutory authority, and NMFS's EFH conservation recommendations are not binding.

In response to concerns about the scope and purpose of Appendix G, NMFS revised the text to clarify that coordination and consultation required by Section 305(b) of the Magnuson-Stevens Act does not supersede the regulations, rights, interests, or jurisdictions of other federal or state agencies. Interested parties may comment on the revisions in response to the Federal Register notice of availability for the final EIS.

Comments: Two commenters expressed concern about the inclusion in Appendix G of tables from the 1999 EFH Environmental Assessment (EA) for comparative purposes. One commenter said that the word "threat" used in those tables to describe the potential effects from non-fishing activities should not be repeated in the EFH EIS. Another commenter thought that Table 2 could be used out of context and should be revised to reflect existing habitat protections.

Response: NMFS agrees that including the tables from the 1999 EA could be confusing, and omitted those tables from the final EIS.

Comment: One commenter stated that Appendix G conveys the erroneously broad notion that "EFH is the geographic area where the species occurs at any time during its life" (draft EIS Appendix G, Section 1, G-2) and that the concept of "essential" or "necessary" habitat is lacking.

Response: NMFS deleted the language cited by the commenter and revised the text to clarify that EFH is defined in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

Comment: Numerous commenters suggested that Appendix G should be revised because it does not reflect the current science and references and is not focused on Alaska specific impacts.

Response: NMFS agrees that Appendix G should use the best scientific information available to identify conservation measures that can be taken to avoid, minimize, or offset adverse effects to EFH from non-fishing activities. NMFS revised Appendix G as appropriate to focus on Alaska specific impacts.

Comment: One commenter stated that Appendix G could be greatly reduced in scope and otherwise simplified if NMFS adopts Alternative 6 for describing and identifying EFH, thereby limiting EFH designation to the EEZ.

Response: NMFS agrees, insofar as Alternative 6 would eliminate EFH designations in freshwater areas, estuaries, or nearshore marine waters under jurisdiction of the State of Alaska. However, as discussed in Section 4.5.1.3, Alternative 6 is not consistent with the Magnuson-Stevens Act because it fails to identify nearshore and freshwater habitats that are necessary to managed species of fish for spawning, breeding, feeding, or growth to maturity. Even if NMFS could forego EFH designations in those areas, NMFS would continue to have authority under the FWCA, NEPA, and other laws to comment on non-fishing activities that impact living marine resources and their habitats.

Comments on Specific Sections of Appendix G

Silviculture/Timber Harvest

Comment: Several commenters asserted that NMFS did not consider that the regulations, standards, and best management practices (BMPs) of the Alaska Forest Resources and Practices Act are fully protective of fish habitat from the hazards associated with timber harvest. The commenters said that the conservation recommendations for timber harvest activities duplicate the efforts of other state and federal resource management agencies and are redundant and harmful to timber harvesting businesses.

Response: Appendix G cites the Alaska Forest Resources and Practices Act BMPs as siliviculture/timber harvest conservation recommendations, along with the BMPs developed for the Tongass National Forest Land Management Plan and for the Chugach National Forest Land Management Plan. The silviculture industry currently operates under these standards and BMPs and would not be harmed by having those recommendations included in Appendix G. NMFS has not developed additional BMPs and participated in developing the aforementioned BMPs for timber harvest. The list of timber harvest conservation recommendations paraphrases the content of these BMPs and is not duplicative.

Comment: One commenter expressed concern that the conservation recommendations for timber harvest would not receive critical review by the Council because they are contained in an appendix to the EIS.

Response: NMFS disagrees. The Council is aware of the scope of Appendix G and has provided specific guidance to staff regarding its content. Moreover, Appendix G is subject to public review and comment along with the rest of the EIS.

Comment: One commenter said that Appendix G must clearly state that its conservation recommendations are advisory only and that projects cannot be denied because they do not comport with one or more recommended conservation measures.

Response: NMFS agrees. The advisory nature of the recommendations is stated clearly in Appendix G. NMFS has no authority under the Magnuson-Stevens Act to deny or impose conditions upon projects that do not incorporate conservation recommendations.

Comment: Several silviculture industry commenters said Appendix G should clarify that potential impacts to EFH from forestry would not occur if Alaska Forest Resources and Practices Act guidelines are followed, and that violation rates are rare (average compliance rate >90 percent). The commenters said NMFS should acknowledge that the State of Alaska has been successful in protecting fish habitat through implementation of these guidelines and associated BMPs. A conservation group commented that the impacts of logging on private lands, including construction and maintenance of logging roads, are minimally regulated and have large impacts on EFH. The commenter stated that the Alaska Forest Resources and Practices Act regulations are rarely enforced with minimal consequences for violators, and encouraged NMFS to monitor timber harvest and road building in Alaska and play a role in mitigating impacts.

Response: Appendix G acknowledges that recent revisions of both state and federal timber harvest regulations and BMPs have resulted in increased protection of EFH on state, federal, and private timber lands. However, Appendix G also notes that if these management practices are not fully implemented or effective, adverse effects to EFH are likely. NMFS revised Appendix G to indicate that BMPs are implemented at a rate of about 90 percent and to reference current data on their effectiveness at protecting fish habitat. NMFS is involved in mitigating potential impacts through the review of federally funded or permitted projects that may adversely effect EFH.

Comment: Many resource developers and foresters commented that Appendix G combines timber harvest and deforestation when in fact these are two different actions. Deforestation is a permanent land use conversion, whereas timber production areas on state and private lands must be fully restocked within 7 years of harvest and lands are managed for the continual production of timber.

Response: NMFS agrees that these two land development actions should be addressed separately and revised Appendix G accordingly.

Comment: One commenter disagreed that logging impairs fish passage through inadequate design, construction, and/or maintenance of stream crossings.

Response: Appendix G states that while current standards and BMPs for road crossings including culverts are intended to avoid impairment of fish passage, many older stream crossings are not providing fish passage and require repair. Even modern crossing structures can fail, with adverse effects to EFH, although this occurs with much less frequency than in the past.

Comment: Many resource development agencies and corporations commented that conservation measure #3 is specific to California where numerous salmon stocks are listed under the Endangered Species Act as threatened or endangered, and thus this recommendation does not apply to Alaska and should be replaced with a reference more appropriate for Alaska.

Response: NMFS disagrees. Recommendation #3 is a clearly cited reference to the Tongass National Forest Land Management Plan's recommendation to avoid timber harvest adjacent to wetlands. This recommendation is specific to the Tongass National Forest in southeast Alaska and is a recommendation that would protect EFH in many instances.

Comment: A resource development group commented that Appendix G inaccurately states that timber harvest can cause increased stream temperatures and low oxygen levels resulting in significant mortalities to pink and chum salmon.

Response: NMFS clarified Appendix G to explain that significant pink salmon prespawner mortalities have been documented in southeast Alaska streams when high escapements and low flows combined, resulted in low dissolved oxygen levels. This phenomenon has occurred in logged and unlogged streams, and generally is the result of streams lacking protective riparian buffers.

Comment: One commenter offered the correction that timber harvest in Alaska does not reduce the permeability of soils and increase the area of impervious surfaces because the most prevalent methods of timber harvest, cable yarding and helicopter logging, minimize the compaction of soils.

Response: NMFS agrees and modified Appendix G to describe the minimal effects of cable yarding and helicopter logging on soil compaction and permeability.

Riverine Mining

Comments: Several commenters asserted that NMFS is not an authority on mining and the conservation recommendations are redundant, unrealistic, and overly restrictive. In addition, the commenters expressed concern that the recommendation to avoid mining in EFH is not reasonable since NMFS has indicated that most waters and streams in Alaska are EFH.

Response: NMFS agrees that it is not an authority on mining. The recommendations contained in Appendix G include actions that can contribute to the conservation, enhancement, and proper functioning of EFH. They should be viewed as options to avoid, minimize, or compensate for adverse impacts and promote the conservation and enhancement of EFH. Ideally, non-water-dependent actions should not be located in EFH if such actions may have adverse impacts on EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. NMFS recognizes that impacts to EFH from specific projects may be unavoidable and the impacts of these actions should be minimized to the extent practicable.

Dredging

Comments: Several commenters recommended that Appendix G differentiate between maintenance dredging and dredging in locations that are undisturbed. The commenters recommended that there should be no mitigation or other onerous requirements associated with maintenance dredging or additional dredging in previously disturbed areas.

Response: NMFS agrees that maintenance dredging may affect EFH to a lesser extent than dredging in an area previously undisturbed. However, in some cases routine or maintenance dredging has the potential to impact areas that have been previously undisturbed (e.g., new disposal sites for dredged material) and site specific EFH conservation recommendations would be provided to the action agency through the EFH consultation process. Such recommendations are non-binding, and any restrictions are applied at the discretion of the appropriate action agency.

Vessel Operations/Transportation/Navigation

Comment: A transportation industry commenter expressed concern regarding an Appendix G conservation recommendation that calls for avoiding disturbance to eelgrass beds, mudflats, and wetlands as part of project design, and providing suitable compensatory mitigation in situations where such impacts are unavoidable (with the approval of appropriate regulatory agencies). The commenter stated that this would affect potential development or expansion in areas that contain this type of habitat.

Response: The recommendations contained in Appendix G include actions that can contribute to the conservation, enhancement, and proper functioning of EFH. They should be viewed as options to avoid, minimize, or compensate for adverse impacts and promote the conservation and enhancement of EFH. Ideally, non-water-dependent actions should not be located in EFH if such actions may have adverse impacts on EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. NMFS recognizes that impacts to EFH from specific projects may be unavoidable and the impacts of these actions should be minimized to the extent practicable.

Pile Installation and Removal

Comment: Several commenters stated that the Appendix G conservation recommendations for pile driving and removal are impractical, and that some of the recommendations may harm habitat.

Response: NMFS reviewed the recommendations and deleted two that may have been impractical or unnecessary (one involving the placement of clean sand around the base of old pilings before removal, and one involving the placement of clean fill in holes left following the removal of piles). NMFS also modified the recommendation to drive broken pile stubs below the substrate surface to prevent release of contaminants from treated wood into the water column. The revision clarifies that driving pile stubs below the surface should be done to the extent practicable, in response to a comment that doing so is not always feasible.

Comment: Several commenters were concerned that Appendix G recommendations regarding prohibition of the use of creosote treated timber in the nearshore marine environment are inconsistent with U.S. Army Corps of Engineers Nationwide Permit Regional Condition B, which prohibits the use of creosote treated timbers in freshwater.

Response: Substantial scientific information indicates that creosote and its component pesticides, primarily polycyclic aromatic hydrocarbons, may harm EFH and federally managed fish species. NMFS has a responsibility under the Magnuson-Stevens Act to recommend measures to conserve EFH using the best available science. NMFS is coordinating with the Corps of Engineers and other agencies to investigate options for revising the regional permit conditions regarding creosote.

Log Transfer Facilities/In-water Log Storage

Comment: Several comments supported Appendix G's direct reference to the siting and operational guidelines for log transfer facilities (LTFs) developed by the Alaska Timber Task Force and stated that these guidelines should be cited in the recommended conservation measures.

Response: NMFS agrees. The siting and operational guidelines for LTFs are cited as conservation recommendation #7 of section 4.9.

Comment: A resource development corporation commented that the discussion of commercial forestry and LTFs in Appendix G dwells on worst-case scenarios from old studies that predate current BMPs and ignore the effectiveness of modern BMPs. The commenter stated that the conservation recommendations are vaguely worded and either already required by current BMPs, unsupported by any evidence, or unrelated to the protection of managed fish species.

Response: Many logging activities occur coincident with sites that were harvested or supported LTFs that were developed under old forest management regulations and BMPs. Appendix G acknowledges the existence and effectiveness of modern BMPs for timber harvest activities and LTF siting and operations. NMFS clarified this point for the final EIS.

Comment: One commenter suggested that the release of hazardous materials such as oil from heavy machinery be added to the list of potential adverse effects from LTFs.

Response: While release of oil from heavy machinery is unlikely if BMPs are followed, NMFS agrees that there is a potential for releases of such hazardous materials and modified Appendix G to note this possibility.

Point Source Discharges

Comment: One commenter asked NMFS to eliminate the Appendix G recommendation to avoid siting pipelines and treatment facilities in wetlands and streams. The commenter said that in numerous cases the U.S. Fish and Wildlife Service has determined that it is more important to minimize upland habitat impacts than wetland impacts.

Response: NMFS disagrees that the recommendation should be deleted. Pipelines and treatment facilities are not water-dependent with regard to positioning, and avoiding the placement of pipelines within streambeds and wetlands can reduce inadvertent infiltration into conveyance systems and retain natural hydrology of streams and wetlands. If NMFS's recommendations for a specific project differ from those of another resource agency, the applicable regulatory agency would decide which measures best serve the public interest.

Oil and Gas Exploration, Development, and Production

Comment: A federal agency recommended adding information to Appendix G regarding oil spill risk, its likelihood, and how to balance EFH conservation recommendations with effects on economics or operational realities of oil and gas projects. Another commenter took issue with specific language stating that offshore oil and gas development inevitably results in oil entering the environment.

Response: Information regarding the risk of an oil spill is project specific. Balancing EFH conservation recommendations against the economics or operational realities of oil and gas projects is the purview of the action agency; NMFS's role is to provide recommendations for minimizing effects to EFH using the best available scientific information. The language regarding oil entering the environment was not meant to imply that every oil and gas facility will experience an oil spill, but rather that oil development in a given geographic area typically results in some amount of oil, be it large or small, entering the environment. NMFS revised Appendix G to clarify this point.

Comment: A federal agency requested that NMFS insert a reference for the statement that "petroleum exploration/development/production occurs…usually over soft-bottom substrates, although hard-bottom habitats may be present in the general vicinity."

Response: NMFS deleted the statement cited by the commenter.

Comment: A federal agency and other commenters recommended that NMFS locate more relevant scientific studies to draw conclusions on the effects of noise and other impacts of oil and gas exploration, development, and production. These commenters also were concerned that NMFS failed to recognize the existing federal and state oversight of this industry.

Response: NMFS revised Appendix G to include more relevant scientific studies and to explain more clearly that non-fishing activities are subject to a variety of regulations that limit environmental impacts.

Marine Mining

Comment: A mining industry commenter stated that the conservation recommendation to avoid mining in waters containing EFH implies that mining should not be done at all.

Response: NMFS disagrees. Ideally, non-water-dependent actions should not be located in EFH if such actions may have adverse impacts to EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. NMFS also recognizes that impacts to EFH from specific projects may be unavoidable and the impacts of these actions should be minimized to the extent practicable.

Comments Regarding Compliance with Applicable Laws

Comment: Many commenters expressed an opinion about whether the EIS meets the requirements of the Magnuson-Stevens Act and the joint stipulation and court order that required development of the EIS. In general, fishing industry commenters thought the EIS met the applicable requirements, and conservation group commenters thought it did not. Reasons cited by commenters for alleged noncompliance included failure to employ the proper legal standards, failure to consider all relevant information, and reaching arbitrary conclusions. Commenters said that the analysis focused on the effects of fishing on fish rather than the effects on habitat, and used too high a standard for evidence that fishing adversely affects EFH. A non-fishing industry association alleged that the broad EFH designations violate the Magnuson-Stevens Act and the analysis of non-fishing actions that may adversely affect EFH fails to incorporate the best available scientific information.

Response: NMFS finds that the final EIS provides all of the information required by Section 303(a)(7) of the Magnuson-Stevens Act and 50 CFR 600.815(a) and meets the requirements of the joint stipulation and order approved by the U.S. District Court for the District of Columbia. The final EIS addresses the applicable legal standards, uses the best available scientific information, and explains the basis for its conclusions. Additional information supporting these conclusions is documented in the administrative record. In response to public comments on the draft EIS and an independent peer review, the final EIS includes additional supporting information and analyses.

The analysis of the effects of fishing on EFH contains all of the information required by 50 CFR 600.815(a)(2). The analysis considers the effects of fishing on habitat features within EFH, as well as the consequences of habitat alteration for managed species of fish. The analysis of effects to managed species provides necessary information to understand the degree to which Council-managed fishing reduces the quality and/or quantity of EFH, and the degree to which fishing may reduce the capacity of EFH to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. The EFH regulations at 50 CFR 600.815(a)(2)(ii) provide the applicable threshold for Council action: "Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature." The EIS examines the available information and finds no indication that fishing reduces the capacity of EFH to support managed species. Despite this conclusion, the EIS identifies a variety of practicable management measures that could be taken to provide additional habitat protection. As noted in the preamble to the final EFH regulations, "[i]t is not appropriate to require definitive proof of a link between fishing impacts to EFH and reduced stock productivity before Councils can take action to minimize adverse fishing impacts to EFH to the extent practicable" (67 FR 2354; January 17, 2002). Thus, even in the absence of clear linkages between habitat and stock productivity, the Council has the authority to take additional precautionary action to reduce potential adverse effects to EFH, if warranted. Based on the information and analysis in the final EIS, the Council chose to support Alternative 5C for minimizing the effects of fishing on EFH. Alternative 5C includes extensive new bottom trawl closures designed to protect relatively undisturbed habitats in the Aleutian Islands; new closures to all bottom contact fishing in six areas of the Aleutian Islands to protect coral garden habitats, which are especially diverse and vulnerable; and new closures to bottom trawling in ten areas on the Gulf of Alaska slope to reduce the effects of fishing on rocky areas that may support coral. The Council determined that adopting these measures is an appropriate and precautionary step in light of the scientific uncertainties about the effects of habitat disturbance for managed species. Moreover, the Council determined that Alternative 5C is a practicable option to enhance protection for the most vulnerable habitats while minimizing costs for the fishing industry.

The description and identification of EFH contains all of the information required by 50 CFR 600.815(a)(1). The Council's preferred alternative incorporates the best available information regarding the distribution and relative abundance of managed species, and employs a new analytical methodology that reduces the size of EFH descriptions for many species. The analysis of non-fishing actions that may adversely affect EFH (Appendix G) has been revised in response to public comments and incorporates the best available scientific information.

Comments: Several conservation groups criticized NMFS for delegating the agency's public process to an industry-dominated process. The commenters also asserted that selecting and finalizing alternatives by the vote of a non-federal body (the Council) undermines the fundamental requirements of the National Environmental Policy Act (NEPA).

Response: NMFS disagrees with the criticism. Section 302 of the Magnsuon-Stevens Act requires Councils to prepare fishery management plans and amendments as necessary and submit those documents to the Secretary. Under Section 304 of the Magnuson-Stevens Act, the Secretary may approve, disapprove, or partially approve such plans and amendments. The Secretary, acting though NMFS, advises the Council regarding technical matters as well as compliance with the Magnuson-Stevens Act and other applicable laws. The Council process affords ample opportunity for public review and comment on proposed actions. During Secretarial review of Council actions, NMFS provides another opportunity for public comment before deciding whether to approve, disapprove, or partially approve the action.

The Council's role in the development of the EIS (or any other NEPA analysis for Council actions) is to define the purpose and need for action and the range of alternatives, and to assist with the analysis as appropriate. Depending on the action, the Council either takes a lead role or a supporting role in developing a NEPA analysis that complies with all applicable requirements and can be adopted by the

Secretary to support NMFS's decision to approve, partially approve, or disapprove the action recommended by the Council. NMFS disagrees that having the Council develop the alternatives violates NEPA.

Comments: A resource development group asserted that the EFH designations proposed in the draft EIS are excessively broad and render meaningless the statutory definition of EFH in violation of the Magnuson-Stevens Act, and are arbitrary and capricious under the Administrative Procedures Act. The commenter also said that amendment of an FMP to designate EFH is a rule within the meaning of the Administrative Procedures Act and should be treated as such.

Response: NMFS disagrees. The EIS includes a wide range of alternatives for describing and identifying EFH, based upon the best available scientific information regarding the habitat requirements, distribution, and relative abundance of species managed by the Council. As noted in the EIS, three of the alternatives are not consistent with the Magnuson-Stevens Act, but the other three alternatives are, and the EIS provides the rationale and scientific basis for each alternative. Amendment of an FMP to designate EFH is not a rule within the meaning of the Administrative Procedures Act and does not require codification in the Code of Federal Regulations.

Comments: A number of commenters addressed the adequacy of the draft EIS under NEPA. Some commenters affiliated with the fishing industry supported the range of alternatives and said the draft EIS complies with NEPA. Commenters from several conservation groups said the alternatives for minimizing the effects of fishing on EFH are redundant and unresponsive to the EFH and NEPA mandates. The commenters said the draft EIS does not comply with NEPA because it does not consider all relevant information; fails to consider fully and fairly the direct, indirect, and cumulative effects of fishing on the environment; and fails to explain these impacts to the public in an understandable fashion. The same groups asserted that the draft EIS violates NEPA because NMFS failed to solicit the views of those who live in small communities throughout Alaska, and did not hold public meetings in communities that are affected by ecological harm from industrial fishing practices. The commenters said NMFS violated NEPA by permitting status quo fishing practices that have adverse effects on EFH to continue during development of the EIS, and failing to comply with NEPA's procedures for incomplete information. Other commenters said the draft EIS does not take a "hard look" as required by NEPA at effects to slow growing species.

Response: NMFS disagrees with the criticisms and finds that the EIS complies fully with NEPA. The EIS includes a wide range of alternatives to address the stated purpose and need for all three actions considered, and uses the best available scientific information to evaluate the direct, indirect, and cumulative environmental consequences of the alternatives. The alternatives for minimizing the effects of fishing on EFH are distinctly different from one another, although some of them have common elements because each alternative adds successively more restrictive management measures. The methods used to display the analysis are similar to those used in many other NEPA analyses, and the final EIS incorporates a number of revisions to clarify items that various commenters thought were unclear in the draft EIS. NMFS sought comments from all interested parties by publishing notices in the Federal Register, holding numerous public meetings, and using the Council's paper and electronic mailing lists to inform the public of opportunities for input. NMFS held public meetings related to the development of the EIS in many communities that have a stake in the fishing industry and habitat conservation, such as Kodiak, Sitka, Unalaska, Anchorage, Juneau, and Seattle. NMFS did not violate any law by allowing fishing to continue while NMFS developed the EIS. The EIS clearly discloses the incomplete scientific information regarding the distribution of habitat types, the functional linkages between habitats and fish species, and the effects of fishing and other human activities on fish habitat, and summarizes the existing scientific information NMFS used to conduct the analysis, in accordance with the NEPA regulations at 40 CFR 1502.22. The EIS examines in detail the effects of fishing on many aspects of the environment, including slow growing and fragile living substrates such as corals and sponges, and slow growing fishes such as rockfish.

Comments: A conservation group recommended that NMFS reevaluate its conclusions regarding the effects of fishing on EFH in a second draft EIS. The commenter said a second draft EIS should not rely on MSST as a standard for evaluating fishery effects, and instead should focus on habitat features that likely provide functions to managed species and infer that these habitat features are linked to productivity of managed species.

Response: NMFS disagrees that a second draft EIS is necessary under NEPA. The final EIS incorporates many revisions in response to public comments on the draft EIS and the peer review conducted by the Center for Independent Experts, but these revisions are not substantial changes that warrant preparation of a second draft EIS. As discussed above, the evaluation of the effects of fishing on EFH considered other information besides stock status relative to MSST to assess the consequences of habitat alteration for managed species. The analysis also considered published literature regarding the habitat requirements of managed species, time series of stock status relative to changes in fishing effort, and the professional opinions of NMFS experts in the biology and stock structure of the various species. Appendix B to the final EIS clarifies this point and discusses in detail the information NMFS used to reevaluate the effects of fishing on EFH based on public comments and the Center for Independent Experts review. NMFS did not have evidence to indicate direct habitat linkages to feeding, spawning/breeding, and/or growth to maturity for managed species, and the information NMFS analyzed did not support inferring that a certain amount of habitat disturbance yields a proportional decrease in productivity of managed species.

Comment: A federal environmental agency said the EIS needs to identify tribal resources, if applicable, and assure that treaty rights and privileges are addressed appropriately.

Response: Alaska Native groups are recognized as Indian tribes under Executive Order 13175, and compliance with that order is addressed in Appendix I. During the development of the EIS, NMFS encouraged Alaska Native participation in numerous public meetings. These meetings were held in various locations throughout Alaska, including small communities, to ensure ample vetting to Alaska Native groups and to receive their input. Alaska Natives testified at some of those meetings. Furthermore, the Council includes an Alaska Native representing the Community Development Program (a program specifically designed to benefit Alaska Natives) as a voting member. NMFS will continue to work with Alaska Native groups during implementation of the EFH provisions of Council FMPs.

Comments: A federal environmental agency said the draft EIS does not disclose what efforts NMFS and the Council took to ensure effective public participation, particularly from low income and minority communities. The commenter also suggested moving the section that addresses environmental justice requirements (Executive Order 12898) from Appendix C into the main body of the EIS, with a corresponding reference in the Table of Contents.

Response: Appendix A describes the scoping process NMFS used to obtain public input early in the planning of the EIS. As noted above, throughout development of the EIS NMFS sought comments from all interested parties by publishing notices in the Federal Register, holding numerous public meetings, and using the Council’s paper and electronic mailing lists to inform the public of opportunities for input. Many low income and minority communities engaged in the fishing industry sent representatives to Council meetings, some of whom testified on EFH issues at various points during the development of the EIS.

The EIS addresses compliance with applicable laws and other requirements in Appendix I, which is clearly identified in the Table of Contents. Appendix I references the more detailed evaluation of effects related to environmental justice that appears in Appendix C. NMFS does not agree that the environmental justice section needs to appear in the main body of the EIS versus an appendix.

Other Comments

Comment: One commenter suggested that the Division of Forestry within the Alaska Department of Natural Resources should be a cooperating agency for the development of the EIS. To justify the request, the commenter criticized the discussion of the Alaska Forest Resources and Practices Act and associated management practices in the draft EIS.

Response: NMFS disagrees that the Division of Forestry should be a cooperating agency, but NMFS met with Division of Forestry staff and the Board of Forestry during the development of the EIS to discuss ways to ensure the EIS accurately reflects existing forest management practices related to fish habitat, including the requirements of the Alaska Forest Resources and Practices Act.

Comment: A federal agency noted that the description of salmon fishery management in Chapter 3 does not mention federal subsistence fishery management under Title 8 of the Alaska National Interest Lands Conservation Act. Department of the Interior land management agencies and the Forest Service jointly manage the harvest of salmon and other fish and wildlife species by rural residents on waters within proclamation boundaries of federal land units. The commenter recommended adding this information to the discussion of salmon management in Chapter 3.

Response: NMFS agrees and added the information to Section 3.4.2 of the final EIS.

Comment: A federal agency suggested adding a discussion of herring biology to Section 3.2.4.2, which describes other important forage fish. The commenter acknowledged that the draft EIS also discusses herring in the context of a state managed commercial fishery (Section 3.4.2.4).

Response: NMFS agrees and added the information to Section 3.2.4.2 of the final EIS.