

DRAFT FOR SECRETARIAL REVIEW

ENVIRONMENTAL ASSESSMENT,

REGULATORY IMPACT REVIEW

and

INITIAL REGULATORY FLEXIBILITY ANALYSIS

OF

AMENDMENT 2

TO THE FISHERY MANAGEMENT PLAN FOR THE

**COMMERCIAL KING AND TANNER CRAB FISHERIES OF THE BERING SEA AND
ALEUTIAN ISLANDS**

(Establish the Norton Sound Section of the Northern District of the king crab fishery as a superexclusive registration area)

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EXECUTIVE SUMMARY

The Norton Sound summer king crab fishery has a unique collection of problems which makes fishery management difficult. These problems include overcapitalization, short seasons, high management costs, non-achievement of guideline harvest levels (GHL), and a failure to meet the goals and objectives of the Bering Sea crab FMP and the Magnuson Act. This fishery has the smallest biomass and GHL in the Bering Sea/Aleutian Island crab fisheries. Historically, the fishery has been characterized by years with low levels of participation and fairly high catch rates followed by years with high levels of participation and low catch rates. Lately, a combination of factors has led to high participation which is expected to continue into the future. These factors are based primarily on the overcapitalized crab fleet and on participants' efforts to establish catch histories in the event individual fishing quotas (IFQ) are instituted.

The Norton Sound summer king crab fishery was established by the Alaska Board of Fisheries in 1977 at the request of local residents. This was an attempt by local residents to broaden their fishery base. The region has a 35% unemployment rate and median household income of around \$16,000. Prior to 1993 only a few local residents participated in the fishery. Most believed their limited catching capacity was greatly exceeded by the larger crab vessels, they had difficulty finding a market for their crab and, at least recently, that the investment in crab pots was not justified by a four day or less fishery. Traditional salmon and herring fisheries in the region have failed lately and there are currently few viable fisheries remaining. The 1993 king crab fishery represented the largest fishery in the region in terms of income.

In 1989 and 1990 the fishery lasted four days or less. In 1991 the fishery was not opened because the managing agency, the Alaska Department of Fish and Game, did not believe that adequate management could occur given the small GHL and the available fleet effort. When it was opened again in 1992 there was a GHL of 300,000 pounds and a new limit of 100 crab pots per vessel limit. A total of 27 mostly large vessels, fishing 2,635 pots, registered to participate in the fishery. This was the second highest recorded fleet/gear effort experienced. Managers, estimating expected catch rates based on historical performance, pre-announced a two day fishery. When the fishery closed only 26% of the available crab had been harvested. Once closed, a combination of an already expended management budget and large fleet/gear effort focused on the remaining portion of a small GHL posed an unacceptable resource threat to reopen.

Prior to the 1993 season, the Alaska Board of Fisheries instituted numerous management measures to conserve the resource and allow fair harvest sharing opportunities. These included area closures, pot limits, and season adjustments. More recent management changes further restrict pot limits to 50 for vessels over 125' and 40 for vessels under 125', change the season opening date to July 1 from August 1, and designate the fishery as superexclusive. This latter measure was rejected by the Secretary of Commerce after the season began. However, industry confusion was such that the 1993 fishery occurred as if it were a superexclusive fishery. A total of 14 vessels participated in this fishery, all of which were under 100' and all but two under 50'. This fishery lasted almost two months and 98 percent of the allowable harvest was achieved.

Two management alternatives to the status quo are considered to remedy the aforementioned problems for this unique area: superexclusive registration and exclusive registration. The current fishery is nonexclusive and any vessel can participate in it regardless of participation in other crab fisheries. The effect of superexclusive registration would be that vessels participating in this fishery could not participate in any of the other king crab fisheries managed under the federal crab FMP. Additionally, vessels fishing for king crab in Norton Sound could not fish in any other king crab fisheries off the State. This action will effectively limit participation by the most highly mobile large crab vessels resulting in a fishery consisting of smaller, less mobile vessels. Choosing exclusive registration would prevent vessels from participating

in other exclusive king crab fisheries such as Bristol Bay but would not eliminate vessels from participating in nonexclusive fisheries such as Adak and the Bering Sea. Thus, unless the Adak red king crab fishery is also designated as exclusive, there is no means of forestalling participation by much of that fleet in Norton Sound and not achieving biological and utilization goals.

The major difference between the alternatives is who will participate in the fishery: either primarily large, Bering Sea crab vessels or smaller, possibly more regionally based vessels. The effects of who participates include how long the seasons will last, how difficult monitoring will be, what the ex-vessel revenues will be, what new markets for crab might be developed, and which communities will benefit from income and services associated with the fishery. None of the alternatives considered are likely to significantly affect the quality of the human environment. Likewise, none of the alternatives would directly affect the amount of crab available for harvest, nor would other fishing activities change significantly in a manner that would affect the biological or physical environment. However, the greater the fleet/effort combination, such as that expected under exclusive registration or, most certainly under status quo, the more likely to under or over harvest the GHL, similar to pre-1993.

The large vessels that participate in the Norton Sound summer fishery gain only a small percentage of their annual crab landings from this fishery. The primary fisheries for these vessels are Tanner crab fisheries and Bristol Bay red king crab. The small vessels that participated in 1993 are different from this in that most had limited fishing activity in 1992, in part due to local herring closures, and none participated in shellfish fisheries that year.

In 1992, 27 large vessels participated and 70% of the permit holders were from Washington. Prior to 1993, all of the large vessels either process the crab onboard or delivered it to processors in the Pribilofs or Dutch Harbor. They bought few services or supplies in the Nome area. In 1993, 14 small vessels participated and 64% of the primary permit holders (captains) were from Alaska. All of the smaller vessels provisioned out of Nome and many of the fishermen were from the region or worked on vessels stored in the region. In addition, a new fresh market for summer king crab was developed and resulted in higher ex-vessel prices than that received for crab that are processed and frozen. Local residents are maintaining plans to develop this market even further in coming years. Most of the fishermen on the small vessels are expected to be unemployed if they do not participate in this fishery. The infusion of employment and income from the 1993 small vessel fishery was significant in the Nome area.

As part of the analysis, a linear model was developed to determine net revenues from the fishery after deducting major operating expenses: fuel, bait and crew shares. When the number of participants are estimated, the model estimated the season length. The model was tested by back casting the 1992 and 1993 seasons. While 14 vessels participated in 1993, several had very few days fishing and correspondingly low landings resulting in a "full time" fleet of 9 vessels. Therefore, the model was adjusted with due consideration given to actual (rather than average) participation rates, weather, and differences in vessel performance. The results were similar to the actual season lengths. Three scenarios of future fleet participation under the alternatives were modeled and the results compared. A fleet composed of 27 to 29 mostly large vessels was predicted to result in a 6 day fishery with net revenues of about \$6,250 per vessel. A fleet of 20 small vessels was expected to result in an 11 day fishery with net revenues of about \$10,500 per vessel. If revenues increase due to expanded markets for fresh crab, the small vessels' revenues would increase under either scenario. The small vessels are predicted to be more economically efficient because they use less fuel and soak their pots longer which results in correspondingly higher catch per pot.

The switch to superexclusive registration would create a management environment discouraging participation by most if not all large crab vessels and to fishing by all catcher/processors. The

management tradeoffs for this would be unbiased reporting of catch per pot, bycatch, and deadloss from the observed portion of the fleet versus accurate daily catch reporting of all harvest. The improved accuracy of a slower paced fishery allowed, and is expected to continue to allow, fuller attainment of GHLS. Better daily reporting is possible because the smaller vessels rarely hold their crab in live tanks for extended periods but deliver after each trip. In addition, a season lasting a month or less and involving no at-sea enforcement, such as that predicted for superexclusive registration, would reduce administrative and enforcement costs.

Overall, superexclusive registration is expected to result in greater benefits to the nation than either the status quo or exclusive registration. These benefits are at the cost of a transfer of participation and income from a predominately Washington based large vessel fleet to a predominately Alaskan based small vessel fleet. Norton Sound crab contributed no more than 0.7% to any of the 26 vessels yearly crab landings for 1992 and no more than 1.6% of the total for any of the C/Ps in 1990. Likewise, participation in the fishery for more than one year is low, with only one vessel in 1992 having participated in 1990. Therefore, neither individual vessels nor participants in the pre-1993 fleet were dependent on this fishery in terms of year to year participation or landings within any one year.

1.0 INTRODUCTION

The Bering Sea and Aleutian Islands crab fisheries in the U.S. Exclusive Economic Zone (EEZ) are managed under the Fishery Management Plan for the Commercial King and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands (BSAI). The fishery management plan (FMP) was developed by the North Pacific Management Council (Council) under the Magnuson Fishery Conservation and Management Act (Magnuson Act), as a cooperative State of Alaska (State)-Federal FMP in an attempt to avoid State-Federal coordination problems that were encountered in the previous king and Tanner FMP's. The BSAI king and Tanner crab FMP was approved by the Secretary of Commerce (Secretary) and became effective in 1989. Joint management defers much of the regulatory authority to the Alaska Board of Fisheries (Board) (FMP, Appendix A and C).

The BSAI crab FMP contains three categories of management measures. Category 1 contains measures which can only be implemented by the Council and Secretary. Category 2 contains a list of measures frameworked in the FMP and delegated to the State. Category 3 contains a list of management measures deferred to the State. Items in categories 2 and 3 retain Secretarial oversight.

Actions taken to amend Fishery Management Plans or implement other regulations governing the crab fisheries must meet the requirements of Federal laws and regulations. In addition to the Magnuson Act, the most important of these are the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), Executive Order (E.O.) 12866 and the Regulatory Flexibility Act (RFA).

NEPA, E.O. 12866 and the RFA require a description of the purpose and need for the proposed action as well as a description of alternative actions which may address the problem. This information is included in Section 1 of this document. Section 2 contains information on the biological and environmental impacts of the alternatives as required by NEPA. Impacts on endangered species and marine mammals are also addressed in this section. Section 3 contains a Regulatory Impact Review (RIR) which addresses the requirements of both E.O. 12866 and the RFA that economic impacts of the alternatives be considered. Section 4 contains the Initial Regulatory Flexibility Analysis (IRFA) required by the RFA which specifically addresses the impacts of the proposed action on small businesses.

This Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility Analysis (EA/RIR/IRFA) addresses the change in management of the Norton Sound summer king crab fishery from non-exclusive registration to some form of exclusive registration.

1.1 Purpose of and Need for the Proposed Action

The Norton Sound summer king crab fishery has a unique set of problems that makes fishery management difficult. This EA/RIR/IRFA explains these problems and analyzes possible alternative solutions.

The problems are associated with conservation and management of a fishery with a small biomass, small GHL and a stock on the edge of its geographic range which makes it biologically sensitive.

- A. Too much effort creates a fishery too short to manage effectively.
- B. High management and enforcement costs.
- C. Lack of management precision creates over- and under-harvest of GHL.
 1. Overharvest can jeopardize the stock and threatens local subsistence fishery.

2. Underharvest underutilizes the fishery resource and fails to achieve optimum yield.
- D. Vessel safety under limited duration fisheries.
- E. Goals and objectives of FMP are not being met.

Over the past 15 years, highly efficient crab fishing vessels in excess of that required to harvest a small available biomass have stifled proper management. The fishery is historically one of only two small crab fisheries open during the summer and has attracted numerous crab vessels. In addition, the quest for catch history for future IFQ's has recently encouraged vessel owners to fish in areas they normally wouldn't fish. These factors, in combination with one of the smallest harvest quotas in the Bering Sea, nearly an order of magnitude below the next smallest fishery, have led to a nearly unmanageable fishery. This excess fishing capacity results in the entire quota being harvested in two to three days and has frustrated management attempts to accurately achieve the GHL, leading to habitual over or underharvest. Management costs are high relative to other BSAI crab fisheries. The State has placed a high priority on managing this fishery by expending over \$0.05 per pound in administrative and enforcement costs. Short fishing periods have also meant that all vessels had to fish, regardless of possible dangerous weather conditions. If a skipper chose not to fish due to extreme weather, the vessel would not receive that year's catch history. The rushed nature of the fishery has also precluded responsible stewardship for stock conservation required by the crab FMP.

1.2 History of the Issue

A thorough description of the management and history of this fishery is found in sections 1.4.2 and 1.4.3. This description forms the basis for the proposed amendment.

1.3 Alternatives Considered

This analysis considers three management alternatives to address the current situation in the Norton Sound king crab fishery. Several other alternatives were considered and ultimately rejected during preliminary analysis as unworkable or overly burdensome. These included a further reduction of the pot limit, superexclusive registration in Norton Sound under Category 2, and trip limits. Limited access was rejected since such a management regime is already under analysis by the Council. If approved by the Council, limited access is scheduled to be implemented no earlier than 1996. Three alternatives are fully analyzed in this document: no action, superexclusive registration in Category 1, and exclusive registration.

1.3.1 Alternative 1: Status Quo

This alternative would institute no new management measures in the Norton Sound king crab fishery. The Norton Sound king crab fishery would continue to be managed by the State of Alaska. Existing regulations (more fully described in Section 1.4) include a guideline harvest limit (GHL), vessel size specific pot limits, a July 1 fishery opening date, closed area within 15 miles of shore and nonexclusive registration.

1.3.2 Alternative 2: (Council's Preferred Alternative) Superexclusive Registration for Norton Sound King Crab in Category 1

This alternative would add superexclusive registration for the Norton Sound king crab fishery as a management option to Category 1 of the BSAI crab FMP. The Norton Sound king crab fishery would be designated as the only superexclusive registration area. In addition, those management measures already existing would remain effective. Therefore, any vessel participating in this fishery would not be

able to participate in other statewide or BSAI king crab fisheries, such as Adak, Bristol Bay, Dutch Harbor, Pribilof, St. Lawrence, or St. Matthew during that registration year.

1.3.3 Alternative 3: Exclusive Registration in the Norton Sound King Crab Fishery

This alternative would recommend designating Norton Sound as an exclusive king crab registration area. Currently, this is a category 2 management measure option in the BSAI crab FMP. Therefore, by choosing this alternative the Council would be recommending that the Board change the registration status of the area. Should this alternative be chosen by the Council and implemented by the Board, any vessel fishing in the Norton Sound king crab fishery would not be able to fish in any other exclusive king crab fishery, but would be able to fish in any nonexclusive area for king crab. At this time all king crab areas in the BSAI are nonexclusive except Bristol Bay and Dutch Harbor, which are exclusive.

1.4 Background

This section presents background information necessary to understand the problem and the effects of the alternatives. Three types of background information are presented: environmental, general BSAI fisheries, and Norton Sound fisheries specific.

1.4.1 Biological and Physical Environment

1.4.1.1 Physical

The Norton Sound Section of the Bering Sea king crab fishery includes waters east of 168°W. long., north of the latitude of Cape Romanzof (61°49'N. lat.) and south of the latitude of Cape Prince of Wales (65°36'N. lat.). Major characteristics of the physical environment are described in the FMP, Appendix D and the Environmental Assessment for this plan (1989).

Muench *et al.* (1981) described Norton Sound as follows: a shallow, high-latitude embayment extending eastward from the northern Bering Sea and forming an indentation in the central west coast of Alaska. Depths vary from less than 10 m in the southern portion to more than 30 m in a trough-like feature which trends east-west in the nearshore region just south of Nome; average depth in the sound is about 20 m. The bottom surface is characterized by sandy silt (Yukon mud) originating from the Yukon River that has been deposited in the Norton Sound. This sediment forms deposits tens of centimeters thick in parts of central Norton Sound and several meters thick off the present subdelta and around the margins of Norton Sound. In places the silty mud contains thin beds of shells and pebbles (Nelson, *et.al.*, 1981). Two promontories extend into the sound about two-thirds of the way toward its eastern end, Cape Darby from the north and Stuart Island from the south (Figure 1).

Extreme seasonal variability characterizes Norton Sound. The sound is ice-free and air temperatures are well above freezing during the three-month summer (June-September). By November, air temperatures drop well below freezing and ice formation has typically begun along the northern shore, with first ice forming on the surface in Norton Bay at the northeast corner of the sound. By mid-December the entire Sound is more or less ice covered. Breakup of ice typically occurs in April or May. The higher temperatures and increased discharge from the rivers trigger ice breakup along the coast. Northward-flowing water currents, aided by offshore winds, carry ice away from the delta. By June the high sediment influx from the Yukon River dominates the coastal processes in the delta region (Ray & Dupre, 1981). The spring Yukon River run-off and concurrent ice melt creates a freshwater lense in the semi-enclosed Norton Sound. The occurrence of this lense and its prolonged effects during the commercial king crab fishery can contribute substantially to deadloss and handling mortality. During open water periods

the area is susceptible to poor weather conditions primarily in August. These conditions are extreme enough to force small vessels to shore.

1.4.1.2 Biological

A complete summary of the fauna of Norton Sound can be found in Gusey (1979). This includes a description of fish, marine mammals, and birds. The major commercial finfish fisheries of importance in Norton Sound are: chum salmon (*Oncorhynchus keta*), pink salmon (*O. gorbuscha*), and herring (*Clupea harengus pallasii*) (R. Otto, pers. comm.). The economic opportunities for commercial fishermen in these fisheries are severely limited due to either depressed stocks (chum salmon), environmental conditions (herring) or lack of consistent market availability (pink salmon and herring). There are also king salmon (*O. tshawytscha*) and silver salmon (*O. kisutch*) fisheries of moderate importance.

The Norton Sound red king crab stock (*Paralithodes camtschatica*) is identified as a separate biological and geographical subgroup of red king crab in the Bering Sea. This stock is thoroughly described in Powell *et al.* (1983). Size at maturity is smaller than other BSAI red king crab stocks and the crabs themselves are distinct in appearance. This stock is currently only 1/3 of its legal male crab virgin biomass. (Stocks were monitored 1976-1991 by National Marine Fisheries Service (NMFS) trawl surveys and 1980-1985 by Alaska Department of Fish and Game (ADF&G) pot surveys). The stock is concentrated in a small geographical area adjacent to Nome. The legal male population available for commercial harvest is estimated at 3 million plus pounds. With controlled effort and minimization of deadloss and handling mortality, this stock is capable of providing small but continuous opportunity for a subsistence fishery as well as sustainable winter and summer commercial fisheries. The NMFS trawl survey data indicates the Norton sound red king crab population is stable and gradually rebounding (Lean and Bue, 1993). The Norton Sound red king crab stocks are considered to be depressed in comparison to historical levels, but are considered to be stable at the present low population levels and with the conservative management exploitation rates. Blue king crab (*P. platypus*) and Tanner crab (*Chionoecetes opilio*) are occasionally encountered in outer Norton Sound (approximately west of Sledge Island) but have never been a large component of research, subsistence or commercial catches (R. Otto, pers. comm.).

1.4.2 Description of Bering Sea/Aleutian Islands Crab Fisheries

Within the BSAI area, brown, red and blue king crab are harvested. The BSAI king crab fisheries currently consist of two types of registration areas: nonexclusive and exclusive. The nonexclusive areas are Adak and the Bering Sea. The Bering Sea area includes the Pribilof district and the Northern district which has three sections, St. Matthew, Norton Sound and Saint Lawrence, (Figure 2). The exclusive areas are Bristol Bay and Dutch Harbor (FMP, Appendix E and 5 AAC 34.020(a); except that 5 AAC 34.020 (a)(1), designating Norton Sound as superexclusive, has been superseded by Secretarial order with regard to Federal waters of the Norton Sound section). Vessels may fish in only one exclusive registration area and in any nonexclusive registration areas during the registration year. Different pot limits are established for each of the Bering Sea and Bristol Bay fisheries (ADF&G 1993 Commercial Shellfish Regulations).

Based on historical population levels, all BSAI king crab fisheries are considered to be depressed. For example, the Dutch Harbor red king crab fishery has been closed since 1983. The open fisheries are exploited by an overcapitalized, mostly large vessel, fleet consisting of catcher processors and catcher vessels. These vessels, numbering up to 332, are highly mobile and capable of moving between crab registration areas and quickly harvesting the quotas from any of the BSAI king and Tanner crab fisheries (Tables 1 and 4 - 11).

With the exception of the Norton Sound king crab fishery, the BSAI king and Tanner crab fisheries open in the fall. Some of these fisheries, such as the St. Matthew area fishery, last only a few days. Others, such as the Adak brown king crab fishery, may continue as long as nine months (Tables 4-11). These fisheries vary in size from small, (Norton Sound, 200,000-300,000 pounds) to medium (St. Matthew and Pribilofs, 1 to 3 million pounds), to large (Bristol Bay, more than 16 million pounds), (Tables 1 and 4 - 11).

The Norton Sound section of the Northern district in Area Q has a shellfish fishery consisting only of red king crab. Red king crab have been used for subsistence purposes by local residents prior to historic times. Results of the population assessment surveys conducted for red king crab in Norton Sound are summarized in Table 3. Data from population studies, winter research studies, mining impact studies, and from 13 commercial fishing seasons have greatly increased knowledge of the Norton Sound king crab (FMP Appendix F; Stevens 1992).

1.4.3 Description of the Norton Sound Red King Crab Fishery

There are three king crab fisheries in the Norton Sound section: the subsistence fishery and the winter and summer commercial fisheries. Each are described below.

1.4.3.1 Subsistence Fishery

Red king crab are utilized by Norton Sound residents for subsistence use mainly during the winter. Annual harvests range from 5,000 to 10,000 crab (Table 2). Fishing occurs through holes or cracks in the ice with handlines and pots. Several factors impact fishing success: the crab population and recruitment levels, ice and weather conditions, and the near shore winter distribution of crab. The winter crab fishery depends on extreme weather conditions and without these severe conditions, shorefast ice becomes unstable and crab pots may be carried away or fishers are unable to cross open leads in the ice to get to their pots. Low air temperatures, wind and drifting snow are the primary factors that determine effort levels in the winter crab fisheries, rather than crab densities.

1.4.3.2 Winter Commercial Fishery

A winter commercial fishery exists in the Norton Sound Section from December 15 - May 15. The fishery typically takes place near the city of Nome. This fishery is conducted through the ice using crab pots and hand lines. The crab are most often sold live to a fresh market, both locally and in Anchorage. During the mid-winter months, commercial fishermen find it difficult to keep live crab from freezing in the same environmental conditions that the subsistence fishermen experience, above. Although preferred by Nome residents, whole fresh frozen crab has not been accepted by other markets. Recent harvests ranged from a few crab to nearly 10,000 (Table 2).

1.4.3.3 Summer Commercial Fishery

1977-1992 Fishery

Prior to 1977, there was no commercial king crab fishery in Norton Sound. Local residents, who participated in the winter and summer subsistence harvest of king crab, petitioned the Board to open commercial fishing in their area. It was opened in 1977. Seasons, size limits and harvest guidelines were established for the Nome section summer commercial fishery. Public testimony indicated that local Nome residents planned on participating in the summer fishery to provide income in addition to the limited herring and salmon opportunities available. The Board allowed an experimental commercial fishery in both

the winter and summer of 1977 and an open summer fishery in 1978. Local fishers tried to participate in the summer fishery, but were greatly overwhelmed by the disparity of efficiency of the Bering Sea crab fleet, (Lean pers. comm.). During the first few years of the fishery at least three local vessels participated in the fishery. However, they were unable to catch crab in quantities large enough to entice a larger vessel or processor to buy their crab.

In 1977, seven vessels participated and landed over 520,000 pounds in 60 days. In 1978, eight vessels participated in a 60 day fishery, landing over 2 million pounds of king crab. By the next year, the 3 million pounds GHL was landed in 16 days when effort increased to 34 vessels. In 1979, changes in regulations set subsistence and winter commercial harvest levels, and limited the amount of harvest available to the summer commercial fishery. During this period the public also proposed establishing the entire Bering Sea registration area as exclusive. Bristol Bay and Dutch Harbor were already exclusive registration areas at that time. The local proposers noted that the original justification for the nonexclusive designation of the Bering Sea registration area (foreign allocation) was no longer applicable as the domestic crab fleet was fully utilizing crab resources from this area. The need to control the rapidly expanding and highly mobile Bering Sea crab fleet, capable of catching the existing harvest quotas from this area in very short periods of time then moving to other crab areas in the state, was also an expressed concern. Because the Bering Sea registration area included the Pribilofs and St. Matthew sections, the Board denied these Norton Sound proposals. Instead, it enacted regulations reducing the summer fishery exploitation rate and closing the area fifteen miles seaward from shore in an attempt to protect females and sublegal males, and to insure the availability of crab to the nearshore winter fisheries.

The 1979 season began a cycle of fluctuations of vessel participation: a few vessels experiencing high catches in one year would attract additional vessels the following year; the second year catches, spread over a larger fleet, would be relatively poor; the following year fewer vessels would participate and vessel averages would again increase (Table 1).

In 1981 the Board enacted a 15 mile closure along the Norton Sound coast. This was to protect sub-legal and female crab which congregated near shore and to assure winter fishery availability. Also at this time the season start date was changed from July 15 to August 1. The change of start date was the final reason for local vessels to leave the fishery since the August weather in Norton Sound is often too rough for the small, open vessels used by local fishermen.

In 1982, additional regulations to assure subsistence availability reduced the allowable harvest of the summer fishery to one half of the available harvestable excess. In that year, a three day fishery produced only 230,000 pounds. Over the next few years, the reduction of the allowable harvest coupled with inadequate markets on the fishing grounds caused a shift from a predominantly catcher fleet to a catcher processor (C/P) fleet. Participation and season length, while remaining below historical levels, continued to fluctuate. Overall the season has remained too short to manage effectively.

Recognizing that king crab stocks were not responding throughout the BSAI, in 1992 the Board implemented more conservative exploitation strategies by setting pot limits in some of the Bering Sea crab fisheries (Tables 1 and 4-9). In Norton Sound, a 100 pot limit was established in 1992. This restrictive limit was prompted by the closure of the fishery in 1991 when ADF&G determined that, due to excessive effort, the fishery could not be opened without possibly damaging the Norton Sound king crab stocks (Lean and Bue 1992). Even with this restrictive pot limit, 27 vessels participated in the 1992 fishery resulting in the second highest recorded number of pots fished in any season. Faced with this amount of effort, managers, using the last six year catch per pot average, pre-announced a two day season.

The result of the intense fishery in Norton Sound in 1992 was that optimum yield (OY) was not achieved from the resource. Approximately 76,000 pounds were harvested from a 300,000 pound GHL. Deadloss of about 1,800 pounds occurred when some vessels entered freshwater lenses in Norton Sound and contaminated their holding tanks. Reopening the fishery considering the excessive effort present on the grounds was not an option. The average gross revenues for the 27 vessels that participated, based on average ex-vessel value of \$1.75/lb, was less than \$5,000. Only seven (26%) of the 27 vessels that participated in the fishery were manned by Alaskan resident permit holders and only one of these was a local resident (Table 16).

The two day 1992 fishery, with its preannounced closure, was the most extreme of the past three annual fisheries; the others being 1989 and 1990. In both those years the fishery lasted less than 4 days. In 1989 the GHL was exceeded by 25%. In 1990 the fishery was closed after 4 days with the GHL almost completely taken; a feat made possible because only four vessels participated and each was a catcher/processor with an observer onboard who made daily reports, (Table 12). The 1992 fleet was composed primarily of catcher vessels who do not carry observers. As noted earlier in the analysis, the 1991 fishery was not opened since effective management was not thought to be possible.

The management, enforcement and administrative costs for this fishery are very high relative to the size of the GHL. ADF&G budgets have routinely exceeded \$0.05 per pound compared to costs of less than \$0.01 per pound in other BSAI crab fisheries. Management responsibilities include tank checks, observer briefing and debriefing, daily reporting of harvests, observations of landings, and aerial surveillance. In addition, at-sea processors are required to fund observers, a significant cost in 1990 when all four vessels were C/Ps.

1993 Fishery

In the fall of 1992, Norton Sound citizens again appealed to the Board to make Norton Sound a superexclusive area for king crab under the Category 2 provision of the FMP for exclusive registration (proposal 312). During the February 2-10, 1993, shellfish meeting, the Board took three concurrent actions affecting the Norton Sound fishery and its management: 1) the pot limit was reduced from 100 pots for all vessels to 50 pots for vessels over 125 feet overall length and 40 pots for vessels under 125 feet; 2) moved the season opening date from August 1 to July 1; and 3) designation as a superexclusive registration area. Each of these actions was intended to slow the fishery and allow for inseason management. The Board's understanding was that superexclusive registration was a subset of exclusive registration and was a frameworked management tool under category 2 of the FMP, available to the State.

The Alaska Crab Coalition (ACC) appealed the Board's decision. The FMP-designated Crab Interim Action Committee, (CIAC), met June 18, 1993, to discuss the appeal. After review of the information, NOAA General Counsel's recommendation to the Secretary was that superexclusive was not provided for within the exclusive registration section of Category 2 of the FMP.

The crab fishery began July 1 with superexclusive registration in effect. On July 15, the Secretary published an interim rule which superseded the use of superexclusive registration by the State. After the Secretary's action, ACC requested the Department to close the Norton Sound fishery until some of their fleet could gear up and participate in the fishery. On July 21, 1993, the State appealed the Secretary's ruling, stating that it believed that superexclusive designation was in fact an available option within the FMP. This appeal was later denied. Meanwhile, vessels which might have fished in Norton Sound in 1993, did not do so because of the possibility that the Secretary might rule in favor of the State. If this happened, the area would have remained superexclusive and the boats registered there could not have

fished in any of the larger king crab fisheries in the Bering Sea. This uncertainty about the area's status created a de facto superexclusive area in 1993.

The 1993 Norton Sound commercial king crab season opened at noon on July 1. The commercial crab fleet numbered 14 small catcher vessels, composed of herring and salmon gillnetters and salmon seine vessels, the largest of which was 86 feet. A catcher/processor was on the fishing grounds to take crab deliveries but did not fish. Nine (64%) of the 14 vessel permit holders were Alaskan residents and 4 (28%) were local residents (Table 15). The GHLL of 340,000 pounds equated to an exploitation rate of approximately 10% of the total legal male population, the rate established by the Board in 1988.

The superexclusive registration aspects, along with a lowered pot limit, reduced the Norton Sound fishery effort dramatically in 1993. Participation declined almost 50% from the 27 boats which fished in 1992, but is more dramatic in the actual reduction in the overall length of the vessels participating in the fishery, (Tables 15 and 16). The Board, anticipating a longer season with a superexclusive designation, extended the fishing season by opening the area a month early, on July 1. Other small vessels which might have considered participating in this fishery had to choose between the more lucrative Bristol Bay salmon fishery or a more protracted crab fishery.

Due to the nature of the small vessel fleet, all vessels made day trips and all landings were easily monitored. Therefore, after the fishery opened, managers relaxed the 15 mile closure line by five miles. This decision allowed access to adult male crabs that had not yet migrated outside of the closed area.

The 1993 season was open for 58 days, a dramatic increase from the 1992 season and comparable to the early history of the fishery (Table 1). The fishery was closed by emergency order (the normal means of closing BSAI crab fisheries) when the harvest of the 340,000 pound GHLL was projected to be reached. This is the first commercial summer crab season during which a significant portion of the harvest passed through Nome. Two local buyers sold 11,000 lbs on the fresh market in Nome and Anchorage. In the past, fishing vessels either delivered their catches to the floater or catcher processors, or to shoreside facilities in the Pribilof Islands or Dutch Harbor.

The issue of superexclusive registration was brought before the Council in September 1993. At that time the Council voted to have superexclusive registration for Norton Sound analyzed as an FMP amendment.

2.0 NEPA REQUIREMENTS: ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

An environmental impact statement must be prepared for major Federal actions significantly affecting the quality of the human environment. Determination of significance requires consideration of context and intensity, including (1) the degree to which public health or safety is affected, (2) unique characteristics of the geographic area concerned, (3) the degree to which the environmental effects are likely to be highly controversial, (4) the degree to which effects are highly uncertain or involve unique or unknown risks, (5) the degree to which the action establishes a precedent for future actions with significant effects or represents a decision in principle about a future consideration, (6) whether the action is individually insignificant but likely to result in cumulatively significant impacts, (7) the degree to which the action adversely affects entities listed in or eligible for listing in the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural or historic resources, (8) the degree to which threatened or endangered species, or their habitat, are adversely affected, and (9) whether a violation of Federal, State or local law for environmental protection is threatened. In addition, consistent with NOAA Administrative Order 216-6, determination of significance also requires evaluation of whether any fishery management plan or amendment may reasonably be expected to (1) jeopardize the long-term productive capability of any stocks that may be affected by the action, (2) allow substantial damage to the ocean and coastal habitats, (3) have a substantial adverse impact on public health or safety, (4) adversely affect an endangered or threatened species or a marine mammal population, or (5) result in cumulative adverse effects that could have a substantial effect on the target resource species or on any related stocks that may be affected by the action.

2.1 Environmental Impacts of the Alternatives

The environmental impacts generally associated with crab fishery management actions are effects resulting from (1) harvest of crab stocks which may result in changes in food availability to predators, changes in the population structure of target crab stocks, and changes in community structure; (2) changes in the physical and biological structure of the benthic environment as a result of fishing practices, e.g., effects of crab fishing and processing discards; and (3) entrapment of non-target organisms in active or inactive fishing gear. None of the alternatives considered would result in changes to the amount of crab harvested in the Norton Sound king crab fishery. Therefore, there is no basis to conclude that any effects on the environment would be different under any of the alternatives considered.

2.1.1 Alternative 1 Status Quo

Under this alternative, no new management measures would take place. Existing regulations include a guideline harvest limit, vessel size-specific pot limits, and nonexclusive registration. It is anticipated that large vessels from the Bering Sea crab fleet would participate in the Norton Sound fishery, as well as elsewhere in the BSAI. The fishing season would be relatively short (2 days in 1992). To the extent that a shorter fishing season causes less precise quota management, some overharvesting could occur. The faster pace of the fishery could result in increased deadloss (due to handling) and increased handling mortality of females and juveniles (due to less time for selective gear placement). Fewer crab would remain in the ecosystem to provide food for predators or, in turn to consume other prey species. Several animals prey on crab, including red king crab. Marine mammals that prey on crab include sea otter, walrus, and harbor, spotted and bearded seals. Limited data show that crab apparently contribute only a minor part of their diets. Several fish species, (Pacific cod, halibut), are known to prey on juvenile crab.

The incidental harvest of non-target species in this fishery is minimal to non-existent and could occur with equal probability under any of the alternatives. Species caught incidentally have included: halibut,

flounder, sculpin, rockfish, starfish. None of the alternatives adversely effect the salmon, herring, and halibut fisheries in Norton Sound.

Ghostfishing refers to what happens when lost fishing gear continues to trap or entangle fish or shellfish resulting in subsequent mortalities (Stevens *et al.*, 1993). The total number of pots fished per year in Norton Sound has ranged from 360 to 3583. The percent of lost gear is unknown but presumed to be very low due to the shallow depths of Norton Sound. Alaska Commercial Shellfish Regulations (5 AAC 39.145) require that each pot have at least one biodegradable escape panel (cotton twine or galvanic timed release device) therefore this adverse impact is reduced. Any impact of ghostfishing on crab or other stocks is considered to be negligible and would occur equally under any of the alternatives.

2.1.2 Alternative 2 Super-Exclusive Registration for Norton Sound King Crab in Category 1

The Norton Sound king crab fishery would be designated a super-exclusive registration area in addition to those management measures already existing. The State would implement this measure by promulgating State regulations applicable to vessels registered under the laws of the State. Any vessel participating in this fishery would not be able to participate in other BSAI king crab fisheries (Adak, Bristol Bay, Pribilofs, or St. Matthew). Given the biogeographic considerations of Norton Sound, populations at the extreme geographic limits of a species' range are likely to be vulnerable to overharvest and should be managed more restrictively to maintain minimum spawning biomass (Kruse, 1993). Such a restriction would be realized with super-exclusive registration. It is likely that under this alternative, fewer large, highly mobile, vessels would harvest king crab in Norton Sound, resulting in a relatively longer fishing season. A longer fishery could result in decreased deadloss, increased soak time of pots (resulting in pot "selectivity", smaller sub-legal crab have opportunity to escape), and reduced handling mortality of females and juveniles. Assuming that a longer season would promote greater management precision, the potential for overharvesting stocks would be reduced. Only those crab that are part of the harvest quota would be removed, more crab would remain in the ecosystem, providing food for other predators. This would also result in more prey species being consumed by crab. It is possible that with a longer season, a herring bait fishery could occur, but would not significantly impact the local herring stock.

2.1.3 Alternative 3 Exclusive Registration

Under this alternative, the environmental impacts are not specifically known. The registration designation will impact the length of the season; a very short season is expected with a non-exclusive registration (2 days in 1992) and a longer season is expected with a super-exclusive registration (similar to the situation in 1993 where the season was 58 days). The length of the season with an exclusive designation will depend upon such factors as: registration designation in other districts and closures of other areas. One might expect the environmental impacts to be intermediate in nature to those of non-exclusive registration and super-exclusive registration.

2.2 Impacts on Endangered, Threatened or Candidate Species

Species that are listed, or proposed to be listed, under the Endangered Species Act that may occur in the Norton Sound area include: the endangered fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), blue whale (*Balaenoptera musculus*), right whale (*Eubalaena glacialis*), bowhead whale (*Balaena mysticetus*), Arctic peregrine falcon (*Falco peregrinus tundrius*), the threatened spectacled eider (*Somateria fischeri*), and the candidate Steller's eider (*Polysticta stelleri*).

A consultation pursuant to Section 7 of the Endangered Species Act concluded that the BSAI crab fisheries were not likely to adversely affect endangered or threatened species or critical habitat (October 24, 1990). A similar consultation is being pursued with the U.S. Fish & Wildlife Service regarding the short-tailed albatross and other birds that are proposed or candidates for listing under the ESA. None of the alternatives considered are expected to affect any candidate or listed species.

2.3 Impacts on Marine Mammals and Seabirds

NMFS has reviewed the potential for incidental taking of marine mammals that might result from the listed alternatives. The potential is considered to be remote. None of the alternatives considered are expected to change the amount of crab harvested or other fishing activities in a manner that would result in an affect on any marine mammal species. Under provisions of the Marine Mammal Protection Act, NMFS classified the Alaska shellfish pot and ring net fisheries, which include crab fisheries, as Category III fisheries (54 FR 16072, April 20, 1989). Category III fisheries are defined as those where existing data or knowledge on the incidental take of marine mammals by gear type, fishing methods, areas, or seasons, indicate that it is highly unlikely that any marine mammals will be incidentally taken by a randomly selected vessel in the fishery during a 20 day period. Intentional harassment of threatened or endangered marine mammals is prohibited by the Endangered Species Act. However, some harassment by fishermen likely occurs despite this prohibition. Because species listed are not likely to interact with the crab fisheries, the probability of intentional harassment related to this fishery is low.

The U.S. Fish and Wildlife Service has management responsibility for seabirds in Alaska. It has prepared an Alaska Seabird Management Plan. Most seabirds in Alaska spend about 80 percent of their lives at sea where they feed. The most numerous seabirds in Alaska are northern fulmars, storm petrels, kittiwakes, murres, auklets, and puffins. Seabirds, especially northern fulmars, have been reported to fly into crab lights at night. The effect, if any, of short or long fishing seasons under any of the alternatives would have on the amount of night time fishing is not applicable to the summer commercial crab fishery in Norton Sound considering the average daylength is 22 hours at this time of year.

2.4 Environmental Impacts on Habitat

Commercial crab processing operations in the BSAI have resulted in the discharge into the environment of a variety of solid and liquid wastes. This impact was analyzed in the EA of the FMP (1989) and determined not to be harmful to the ecosystem. There is no reason to conclude that the environmental impacts on habitat will differ under any of the alternatives.

2.5 Coastal Zone Management Act

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 Section 30(c)(1) of the Coastal Zone Management Act of 1972 and its implementing regulations. This determination has been submitted for review by the responsible state agency under section 307 of the Coastal Zone Management Act.

2.6 Conclusions or Findings of No Significant Impact

None of the alternatives considered are likely to significantly affect the quality of the human environment, and the preparation of an environmental impact statement for selection of Alternatives 2 or 3 as the preferred alternatives is not required by Section 102(2)(C) of the National Environmental Policy Act or its implementing regulations. Neither the amount of crab harvested or other fishing activities would change significantly in a manner that would affect the biological or physical environment. However, the

greater the fleet/effort combination, such as that expected under exclusive registration or, most certainly under status quo, the more likely to under or over harvest the GHL, similar to pre-1993.

3.0 REGULATORY IMPACT REVIEW: ECONOMIC AND SOCIOECONOMIC IMPACTS OF THE ALTERNATIVES

This section provides information about the economic and socioeconomics impacts of the alternatives including identification of the individuals or groups that may be affected by the action, the nature of these impacts, quantification of the economic impacts if possible, and discussion of the trade offs between qualitative and quantitative benefits and costs.

This section also addresses the requirements of both E.O. 12866 and the Regulatory Flexibility Act (RFA) to provide adequate information to determine whether an action is "significant" under E.O. 12866 or will result in "significant" impacts on small entities under the RFA. E.O. 12866 defines a "significant regulatory action" as likely to result in (1) an annual effect on the economy of \$100 million or more; (2) an adverse effect in a material way on the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities; or (3) a novel legal or policy issue. Requirements of the RFA are addressed in Section 4.

The requirements for all regulatory actions specified in E.O. 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.

3.1 Analysis of Alternative 1: Status Quo, Allowing the Norton Sound King Crab Registration Area to Remain Non-Exclusive

As a non-exclusive registration area, access to all vessels that wish to participate in the Norton Sound king crab fishery is unrestricted whether or not they have fished other exclusive or non-exclusive king crab registration areas.

The non-exclusive type registration allows unrestricted vessel participation and creates short and unmanageable derby style fishery with all the attendant problems mentioned in Section 1.1 of this document. The nature of the fleet that has participated, large, highly mobile vessels, and the fishery itself, has constrained the development of local participation in the fishery. This unrestricted fleet is capable of catching the existing harvest quotas from this area in very short periods of time, then move to other crab areas in the BSAI. Alternative 1, status quo, continues fisheries management with difficulties resulting in an over or under harvest of the stocks. The concern with chronic over and under harvest of the resource under derby conditions is more a problem of management precision when the available harvest is so small. Under such conditions, the likelihood of exceeding the overfishing level is greatly increased. This alternative also generates additional enforcement costs to ensure compliance with regulations and to meet the management objectives of ensuring conservation. In the absence of changes to the regulations, effort from the highly mobile, large vessel crab fleet is likely to remain high.

Continued interest in this small quota fishery is the result of a number of factors:

- (a) It is one of the few options available to the crab industry at this time period. Although the Adak brown crab fishery is open during this same time period, that fishery requires an expensive longline set-up. In addition, the accessible fishing grounds for Adak are located 300-2,500 miles from Dutch Harbor and are being fully utilized by a fleet of vessels that have targeted the brown king crab stocks since November of the previous year. Since the starting date of the Norton Sound fishery has been moved to July 1, some of the vessels fishing Pacific cod with modified crab pots, may find switching to Norton Sound more attractive if opportunities were appropriate.
- (b) The Council's continued interest in rationalizing the crab and groundfish fleets stimulates participation in any fishery which fishers believe could gain them catch history toward individual fishing quotas (IFQs).
- (c) The July opening may attract smaller or medium sized vessels from Dutch Harbor, other Alaska Peninsula communities, western Alaska, or Adak Brown crab vessels after that season closes. Several mid-sized vessels participated in 1993 that otherwise might not have with a later starting date.
- (d) Both the groundfish fleet and the crab fleet are overcapitalized. This is resulting in financial difficulties for many vessel owners. A common response has been for more and more vessels to participate in more and more fisheries. Therefore, it is probable that even more vessels would be interested in participating in the Norton Sound summer king crab fishery than have previously.

Should status quo management continue in the Norton Sound summer king crab fishery, it is expected to be prosecuted much as it has in the recent past. Management of the fishery is conducted conservatively with attempts (often unsuccessful) to close the fishery without exceeding the GHL. The 1992 season is an example of what may occur under the status quo fishery. Other management options from categories 2 and 3 of the BSAI crab FMP are available for Board implementation and those from category 1 of the FMP are available for Council use. Management of and participation in both the 1992 and 1993 fisheries are described in Section 1.4.3.3.

3.1.1 Season Start Date

Given a non-exclusive registration area, it is not certain how many vessels would participate in the Norton Sound summer king crab fishery. The change in season start from August 1 to July 1 might have some effect on the number of vessels wishing to participate. Other BSAI crab fisheries starting dates and their length in recent years are listed in Tables 4-11. Groundfish fisheries also occur during the year but they are becoming increasingly compressed into the beginning of the year and, for pollock, in late summer. There are few other federally managed fisheries which occur simultaneous with the Norton Sound fishery during either date. This means that many large vessels would be able to participate in the fishery. Opportunities available to traditional BSAI crabbers include salmon tendering or shipyard work, the normal activities during summer months.

Salmon fisheries in western Alaska occur primarily during July in Bristol Bay and during July and August further north. Therefore, a July 1 start date would permit fewer salmon vessels to participate than does an August 1 start date. Several of the vessels which participated in the 1993 fishery were designed for the herring fishery, which ends before July 1. In addition, several vessels have been built or purchased by western Alaska fishermen's organizations using Community Development Quota revenues. These vessels are in part designed to participate in the Norton Sound king crab fishery. The participation in

1993 by several local vessels, and the purchase of pots and other gear, insures that at least some local residents will participate in the fishery, regardless of the exclusivity restrictions, for the next several years.

Based on available information, it is probable that the number of vessels which would participate in an open access fishery in future years would have at least as much harvesting capacity as was present in the recent past.

3.1.2 Pot Limits

A study of the effects of pot limits on BSAI crab fisheries (Greenberg *et al.* 1992) suggests that restrictive limits will disproportionately impact large vessels. Pot limits, combined with the overcapitalized economically stressed fleet and the inducement to gain catch history for possible IFQs, do not necessarily reduce the total number of pots fished under open access. A 100 pot limitation in the 1992 Norton Sound fishery resulted in the second largest number of pots ever fished (Table 1). Further reductions of the pot limit from 100 to 50/40 pots may or may not reduce total pot effort under open registration in 1994 (1993 was an anomalous year). Additionally, though the change in pot limits in 1993 effectively halved the number of pots that can be used by larger vessels, it would not be expected to halve the number of pot lifts under open access. Fishermen on large mobile vessels have shown a tendency to pull their pots more often when the number of pots they are permitted to use is significantly lower than the number they have chosen to use in the past.

The impacts of pot limits in the Northern district (St. Matthew) blue king crab fishery in 1992 is illustrative of increased pot lifts. For 1992, the vessel pot limit was set at 100, down from an unrestricted average of 170 to 200 pots per vessels in previous years (Table 6). During the 1992 season, the fleet size increased from 68 to 174 with no increase in the GHL. The number of pots fished increased 12%, the number of pot lifts increased 50%, and the average soak time per pot decreased from about 32 hours to about 15 hours. Another example of a fishery expanding after the introduction of pot limits, in this case very restrictive, is the 1993 Pribilof red king crab fishery. This fishery had the same pot limit restrictions as the Norton Sound section in 1993, yet 112 large Bering Sea type vessels entered this six day fishery, (Table 5). Though the GHL was an order of magnitude larger than Norton Sound, it was still significantly small in relation to the number of participants and precipitated a short season.

In fisheries with restrictive pot limits, pots are hauled more often, 12-18 hours or less as opposed to 20-30 or more hours in the Bristol Bay king crab fishery, resulting in decreased catch per pot (CPUE). This can also increase non-target crab bycatch. Increased bycatch of sub-legals and females, associated with increased handling problems due to short soak times, presents a potential for increased deadloss. This is especially true in Norton Sound where crabs can be hauled to the surface and encounter the fresh water lenses and a temperature thermal layer which can be 20°F different between the surface and the bottom during the summer months, (Lean pers. comm.).

Vessels participating in the 1992 Norton Sound summer fishery were subject to a 100 pot limit. In this fishery, the fleet size increased from 10 to 27 vessels, and the average soak time decreased to about 12 hours from a previous level of 30 hours (Lean and Bue 1993). Interestingly, the small vessels that participated in the 1993 Norton Sound king crab fishery, which were under a 40 pot limit, soaked their pots between 24-36 hours (C. Lean and T. Johnson pers. comm.).

Even though the 1993 Norton Sound king crab fishery operated under a reduced 50/40 pot limit and a starting date of July 1, large vessels still wished to participate. The fact that a law suit concerning the registration designation, and not the pot limit, was brought by the ACC and one vessel owner, attests to the fact that traditional BSAI crabbers were interested in participating in the fishery even with low pot

limits. This intent was further evidenced in the requests to halt the Norton Sound fishery until large vessels could gear up and reach the area after Secretarial suspension of the Board's 1993 superexclusive designation.

3.1.3 Social Aspects of the Fishery

Participants in the status quo (pre-1993) fishery are expected to be demographically similar to those who participated in all recent years. Western Alaskans did not participate in any significant way prior to 1993. However, participation by some of them in 1993 will probably lead to additional participation in future years, even under status quo management. This is a result of market development and investments in fishing gear that have already been made.

An examination of the seasonal fishing activities for Norton Sound crab vessels is presented in Tables 13 and 14. The tables show the yearly activities of participating vessels for the same year they participated in the Norton Sound fishery of 1990, 1992, or 1993. For 1993 participants, 1992 participation in other fisheries is used due to the unavailability of 1993 participation records. Fish ticket information from ADF&G was used for this examination since it contained all crab landings, groundfish harvesters, salmon, and herring. The information for 1990 and 1992 focuses exclusively on crab fisheries since these are, with one exception, crab vessels. The information for 1993 examines other fisheries since these vessels are multi-purpose. As can be seen for the 1990 and 1992 fleets, they enter multiple crab fisheries. Most of their landings are from Tanner crab fisheries although 2 of the 1992 participants made most of their landings in the Dutch Harbor crab fishery. A total of 30 different vessels participated in the 1990 and 1992 fisheries. Of these 30 vessels, only one, a small vessel of 32 feet, participated in Norton Sound as its only crab fishery. To the remainder of the fleet, Norton Sound crab contributed no more than 0.7% of any vessel's yearly crab landings for 1992 and no more than 1.6% of the total for any of the C/Ps in 1990.

The 1993 fleet was more diverse in its other fishing activities than the 1990 or 1992 fleets. Of the 14 vessels, 1 participated in salmon in 1992, none participated in other shellfish fisheries, 4 participated in groundfish, and 3 participated in halibut. Nine of the vessels had no fishery participation in 1992. However, investigation into the origin of these vessels suggests that they were not new in 1993 but merely not active in 1992 since the herring fishery was closed in 1992. Several owners of 1993 vessels from the region had hired skippers from outside the region to help teach local residents proper fishing techniques. Other vessels were manned by persons who fish in other local fisheries but who do not live in the region.

The opportunity cost for labor and capital in the Norton Sound summer crab fishery is probably low for both large and small vessels and crew. As discussed above, the larger vessels have few fishing opportunities available with the most likely work being salmon tendering or spending time idle or in maintenance at shipyards. The crew would either be with the vessel, participating in salmon fisheries, on vacation, or possibly working at a different occupation. The majority of the small vessels are assumed to be inactive at this time of the year. Most have been constructed and purchased for other fisheries. As discussed above, a few are being constructed and purchased by CDQ groups with the express intent of spending part of their time in the Norton Sound king crab fishery. Most of the fishermen on the small vessels, however, are expected to be unemployed if not participating in this fishery. Other than limited commercial and government jobs in Nome, the Norton Sound region has a very weak economy. The people of the region's coastal villages experience chronic unemployment, with the median household income around \$16,000. Approximately 35% of the households in the region live in poverty (U.S. Census 1991).

3.1.4 Management Effects

Should the status quo continue, the fishery would probably last about a week and would probably be conducted by both large and small vessels. Such short seasons, with long soak times for pots fished by small vessels, means that a day lost to weather is quite probably more than one day of productive fishing lost. While the larger crab vessels are capable of fishing in stormy weather, the smaller vessels entering the fishery are not. However, given the short season length, these smaller vessels would probably feel obligated to continue to participate to obtain their share. This raises the very real concern managers have of safety issues; that managers are unable to delay opening for weather and having vessels participate in unsafe conditions.

3.2 Analysis of Alternative 2: Superexclusive Registration for Norton Sound

This alternative addresses the problems found in the Norton Sound crab fishery by restricting participation to those vessels who would fish for BSAI king crab only in Norton Sound. The vessel may fish for other species of shellfish or fish, such as Tanner crabs or salmon. There are currently no superexclusive registration areas for crab in the BSAI, however, the State currently uses shellfish superexclusive registration in the Gulf of Alaska for king crab (areas E, H and M), Tanner crabs (areas A, E, and H) and Dungeness crab (areas A, D and E).

Under this alternative, in order to institute superexclusive registration in the Norton Sound king crab fishery, the Council would add this management option to Category 1 as an FMP amendment. State regulations would implement this amendment. In this manner the king crab fishery in federal waters will be superexclusive. Currently, the king crab fishery within 3 miles of shore, State waters, will remain superexclusive under existing State regulations whether or not the Council acts. It should be noted that the closed area out to 15 miles was relaxed only five miles in 1993. Therefore, superexclusive registration in State waters is not expected to have a significant impact on the fishery whether or not the Council institutes superexclusive registration under the FMP.

The imposition of superexclusive registration in the Norton Sound area would be in addition to the management measures already in use there. As described in Section 1.4, the most important of these measures are GHLL, season start date and vessel size specific pot limits. These regulations would have effects similar to those described above. To the extent that a different fleet participates due to the superexclusive registration, the effects of existing regulations may be different. For instance, if a fleet of smaller vessels day fishing participates, as is expected from the 1993 experience, then the pot limits will not be as restrictive as they would be on a fleet of larger vessels which fish a larger number of pots per vessel.

The general expected effects of superexclusive registration areas were discussed when the BSAI crab FMP was approved (Section 4.7 of the EA dated February 7, 1989). As stated there, exclusive registration, including superexclusive registration, is not an effective means of protecting biological resources, a GHLL is used for that. One exception to this might be the case in which a small, highly concentrated stock of crab are targeted during a short, intense fishery by a fleet capable of exceeding the GHLL. The fishery that took place in Norton Sound in 1992 is very similar to this scenario. These were also some of the reasons that no fishery occurred in 1991 (Lean and Bue 1992, 1993).

The Norton Sound summer king crab fishery in 1993 was, in effect, a de facto superexclusive fishery. This provides a unique opportunity to analyze an alternative which has already been tested under the

appropriate conditions. Alternative 2 directly addresses excess effort in the Norton Sound fishery. See previous history of fishery (1.4.3).

Plausibly, few if any larger crab vessels will fish in Norton Sound with this measure because they earn such a small percentage of their annual income from this fishery. Profits for large boats would be marginal at best and the small scale fishery would not be expected to provide sufficient earnings to these vessels. The harvest quota is low (340,000 pounds in 1993) relative to the other king and Tanner crab fisheries in the BSAI area. In recent years the ex-vessel value of this fishery has ranged from \$400,000 to \$600,000.

By eliminating the intense concentrated fishery with its derby atmosphere, management aspects of the fishery should improve. Crab handling mortality and deadloss should decrease, due to longer pot soak times. Management and enforcement costs show a distinct decline. Management of the quota is more precise, as shown by the 1993 catch of 335,000 pounds out of 340,000 GHL (1.5% low) (Tables 1 and 12). This improvement in harvest precision is a clear example of optimal utilization of the resource. Overharvest risk is minimized, which ensures sufficient crab biomass for the local subsistence fishery. By having a more relaxed fishery in 1993, the ADF&G area managers were able to easily control the crab fishery along with other area fishery duties.

Another benefit to superexclusive registration is the safety aspect. Derby fisheries are an industry-wide problem, in that fishermen cannot control the times to fish. Often fishermen must fish in dangerous weather or not fish at all and miss the short fishery. The pressure to fish, no matter what the risks, is great, both to make an income and to secure catch history. Superexclusive registration is expected to reduce the derby atmosphere, so vessels have a longer time period to work their pots. Many vessels were able to day-fish in 1993.

The superexclusive designation does not guarantee a profit for a vessel in this fishery. The less mobile fleet could certainly expand in the future, which would reduce the share per boat. Additional boats might be built specifically for this fishery, adding to the already overcapitalized fleet. The comprehensive rationalization plan currently being studied by the Council may address this issue.

3.2.1 Social Aspects of the Fishery

The switch from nonexclusive to superexclusive will probably change the demographics of the participants from large vessels and fishermen, predominantly from non-Alaskan ports to vessels and crew that are predominately Alaskan. This is demonstrated by the change in participant demographics between status quo and 1993. Tables 15 and 16 show the composition of the fleet in terms of residence of primary permit holder. As can be seen, the majority of 1992 participants (70%) were from Washington while the majority of 1993 participants (64%) were from Alaska. In neither case were residents of any state precluded from participating.

The switch to smaller vessels is expected to result in changes as occurred in 1993. In that year, many of the participants had no previous commercial crab fishing experience and many of the participants were from communities adjacent to Norton Sound. Previous years' participation from these communities was reported to be very low or nonexistent. These people have few alternatives for employment in or near their communities. The result is that their opportunity costs, the wages they would be paid in their next best opportunity for employment, are very low. In contrast, persons from most communities connected to the road systems have much more opportunity for employment which results in a higher opportunity cost. What this means is that more of the wages paid to those persons with lower opportunity costs, in this case persons from areas of high unemployment, can be considered economic rent (Nicholson 1978).

Economic rent is profit derived from the fishery as opposed to a pure labor expense. Therefore, all other costs and revenues equal, small vessel crew with lower opportunity costs than those from large vessels, would generate more profits, and therefore net benefits, from the fishery.

The economic impacts on Nome from participation by small vessels and a longer season are relatively much greater than the same magnitude of impacts on traditional crab communities such as Bellingham and Seattle. The crab fishery in 1993 was the most lucrative fishery in the Norton Sound region that year. Since the crab fleet had never provisioned in Nome the fishery resulted in the need for services and supplies that had not been required before. In addition, markets for fresh king crab from the summer Norton Sound fishery were developed. Though only 11,259 pounds were sold in Nome at a price of \$2.20 per pound (Lean 1993), it established a local fresh market. A steady but small amount was also sold in Anchorage, and 500 pounds was even shipped live to New York. (T. Johnson, pers. comm.) The local fishermen's development organization is currently drafting a business plan to market live king crab, and therefore a higher percentage of the harvest is expected to be sold fresh and air shipped from Nome.

3.2.2 Management Effects

The primary management tradeoff of switching to superexclusive registration is between collection of accurate CPUE, bycatch, and deadloss rates, versus accurate daily catch reporting of all harvest. The crabbing vessels fishing under status quo management typically either processed their crab on board (C/Ps), sold to a participating C/P after the season ended, or transported their crab in live tanks to the Pribilof Islands or other, more southern, shorebased processors. All crab harvested by C/Ps were documented by observers as was the catch rates, bycatch, deadloss, etc. In 1992, four C/Ps made daily observer contact, and 23 catcher vessels were unobserved. Therefore, while managers had some independent observations of catch rates from the grounds, they had no absolute idea of magnitude of harvest until some time after the season had closed. During the 1993 fishery, no observer information was available since none of the fishing vessels were C/Ps, who are required to carry observers. However, the one C/P that purchased crab on the grounds had an observer to record deliveries made to it, and shore deliveries were relatively easily monitored by ADF&G staff in Nome. None of the vessels that participated in 1993 used live tanks over extended periods of time, but delivered daily.

3.3 Analysis of Alternative 3: Exclusive Registration, Allowing the Norton Sound King Crab Registration Area to Become Exclusive

As an exclusive registration area, the Norton Sound king crab fishery would allow vessels to participate in this summer fishery but not in other exclusive or superexclusive king crab fisheries. They could participate in non-exclusive king crab registration areas.

Under existing framework of the BSAI crab FMP, this management option is available to the Board under Category 2. If the Council decided this alternative met the goal and objectives of the FMP, they would recommend the Board take action to enact the exclusive status.

The designation of the Norton Sound section as an exclusive registration area does not solve the problem of a derby fishery, where excessive vessel effort harvests the small quotas from this area in a very short period of time. Large, highly mobile crab vessels from Adak could still participate in this summer king crab fishery, and fish other non-exclusive king crab fisheries of the Bering Sea (St. Matthew, Pribilof Islands or Adak) during the rest of the year.

3.3.1 Social Aspects of the Fishery

In order to form a strong economic base for each fishing year, BSAI crab vessels will normally choose either to fish the Adak red or brown king crab fishery or the Bristol Bay king crab fishery. Like the Norton Sound fishery, the Pribilof and St. Matthew king crab fisheries are not large enough, or lucrative enough, by themselves to sustain a large crab vessel. Since the Adak fisheries are not exclusive, any vessel that fishes there and not in Bristol Bay would also be able to fish in Norton Sound. As Tables 8 and 9 show, this fleet has numbered in the teens recently but had become larger in the late 1980s. Therefore, unless Adak was also designated as exclusive, there would be no means of forestalling participation by much of that fleet in Norton Sound. Exclusive registration in Adak is expected to be very restrictive to the fleet since some fishermen fish Bristol Bay and then participate in the Adak fishery. Also, as noted in Tables 10 and 11, the larger vessels almost all participate in the Tanner crab fisheries. It is in these fisheries that they land most of their crab poundage and make most of their revenues.

A designation of Norton Sound as exclusive might force some vessels to choose between the Bristol Bay and the Norton Sound king crab fisheries in some years. However, like the early 1980's, the Bristol Bay stocks could decline precipitously in the near future, and in fact were thought to be doing so in the spring of 1993 when crabbers were warned that the 1993 season might not occur. Should this happen, exclusive registration would not be a sufficient management measure for the Norton Sound fishery and would repeat the 1992 fishery, or see even more participation.

As with Alternative 1, status quo, the future fleet would be expected to consist of large vessels and small vessels whose owners felt they could compete. If the fishery occurred with the speed of 1992, there would be little if any economic benefit. Likewise, the social benefits to communities in the region described for Alternative 2 would not be expected or would occur in a much reduced form.

3.3.2 Management Effects

As stated above, the management of the summer Norton Sound king crab fishery under exclusive registration is expected to be very similar to what is expected under Alternative 1, status quo. The ability of most of the Adak fleet to participate in Norton Sound any year, and the Bristol Bay fleet in years when it is closed, would mean that there would always be a number of large vessels participating. This would continue the management problems that have occurred in the past. These problems include inaccurate accounting of harvest in a real-time manner and under or over harvest of the GHL.

When the Board designates an area, district or section as exclusive, it must produce a written explanation that considers the six factors set out in section 8.2.8 of the BSAI crab FMP. These factors are:

1. The extent to which the designation will facilitate proper management of the fishery.
2. Extent to which such designation will help provide vessels with a reasonable opportunity to participate in the fishery.
3. The extent to which such designation will help to avoid sudden economic dislocation.
4. The extent to which the designation will encourage efficient use of vessels and gear.
5. The extent to which the economic benefits conferred by the designation will be offset by economic costs and inefficiencies.

6. The extent to which other management measures could yield the results desired from the designation.

3.4 Reporting Costs

None of the alternatives considered in this analysis requires more reporting or recordkeeping on the part of industry. Therefore, there is no anticipated increase in reporting costs under any of the alternatives.

Alternative 2, superexclusive registration, is expected to result in a small vessel fleet with no C/Ps catching crab in Norton Sound. This is in sharp contrast to the fishery in 1990 when all four participants were C/Ps. All C/Ps must fund the costs of onboard observers, about \$8,000 per month. The result of switching to superexclusive registration and a decrease in C/Ps will be a decrease in industry reimbursed observers aboard harvesting vessels. Therefore, this alternative is expected to result in a decrease in reporting costs to the industry as a whole.

3.5 Administrative, Enforcement and Information Costs

The management budget for the Norton Sound summer king crab fishery is set by the State of Alaska. This budget is small and has decreased in recent years. It is not anticipated that choosing any of these alternatives will result in an increase to that budget. In past years, much of the administrative and enforcement budget has been spent on aerial surveys to ensure that no fishing occurs following a season closure or within the shoreward closed area.

Any management alternative which lengthens the season, decreases effort, and results in a fleet dependant on daily deliveries, will reduce the need for aerial surveys and thereby reduce enforcement costs. Alternative 2, superexclusive registration would have such an effect. In 1993, management and enforcement of this fishery was much easier than in previous years. This is because there were few processors and managers were able to receive daily landing reports from each. Also, since the pace of the fishery was slowed, and since all vessels came to shore or to a processor each day, there was not need to conduct aerial surveys at the end of the season.

Should superexclusive registration be implemented and result in no at-sea observers, the data previously gathered by the observers will not be available to managers. This information includes bycatch rates, catch rates for sub-legals and females, and independent appraisals of the number of pots used and pot lifts. If this information is deemed necessary for proper management of the fishery, industry/agency costs may increase to pay for at-sea observers.

3.6 Summary of Economic Impacts: Distribution of Costs and Benefits

There are several means of measuring the distribution of costs and benefits from these alternatives. One is to examine the economics of the fishery under each alternative and attempt to determine which would generate the greatest net revenues. This is discussed in Section 3.6.1, below. In short, Alternative 2, superexclusive registration, is predicted to generate the greatest revenues net of certain operating costs.

Another means of examining distribution of costs and benefits is to determine their social distribution. The social impacts of the three alternatives are discussed in Sections 3.1 through 3.3. The choice of Alternative 2, superexclusive registration, will result in the greatest social benefit by offering more employment opportunities in areas of greater unemployment. This alternative will also result in the possibility of expanded fresh crab markets which would result in more local employment and higher ex-vessel revenues. Alternatives 1 and 3 are both likely to result in some local involvement in the fishery

although not at the level predicted for Alternative 2. The social costs will be a transfer of income from primarily Washington based fishermen and vessel owners (larger business entities) to primarily Alaskan based fishermen and vessel owners (smaller business entities). However, the magnitude of this transfer, in terms of the entire BSAI crab fishery, would amount to less than five percent of the total poundage if all 340,000 pounds were transferred.

A third means of examining the summary of distribution of benefits and costs is to determine how the alternatives satisfy the FMP goals and objectives and the Magnuson Act National Standards. These are examined in Sections 3.6.2 and 3.6.3, respectively. In both cases, all alternatives generally satisfy their requirements with the greater benefits and distribution of benefits occurring as discussed above.

3.6.1 Economics of the Fishery

Ideally, a complete description of the costs and revenues of crab production, taking into account rents and quasi-rents, would allow a determination of the profitability of the fishery in past and, possibly, future years. With such information, it would be possible to discuss the economic benefits to the fleet, region and nation resulting from a change in management. Unfortunately, neither accurate nor even approximate vessel cost information exists for BSAI crab vessels (J. Greenberg, M. Hartley, S. Matulich and C. Wiese, pers. comm.). Therefore, it is not possible to determine the costs of harvesting crabs.

In order to allow for some economic comparison between alternatives, several major operating costs are presented in Table 17. Specifically, these major operating costs are fuel, bait and crew shares. Assumptions are based on conversations with crab fishermen, managers, and existing information from other fisheries. The premise of using just the major operating costs is that in the absence of known cost information, such estimates will give some indication of the magnitude of revenue left to pay for other operating costs (lost gear, insurance, repairs, food, etc.), fixed costs and profits. Fourteen variables are estimated for representative large and small vessels. A linear model, presented in Table 18, was developed to accurately account for and track these costs. The model specifies operating costs, harvests, numbers of trips, and revenues for both vessel size groups and overall. Only two variables, n - the number of vessels for each size class, and m - the vessel starting location for each, need to be specified for each model run.

The purpose of the model is to estimate the revenues net of major operating costs that might be generated from a fleet of crab vessels under different participation scenarios. Concurrently, the model estimates the expected season length and number of trips. It can also be used to estimate total expenditures for several operating categories (fuel, bait and crew shares). Given a specified number of vessels, either large or small, and their community of origin for this fishery, the model estimates the combined fleet hourly rate of crab harvest. This rate is then applied to the GHF to determine a season length. In a similar manner, the fleet harvest rate is related to the number and size of vessels specified for the fishery and a total number of trips for the fleet is determined. Using this information, the selected operating expenses are totaled for the fleet and deducted from gross revenues to determine net fleet revenues.

For this model only two sizes of vessels were modeled: large and small. These sizes are based on the characteristics of vessels and on the manner in which they operate. Large vessels are considered to be those primarily over 70', which use circulating seawater to hold their crab, and which typically make crab trips of one week or more between deliveries. This description fits most of the vessels which fished in 1992 with the exception of one vessel that was 32' in length (Table 16). The class includes both catcher and C/P vessels. The small size category is characterized by vessels that typically are less than 70' in length, that make short trips to the crabbing grounds, and that deliver every day or two. The vessels that fished in 1993 fit this description with one exception of an 86' vessel (Table 15). After discussions with

the owner of this vessel, it was decided that its operation pattern in the 1993 fishery fit that of a small vessel. As can be seen, each vessel size class incorporates numerous styles and types of vessels. Therefore, the assumptions used in the model are necessarily general and attempts were made to be conservative (under estimate costs) when in doubt.

The difference in price between the vessel classes deserves attention since it is such an important factor in the relative profitability of the various scenarios. The ex-vessel prices used, \$1.75 for large vessels and \$1.28 for small vessels, are based on the actual average prices received in 1992 and 1993, respectively. In 1992 the fleet sold most of its catch to several C/Ps that participated in the fishery. Since the deliveries came all at once (a two day season) and since there was more than one processor, market economics probably contributed to a competitive ex-vessel price. In 1993 there was only one primary processor on the grounds and the season was almost two months long. This would be expected to lead to a much lower price than received in 1992 due to market imperfections and economies of scale. It should be noted that the crab sold in Nome fetched an ex-vessel average of \$2.20 per pound (Lean 1993). These crab were delivered for local markets and live air shipments to other communities. If the marketing of crab under any of these alternatives changes, such as increased live deliveries to Nome, then these price structures are expected to change. Also, under Alternatives 1 or 3, where both large and small vessels compete during a short season, both would probably receive similar average ex-vessel prices.

It should be noted that these costs and the model results are the analyst's best estimate considering the lack of data. The model assumes that for large vessels one cost structure can be used to represent both catcher and C/P vessels while for the smaller fleet one cost structure represents the gambit from an 86' crabber to herring skiffs. Thus, the modeled results only provide indications as to the most important variables, the amount of income that might be generated, and demonstrate the magnitude of difference between vessel classes.

There are several means possible to test the accuracy of models. One is to back cast known occurrences to determine whether or not the model results match what happened. Another is to conduct a sensitivity analysis where different variables are increased and decreased. The model results are then examined to determine how sensitive they are to variable changes. Both types of testing were conducted on this model and explained below.

As a means of testing the accuracy of the model, back cast runs for 1992 and 1993 were conducted (Table 19). For 1992, the fleet consisted of 26 large and 1 small vessel. This fleet size was run to determine the season length and expected revenues for the actual harvest amount (Scenario A) and the same characteristics with full harvest of the GHL (Scenario B). Several modifications were made to the assumptions presented in Table 17. Large vessels were assumed to use 100 pots (the limit in 1992), all vessels used a 12 hour soak time as reported by ADF&G, large vessels were assumed to have a fishing trip length of 12 hours and the small vessel a trip of 7 hours, all vessels had a catch rate of 4 CPUE, and all vessels received \$1.75 per pound. The back cast Scenario A suggested that the season would have been 1.2 days long and the fleet as a whole would have spent \$72,000 more on the selected operating costs than they received in gross revenues. While the fishery actually lasted 2 days, many of the vessels apparently stopped fishing early, possibly due to low catch rates, effectively prosecuting a 1.5 day or less fishery. (C. Lean, pers. comm.) The model predicts that the 1992 fleet of large vessels suffered an average loss of just less than \$2,800 on fuel, bait and crew shares alone. This concurs with general comments by participants (C. Lean, pers. comm.). Had the full GHL been taken (Scenario B, using a GHL of 340,000 to compare to 1993 results), the season is predicted to have taken 5.4 days and the fleet would have generated revenues of \$112,170 in excess of operating expenses.

The 1993 model back cast was modified to reflect actual vessel participation rates (Table 19, Scenario C). The average landing for the 14 vessels in this fishery was 24,000 lbs. However, based on the very low landings by several of the vessels and very high landings by others (Lean 1993), the fleet was adjusted to 9 active vessels. The vessels were assumed to use a 36 hour soak time based on conversations with fishermen, a 2.9 lb weight per crab was used as reported by ADF&G, and bait was assumed to cost \$0.95 per pound as reported by fishermen. The predicted season length was 29.4 days rather than the actual 58 calendar days or 43 days during which landings occurred. However, in 1993 several of the more productive vessels did not participate in the beginning of the season, weather halted or curtailed fishing on other days, and during part of mid-August effort decreased for reasons unrelated to weather (Lean 1993). Therefore, while the model underestimated the actual season length, the difference is assumed to be due to the more relaxed nature of the long fishery rather than inaccuracies in the model itself. The model predicts that the (modified) 1993 fleet received an average of \$21,276 in net revenues after fuel, bait and crew expenses.

Sensitivity testing of the model showed that the variables expected to have the most effect on the results are: ex-vessel price, crab weight, CPUE, fuel costs, and soak time. A comparison was run between two idealized fleets: the first consisting of one large vessel from Dutch Harbor and the second consisting of one small vessel from Nome. Single vessel fleets were used since the linear nature of the model ensured that adding more vessels would result in standardized, incremental changes. For large vessels, all of which are assumed to originate in Dutch Harbor for purposes of this analysis, the incremental cost is \$4,752 which corresponds closely to industry reports of \$5,000 spent on fuel when traveling to Nome and back. Adding more vessels resulted in shorter seasons but did not affect the number of trips or other costs. For the small vessel fleet, the single vessel was assumed to originate in Nome since most of the vessels are expected to originate somewhere near Nome rather than further away. Table 20 lists the effects of doubling (halving) soak time (trip length) and doubling (halving) CPUE for large (small) vessels. For the base case, large vessels were assumed to have a 15 hour soak time and a CPUE of 8 while small vessels were assumed to have a 6 hour fishing trip and a CPUE of 16.4. Since pot limits have changed between 1992 and 1993, the status quo was projected by rerunning the model for the 1992 fleet operating under 1993 regulations. The 1992 large vessel fleet consisted of 16 vessels under 125' and 10 vessels greater than 125' in length (Table 16). Therefore, based on the new pot limits (50 for vessels > 125' and 40 for vessels < 125') and the size distribution of the 1992 fleet, a 44 pot average for large vessels is used. Only selected operating costs, net revenues and season length are presented since they are the variables of greatest interest. For small vessels, the sensitivity analysis also examines the ex-vessel value of \$1.75 compared to the base case of \$1.28. All results show changes in the expected directions. A change in soak time (trip length) for large vessels has a greater effect than for small vessels. A 50% change in CPUE or the combination of soak time and CPUE had a greater effect for small vessels. An increase in price had the largest effect on small vessel net revenues.

In order to compare expected fleet size and composition under the three alternatives, each was modeled using the assumptions set forth in Table 17 and the model contained in Table 18. The number of vessels and their origin is stated for each scenario. Table 21 presents the scenario for Alternative 1, status quo. The small vessel is assumed to have the same soak time, CPUE and ex-vessel price as the large vessels. The season is predicted to last 7.3 days with total net revenues of about \$165,360 generated.

Super exclusive registration is modeled in Table 22. Scenario 2A models superexclusive registration and assumes a fleet of 20 small vessels rather than the 14 (or 9) which participated in 1993. These vessels are postulated to originate in the ports of: 6 from Nome, 6 from Emmonak, 6 from Bristol Bay and 2 from Dutch Harbor. The vessels originating from the last two ports would be more likely to be non-resident participants. This represents a doubling of the effective effort present in 1993. A fleet of this size is predicted to have a season almost 11 days long. Fewer trips are predicted than for either of the other

Alternatives since small vessels tend to soak their pots longer and therefore are expected to have higher CPUEs. While the season is predicted to last only 11 days, this might extend due to weather or market conditions, especially if many of the crabs go to a fresh market. Scenarios 2B, 2C, and 2D examine the changes to costs and revenues that would occur with increases in ex-vessel price. Net revenues vary from \$260,032 to \$373,932 depending on the ex-vessel price.

Alternative 3 is modeled under 2 scenarios in Table 23. Both scenarios use an assumed fleet size of 10 large vessels and 14 small vessels. In both cases all vessels receive \$1.75 per pound ex-vessel. Scenario 3A uses the other assumptions set forth in Table 17 while in Scenario 3B the soak time is 30 hours for both vessel classes and the CPUE is 16.4 for both. Doubling both of these has the effect of maintaining the same harvest rate and gross revenues for large vessels but decreases their operating costs. Season length is estimated at 8.6 days and net revenue varies from \$256,151 to \$269,834.

The modeling results presented in Tables 21 - 23 show that the 1992 fleet (had the GHL been fully harvested) is expected to generate the lowest net revenues. A combined fleet as expected under Alternatives 3A and 3B (and possibly Alternative 1, see Section 3.1.4) would have almost equal net revenues with a superexclusive fleet under Scenario 2B. However, these net revenues for Alternatives 3A and 3B are achieved at an ex-vessel price of \$1.75 per pound, as opposed to \$1.50 per pound assumed for Scenario 2B.

Given the above caveats, the model indicates that a fleet composed of small vessels operating within a superexclusive management regime is more likely to return greater net revenue after expenditures for fuel, bait, and crew shares. This conclusion is bolstered by the expectation that the small vessels will receive a higher price for their crab in the future, as they develop and expand fresh markets.

3.6.2 Compliance with Bering Sea/Aleutian Islands Crab FMP Goals and Objectives

The crab FMP contains a single goal and seven objectives to which the management of the fisheries should be geared. Each objective is addressed below with a short description taken from the results of this analysis.

Goal The goal of the FMP is to maximize the overall long-term benefit to the nation of the BSAI crab stocks. Based on the definition of optimum yield contained in the Magnuson Act, the crab FMP goal could be interpreted as achieving the optimum yield on a biological, economic and social basis.

Ensure the long-term reproductive viability of king and Tanner crab populations. The viability of the Norton Sound king crab stock is maintained through adherence to conservative GHLS. Fisheries that occur very quickly would be more likely to exceed the GHLS than would those which occur more slowly or are more closely observed. Deadloss can occur if holding tanks with circulating water are contaminated by fresh water or high temperatures. Most smaller vessels do not have such tanks. Discard mortality is caused when juvenile and female crab are brought through the temperature and salinity gradient, handled and returned to the water. Though this occurs under all alternatives, and can be better controlled by prudent use of the 15 mile closed area along the coast; handling mortality will be minimized under alternative 2.

Maximize economic and social benefits to the nation over time. In the absence of good cost information, it is not possible to accurately determine which alternative is most likely to produce higher economic benefits to the fleet, region and nation. A local fleet delivering at least a portion of their catch to Norton Sound communities is expected to generate higher regional benefits. Based on the model calculations, it is most likely that Alternative 2 would provide more economic benefits to the nation. It

is anticipated that this will be accomplished by providing a supply of fresh crab to markets (increased revenues) and by increasing the beneficial economic impacts on coastal communities. Likewise, Alternative 2, followed by Alternative 3, would provide more social benefits since it would result in more income generated in areas of high unemployment.

Minimize gear conflict among fisheries. Gear conflicts are not anticipated to be a problem under any of the alternatives. This is because most conflicts occur when grounds are saturated with pots, which the 50/40 pot limit addresses. Also, the crab fishery occurs in areas not utilized by other fisheries at that time of year.

Preserve the quality and extent of suitable habitat. None of the alternatives are anticipated to adversely impact crab habitat.

Provide public access to the regulatory process for vessel safety considerations. During short, intense fisheries there is great pressure on fishermen to participate regardless of weather conditions. Sometimes these conditions can be hazardous for smaller vessels. As was demonstrated in 1993, a longer season allows fishermen to sit out poor weather rather than risk accidents. Therefore, Alternative 2 has the greatest potential for increasing vessel safety.

Ensure that access to the regulatory process and opportunity for redress are available to all interested parties. None of these alternatives change the regulatory process nor do they provide more or fewer means of redress. However, the persons who initially proposed the Norton Sound summer fishery were local residents. These residents did not feel able to compete in the fishery until 1993. Therefore, the fact that Alternatives 2 and 3 are being considered demonstrates that there is access to the process and opportunity for redress.

Provide fisheries research, data collection, and analysis to ensure a sound information base for management decisions. Fisheries data is collected by observers placed on fishing vessels, primarily C/Ps, and at processors. While data on retained harvest can be obtained from both locations, data concerning CPUE, discard rates, and bycatch can only be collected by observers on board vessels actually fishing. Alternative 1 and possibly Alternative 3 provide the best access to this type of data since C/Ps have participated in the status quo fishery (100% of the 1990 participants) and might participate in an exclusive registration fishery. It is very unlikely that a C/P would participate in a superexclusive fishery in Norton Sound.

Additionally, the Section 8.2.8 of the FMP describes the benefits which can be realized from an exclusive type of registration. Either Alternative 2 or 3 could achieve these benefits.

The use of exclusive area designations can aid in dispersing fishing effort while still allowing the majority of the fleet the opportunity to harvest the majority of the crab. Exclusive registration areas can help provide economic stability to coastal communities (see objective 7.2.2) or to segments of the industry dependent on an individual registration area's crab stocks, particularly if the character of the fishing fleet and the related industry participants depending upon the registration area's potential production would not allow movement to another registration area. This is particularly advantageous to the less mobile vessels if the area in which they fish is not the most profitable area for the more mobile vessels. This will not necessarily provide greater stability for the less mobile vessels because as fishery conditions change from year to year, the mobile vessels can change the area(s) in which they fish. However, on the average, fewer mobile vessels will fish in the less profitable areas if fishing in multiple areas is restricted.

4.0 INITIAL REGULATORY FLEXIBILITY ANALYSIS

The objective of the Regulatory Flexibility Act is to require consideration of the capacity of those affected by regulations to bear the direct and indirect costs of regulation. If an action will have a significant impact on a substantial number of small entities an Initial Regulatory Flexibility Analysis (IRFA) must be prepared to identify the need for the action, alternatives, potential costs and benefits of the action, the distribution of these impacts, and a determination of net benefits.

NMFS has defined all fish-harvesting or hatchery businesses that are independently owned and operated, not dominant in their field of operation, with annual receipts not in excess of \$2,000,000 as small businesses. In addition, seafood processors with 500 employees or less, wholesale industry members with 100 employees or less, not-for-profit enterprises, and government jurisdictions with a population of 50,000 or less are considered small entities. A "substantial number" of small entities would generally be 20% of the total universe of small entities affected by the regulation. A regulation would have a "significant impact" on these small entities if it resulted in a reduction in annual gross revenues by more than 5 percent, annual compliance costs that increased total costs of production by more than 5 percent, or compliance costs for small entities that are at least 10 percent higher than compliance costs as a percent of sales for large entities.

If an action is determined to affect a substantial number of small entities, the analysis must include:

- (1) a description and estimate of the number of small entities and total number of entities in a particular affected sector, and total number of small entities affected; and
- (2) analysis of economic impact on small entities, including direct and indirect compliance costs, burden of completing paperwork or recordkeeping requirements, effect on the competitive position of small entities, effect on the small entity's cashflow and liquidity, and ability of small entities to remain in the market.

4.1 Economic Impact on Small Entities

It is anticipated that Alternative 2 could have a significant impact on a substantial number of small entities. The alternatives contemplated in this amendment would affect who participates in the Norton Sound king crab fishery. Superexclusive registration is predicted to result in an increase in retained revenues and possibly improve market conditions for increasing overall revenues. However, none of the alternatives are expected to result in a reduction in overall revenues. Likewise, while superexclusive registration is expected to reduce industry compliance costs, none of the alternatives is expected to increase compliance costs.

At its most populous, 27 vessels participated in this fishery. This represents less than 10% of the Bering Sea crab fleet. The large vessels that have participated in the Norton Sound summer fishery gain only a small percentage of their annual crab landings from this fishery. The primary fisheries for these vessels are Tanner crab fisheries and Bristol Bay red king crab. The small vessels that participated in 1993 are different from this in that most had limited fishing activity in 1992, in part due to local herring closures, and none participated in shellfish fisheries that year. These small, local vessels comprised 28% of the 1993 fleet.

Overall, the benefits of superexclusive registration are at the cost of a transfer of participation and income from a predominately Washington-based large vessel fleet to a predominately Alaskan-based small vessel fleet. In 1992, 27 large vessels participated and 70% of the permit holders were from Washington. Prior

to 1993, all of the large vessels either processed the crab onboard or delivered it to processors in the Pribilofs or Dutch Harbor. They bought few services or supplies in the Nome area. Norton Sound crab contributed no more than 0.7% to any of the 26 vessels yearly crab landings for 1992 and no more than 1.6% of the total for any of the C/Ps in 1990. Likewise, participation in the fishery for more than one year is low, with only one vessel in 1992 having participated in 1990. Therefore, neither individual vessels nor participants in the pre-1993 fleet were dependent on this fishery in terms of year to year participation or landings within any one year.

In 1993, 14 small vessels participated and 64% of the primary permit holders were from Alaska. All of the smaller vessels provisioned out of Nome and many of the fishermen were from the region or worked on vessels stored in the region. In addition, a new fresh market for summer king crab was developed and resulted in higher ex-vessel prices than that received for crab that are processed and frozen. Local residents are maintaining plans to develop this market even further in coming years. Most of the fishermen on the small vessels are expected to be unemployed if they do not participate in this fishery. The infusion of employment and income from the 1993 small vessel fishery was significant in the Nome area. The 1993 king crab fishery represented the largest fishery in the region in terms of income.

5.0 SUMMARY AND CONCLUSIONS

The Norton Sound summer king crab fishery has a unique collection of problems which makes fishery management difficult. These problems include overcapitalization, short seasons, high management costs, non-achievement of guideline harvest levels (GHL), and a failure to meet the goals and objectives of the Bering Sea crab FMP and the Magnuson Act. This fishery has the smallest biomass and GHL in the Bering Sea/Aleutian Island crab fisheries. Historically, the fishery has been characterized by years with low levels of participation and fairly high catch rates followed by years with high levels of participation and low catch rates. Lately, a combination of factors has led to high participation which is expected to continue into the future. These factors are based primarily on the overcapitalized crab fleet and on participants' efforts to establish catch histories in the event individual fishing quotas (IFQ) are instituted.

The major difference between the alternatives is who will participate in the fishery: either primarily large, Bering Sea crab vessels or smaller, possibly more regionally based vessels. The effects of who participates include how long the seasons will last, how difficult monitoring will be, what the ex-vessel revenues will be, what new markets for crab might be developed, and which communities will benefit from income and services associated with the fishery. None of the alternatives considered are likely to significantly affect the quality of the human environment. Likewise, none of the alternatives would directly affect the amount of crab available for harvest, nor would other fishing activities change significantly in a manner that would affect the biological or physical environment. However, the greater the fleet/effort combination, such as that expected under exclusive registration or, most certainly under status quo, the more likely to under or over harvest the GHL, similar to pre-1993.

The large vessels that participate in the Norton Sound summer fishery gain only a small percentage of their annual crab landings from this fishery. The primary fisheries for these vessels are Tanner crab fisheries and Bristol Bay red king crab. The small vessels that participated in 1993 are different from this in that most had limited fishing activity in 1992, in part due to local herring closures, and none participated in shellfish fisheries that year.

Seventy percent of the primary permit holders on large vessels that participated in 1992 are from Washington while sixty-four percent of those participating in 1993 are from Alaska. All of the large vessels either process the crab onboard or take it to processors in the Pribilofs or Dutch Harbor. They bought few services or supplies in the Nome area. All of the smaller vessels provisioned out of Nome and many were from the region or worked on vessels stored in the region. In addition, a new fresh market for summer king crab was developed. This will result in higher ex-vessel prices than are received for crab that are processed and frozen. Plans are being made in locally to develop this market even further in coming years. Most of the fishermen on the small vessels are expected to be unemployed if not participating in this fishery. The infusion of employment and income from the 1993 small vessel fishery was significant in the Nome area.

As part of the analysis, a linear model was developed to determine net revenues from the fishery after deducting major operating expenses: fuel, bait and crew shares. When the number of participants are estimated, the model estimated the season length. The model was tested by back casting the 1992 and 1993 seasons. While 14 vessels participated in 1993, several had very few days fishing and correspondingly low landings resulting in a "full time" fleet of 9 vessels. Therefore, the model was adjusted with due consideration given to actual (rather than average) participation rates, weather, and differences in vessel performance. The results were similar to the actual season lengths. Three scenarios of future fleet participation under the alternatives were modeled and the results compared. A fleet composed of 27 to 29 mostly large vessels was predicted to result in a 6 day fishery with net revenues of about \$6,250 per vessel. A fleet of 20 small vessels was expected to result in an 11 day fishery with

net revenues of about \$10,500 per vessel. If revenues increase due to expanded markets for fresh crab, the small vessels' revenues would increase under either scenario. The small vessels are predicted to be more economically efficient because they use less fuel and soak their pots longer which results in correspondingly higher catch per pot.

The switch to superexclusive registration would create a management environment discouraging participation by most if not all large crab vessels and to fishing by all catcher/processors. The management tradeoffs for this would be unbiased reporting of catch per pot, bycatch, and deadloss from the observed portion of the fleet versus accurate daily catch reporting of all harvest. The improved accuracy of a slower paced fishery allowed, and is expected to continue to allow, fuller attainment of GHGs. Better daily reporting is possible because the smaller vessels rarely hold their crab in live tanks for extended periods but deliver after each trip. In addition, a season lasting a month or less and involving no at-sea enforcement, such as that predicted for superexclusive registration, would reduce administrative and enforcement costs.

Overall, superexclusive registration is expected to result in greater benefits to the nation than either the status quo or exclusive registration. These benefits are at the cost of a transfer of participation and income from a predominately Washington based large vessel fleet to a predominately Alaskan based small vessel fleet. Norton Sound crab contributed no more than 0.7% to any of the 26 vessels yearly crab landings for 1992 and no more than 1.6% of the total for any of the C/Ps in 1990. Likewise, participation in the fishery for more than one year is low, with only one vessel in 1992 having participated in 1990. Therefore, neither individual vessels nor participants in the pre-1993 fleet were dependent on this fishery in terms of year to year participation or landings within any one year.

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Table 1. Historic Norton Sound red king crab economic performance.

Year	GHL ¹	Season Total ¹	Number Pots Registered	Number Vessels	Number Landings	Number Pots Pulled	Ex-Vessel Value	Total Value ²	Season Length Days/Dates
1977	N/A	0.52	N/A	7	13	5,457	.75	0.39	60 - 7/15 - 9/13
1978	N/A	2.0	N/A	8	54	10,817	.95	1.90	60 - 7/15 - 9/13
1979	N/A	2.6	N/A	34	76	34,773	.75	1.95	16 - 7/15 - 7/31
1980	N/A	1.2	N/A	9	50	11,199	.75	0.90	16 - 7/15 - 7/31
1981	N/A	1.4	N/A	37	108	33,745	.85	1.19	38 - 7/01 - 8/11
1982	0.5	0.2	N/A	11	33	11,230	2.00	0.4	23 - 8/01 - 9/03
1983	0.3	0.4	7,500	23	23	11,195	1.50	0.60	3.8 - 8/01 - 8/05
1984	0.4	0.4	1,248	8	26	9,706	1.02	0.41	13.6 - 8/01 - 8/15
1985	0.4	0.4	1,116	6	26	13,209	1.00	0.40	21.7 - 8/01 - 8/23
1986	0.4	0.5	579	3	2	4,284	1.25	0.62	13.0 - 8/01 - 8/25
1987	0.4	0.3	1,431	9	22	10,258	1.50	0.45	11.0 - 8/01 - 8/12
1988	0.2	0.2	360	2	3	2,350	N/A	N/A	9.9 - 8/01 - 8/10
1989	0.2	0.2	2,555	10	10	5,149	3.00	0.60	3 - 8/01 - 8/04
1990	0.2	0.2	1,388	4	4	3,172	N/A	N/A	4 - 8/01 - 8/05
1991			NO COMMERCIAL FISHERY						
1992	0.3	0.076	2,635	27	26	5,764	1.75	0.13	2 - 8/01 - 8/03
1993	0.3	0.3	560	14	208	7,063	1.28	0.38	58 - 7/01 - 8/28

¹Millions of pounds.²Millions of dollars.

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Table 2. Winter commercial and subsistence red king crab harvests, Norton Sound 1978-1993.

COMMERCIAL			SUBSISTENCE						
Year ¹	Fisher- men	#Crab Harvested	Winter ²	Permits Issued	Permits Returned	Permits Fished	Total Crab Caught ³	Total Crab Harvested ⁴	Average Harvest/fm
1978	37	9,625	1977-78	290	206	149	5	12,506	84
1979	1	221	1978-79	48	43	38	5	224	6
1980	1	22	1979-80	22	14	9	5	213	24
1981	0	0	1980-81	51	39	23	5	360	16
1982	1	17	1981-82	101	76	54	5	1,288	24
1983	5	549	1982-83	172	106	85	5	10,432	123
1984	8	856	1983-84	222	183	143	15,923	11,220	78
1985	9	1,168	1984-85	203	166	132	10,757	8,377	63
1986	5	2,168	1985-86	136	133	107	10,751	7,052	66
1987	7	1,040	1986-87	138	134	98	7,406	5,772	59
1988	10	425	1987-88	71	58	40	3,573	2,724	68
1989	5	403	1988-89	139	115	94	7,945	6,126	65
1990	13	3,626	1989-90	136	118	107	16,635	12,152	114
1991	11	3,800	1990-91	119	104	79	9,295	7,366	93
1992	13	7,478	1991-92	158	149	105	15,051	11,736	112
1993	8	1,495	1992-93	88	76	37	1,195	1,039	28

¹ Prior to 1985 the winter commercial fishery occurred from January 1 - April 30; as of March 1985, the winter commercial harvest may occur from November 15 - May 15.

² The winter subsistence fishery occurs during months of two calendar years (as early as December, through May).

³ The number of crab actually caught; some may have been returned.

⁴ The number of crab "harvested" is the number of crab caught and kept.

⁵ Data unavailable.

Source: ADF&G

Table 3. Results of the population assessment surveys conducted for red king crab in Norton Sound since 1976.

Year	Date	Research Agency	Vessel	Gear Effort	Number of Red King Crab Captured ¹			Population Estimates of Legal Male Crab ³	
					Sublegal Males	Legal ² Males	Females	Numbers	Pounds
1976	9/02 - 9/05	NMFS	Miller-Freeman	Trawl	768	555	180	3,119,800	8,111,480
	9/16 -10/07			158 tows					
1979	7/26 - 8/05	NMFS	Miller-Freeman	Trawl	46	194	40	837,241	2,511,723
				71 tows					
1980	7/04 - 7/14	ADF&G	Altair	Pots	443	3,290	158	1,900,000	6,600,000 ⁴
				397 lifts					
1981	6/28 - 7/14	ADF&G	Altair	Pots	4,097	3,415	1,933	1,285,195	4,755,221
				718 lifts					
1982	7/06 - 7/20	ADF&G	Aleutian #1	Pots	5,019	2,001	424	353,273	1,271,783
				689 lifts					
1982	9/05 - 9/11	NMFS	Miller-Freeman	Trawl	322	107	265	970,646	2,620,744
				50 tows					
1985	7/01 - 7/14	ADF&G	Arctic Sea	Pots	6,086	4,645	181	907,579	2,414,644
				642 lifts					
1985	9/16 -10/01	NMFS	Argosy	Trawl	266	163	151	1,203,000	3,369,000
				78 tows					
1988	8/16 - 8/30	NMFS	Miller-Freeman	Trawl	258	141	218	1,037,000	3,038,000
				82 tows					

¹ Number of crab captured on ADF&G surveys represent data standardized for a 24 hour soak.

² Legal male red king crab were defined as at least 106mm in carapace length for the 1976 NMFS survey; 105mm for the 1979 and 1985 NMFS survey; and at least 121mm in carapace width for all ADF&G surveys.

³ Population est. are valid for the date of the survey, ie either before or after the summer commercial fishery.

⁴ The 1980 estimate has been revised from the original estimate of 13.4 million pounds. The original estimate was thought inaccurate due to under-reporting of recovered tagged crab.

Source: ADF&G

Table 4. Historic Bristol Bay red king crab economic performance.

Year	GHL ¹	Season Total ¹	Number Pota Registered	Number Vessels	Number Landings	Number Pota Pulled	Ex-Vessel Value	Total Value ²	Season Length Days/Dates
1980	70-120	128.1	78,352	236	1,251	567,292	\$.90	\$115.3	40 - 9/10-10/20
1981	70-100 ³	32.9	75,756	177	1,026	542,250	\$ 1.50	\$ 49.3	91 - 9/10-12/15
1982	10-20 ⁴	2.9	36,166	90	255	141,656	\$ 3.05	\$ 8.8	30 - 9/10-10/10
1983			N O C O M M E R C I A L F I S H E R Y						
1984	2.5-6.0	4.1	21,762	89	137	112,556	\$ 2.60	\$ 10.8	15 - 10/1-10/16
1985	3-5	4.2	30,117	128	130	85,003	\$ 2.90	\$ 12.1	8 - 9/25-10/02
1986	6-13	11.1	32,468	159	230	178,370	\$ 4.05	\$ 45.0	13 - 9/25-10/07
1987	8.5-17.7	12.2	63,000	236	311	220,871	\$ 4.00	\$ 48.7	12 - 9/25-10/06
1988	7.5	7.4	50,099	200	201	153,004	\$ 5.10	\$ 37.6	8 - 9/25-10/02
1989	16.5	10.2	55,000	211	287	208,684	\$ 5.00	\$ 50.9	12 - 9/25-10/06
1990	17.1	20.2	69,906	240	331	262,131	\$ 5.00	\$101.2	12 - 11/1-11/13
1991	18	17.1	89,068	302	332	227,555	\$ 3.00	\$ 51.2	7 -11/01-11-08
1992	10.3	8.0	68,189	281	289	205,940	\$ 5.00	\$ 40.0	7 -11/01-11/08

Source: ADF&G

¹Millions of pounds.²Millions of dollars.³Millions of dollars.⁴Inseason revision to 4.7 million pounds.

Table 5. Historic Bering Sea, Pribilof district blue king crab economic performance.

Year	GHL ¹	Season Total ¹	Number Pots Registered	Number Vessels	Number Landings	Number Pots Pulled	Ex-Vessel Value	Total Value ²	Season Length Days/Dates
1980/81	5-8	10.7	31,636	110	258	167,681	\$.90	\$ 9.6	60-9/15-11/15
1981/82	5-8	9.1	25,408	99	312	176,168	\$ 1.50	\$13.6	47-9/10-10/28
1982/83	5-8	4.4	34,429	122	281	127,728	\$ 3.05	\$13.4	15-9/10-09/25
1983/84	4.0 ³	2.2	36,439	126	221	86,428	\$ 3.00	\$ 6.6	10-9/01-09/11
1984/85	.5-1.0	0.3	3,122	16	25	15,147	\$ 2.50	\$ 0.1	15-9/01-09/16
1985/86	.3-0.8	0.5	6,038	26	49	23,483	\$ 2.90	\$ 1.4	26-9/25-10/21
1986/87	.3-0.8	0.3	4,376	16	25	15,800	\$ 4.05	\$ 1.2	55-9/25-11/20
1987/88	.3-1.7 ⁴	0.7	9,594	38	68	40,507	\$ 4.00	\$ 2.8	86-9/25-12/20
1988/89			NO COMMERCIAL FISHERY						
1989/90			NO COMMERCIAL FISHERY						
1990/91			NO COMMERCIAL FISHERY						
1991/92			NO COMMERCIAL FISHERY						
1992/93			NO COMMERCIAL FISHERY						
1993/94 ⁵	3.4	2.6	4,860	112	135	35,942	\$ 4.98	\$12.9	6-9/15-09/21

Source: ADF&G

¹Millions of pounds.²Millions of dollars.³set not to exceed 4,000,000 pounds.⁴ 1980 - 1988 blue crab only⁵ 1993/94 red crab only

Table 6. Historic Bering Sea, Northern district (St. Matthew) blue king crab economic performance.

Year	GHL ¹	Season Total ¹	Number Pota Registered	Number Vessels	Number Landings	Number Pota Ex-Vessel Pulled	Total Value	Season Length Value ²	Days/Dates
1981	1.5-3.0	4.6	2,960	31	119	58,550	\$.90	\$ 4.1	38-7/15-8/21
1982	5.6	8.7	21,894	96	269	165,618	\$ 2.00	\$17.4	15-8/01-8/16
1983	8.0	8.6	38,000	164	235	133,944	\$ 3.00	\$25.8	17-8/20-9/06
1984	2-4	3.7	14,800	90	169	73,320	\$ 1.75	\$ 6.5	7-9/01-9/08
1985	0.9-1.9	2.4	13,000	79	103	51,606	\$ 1.60	\$ 3.8	5-9/01-9/06
1986	0.2-0.5	1.0	5,600	38	43	22,093	\$ 3.20	\$ 3.2	5-9/01-9/06
1987	0.6-1.3	1.1	9,370	61	62	28,440	\$ 2.85	\$ 3.1	4-9/01-9/05
1988	0.7-1.5	1.3	7,780	46	46	10,160	\$ 3.10	\$ 4.0	4-9/01-9/05
1989	1.7	1.2	11,983	69	69	30,853	\$ 2.90	\$ 3.5	3-9/01-9/4 ³
1990	1.9	1.7	6,000	31	38	26,264	\$ 3.35	\$ 5.7	6-9/01-9/07
1991	3.2	3.2	13,100	68	69	37,104	\$ 2.80	\$ 9.0	4-9/16-9/20
1992	3.1	2.5	14,700	174	79	56,630	\$ 3.00	\$ 7.4	3-9/04-9/7 ³
1993	4.4	3.0	5,895	92	136	58,647	\$ 3.23	\$ 9.7	6-9/15-9/21

Source: ADF&G

¹Millions of pounds.²Millions of dollars.

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 Table 7. Historic Dutch Harbor brown king crab economic performance.

Year	GHL ¹	Season Total ²	Number Pota Registered	Number Vessels	Number Landings	Number Pota Pulled	Ex-Vessel Value	Total Value ³	Season Length Days/Dates
1981/82		N/A	0.1	-0- ⁴	6	16	2,906	\$ 2.05	\$ 0.2 75-11/01-1/15
1982/83		N/A	1.1	-0- ⁴	49	136	29,369	\$ 3.00	\$ 3.3 105-11/1-2/15
1983/84		N/A	1.8	4,514	47	132	29,595	\$ 3.05	\$ 5.5 105-11/1-2/15
1984/85		N/A	1.5	1,394	13	67	24,044	\$ 1.35	\$ 2.0 229-7/01-2/15
1985/86		N/A	1.9	1,479	13	67	34,287	\$ 2.00	\$ 3.8 121-7/1-10/31
1986/87		N/A	1.8	1,575	17	71	37,585	\$ 2.85	\$ 5.1 182-7/1-12/31
1987/88		N/A	1.4	3,591	22	77	43,017	\$ 2.85	\$ 4.0 62 -7/01-9/02
1988/89		N/A	1.5	4,215	21	57	40,869	\$ 3.00	\$ 4.5 93-9/01-12/04
1989/90		N/A	1.8	5,635	13	70	43,345	\$ 3.50	\$ 6.3 104-9/1-12/15
1990/91		N/A	1.7	5,225	16	68	54,618	\$ 3.00	\$ 5.1 68-9/01-11/09
1991/92		N/A	1.4	3,760	11	50	40,604	\$ 2.00	\$ 2.8 74-9/01-11/15
1992/93		N/A	1.3	4,222	10	44	37,718	\$ 2.50	\$ 3.3 76-9/01-11/17

99 Source: ADF&G

¹Based on historic catches, 1983/84 - 1991/92.

²Millions of pounds.

³Millions of dollars.

⁴Incidental catches to red king crab fishery.

Table 8. Historic Adak red king crab economic performance.

Year	GHL ¹	Season Total ²	Number Pots Registered	Number Vessels	Number Landings	Number Pots Ex-Vessel Pulled	Total Value	Season Value ³	Length Days/Dates
1980/81	N/A	1.4	2,471	17	52	20,914	\$.92	\$ 1.3	438 -1/15-3/28
1981/82	N/A	1.6	8,698	46	106	40,697	\$ 2.01	\$ 3.2	107 -11/1-2/15
1982/83	N/A	1.7	13,111	72	191	66,893	\$ 3.44	\$ 5.9	76 -11/01-1/15
1983/84	N/A	2.0	19,407	106	248	60,840	\$ 3.43	\$ 6.9	36-11/10-12/16
1984/85	N/A	1.4	8,876	64	113	50,685	\$ 2.10	\$ 2.9	97 -11/10-2/15
1985/86	N/A	.9	8,274	35	89	32,478	\$ 2.15	\$ 1.9	107-11/01-2/15
1986/87	N/A	.7	12,958	33	69	29,189	\$ 3.85	\$ 2.7	107-11/01-2/15
1987/88	N/A	1.2	17,720	71	109	43,433	\$ 4.00	\$ 4.8	107-11/01-2/15
1988/89	N/A	1.6	23,927	73	156	64,374	\$ 5.00	\$ 8.0	34-11/01-12/04
1989/90	N/A	1.1	19,363	56	123	54,513	\$ 4.20	\$ 4.6	107-11/01-2/15
1990/91	N/A	.7	8,500	7	34	10,674	\$ 4.00	\$ 2.8	107-11/01-2/15
1991/92	N/A	.9	2,305	10	35	16,636	\$ 3.00	\$ 2.9	107-11/01-2/15
1992/93	N/A	1.3	2716 ⁴	12	30	16,129	\$ 5.05	\$ 6.5	107-11/01-2/15

¹No preseason GHL's.

²Millions of pounds.

³Millions of dollars.

⁴Includes gear of vessels landing both red and brown crab.

Table 9. Historic Adak brown king crab economic performance.

Year	GHL ¹	Season Total ²	No. Pots Registered ³	No. Vssls.	No. Lndgs.	No. Pots Pulled	Ex-Vssl Value	Total Value ⁴	Season Length Days/Dates
1980/81	N/A	0.05	581	4	4	700	\$.90	\$ 0.05	438 -1/15-3/28
1981/82	N/A	1.2	2,647	14	76	24,627	\$ 2.06	\$ 2.5	227-11/01-6/15
1982/83	N/A	7.8	13,111	99	501	150,103	\$ 3.01	\$23.5	166-11/01-4/15
1983/84	N/A	8.0	17,406	157	1,002	226,798	\$ 2.92	\$23.4	157-11/10-4/15
1984/85	N/A	3.1	5,270	38	85	64,777	\$ 2.00	\$ 6.2	240-11/10-7/08
1985/86	N/A	11.1	7,057	49	386	202,401	\$ 2.50	\$27.8	288-11/01-8/15
1986/87	N/A	12.5	12,958	62	325	392,185	\$ 3.00	\$37.5	288-11/01-8/15
1987/88	N/A	7.8	10,687	46	386	267,705	\$ 3.00	\$23.4	289-11/01-8/15
1988/89	N/A	9.0	23,627	74	455	280,732	\$ 3.20	\$28.8	288-11/01-8/15
1989/90	N/A	10.1	14,724	64	505	324,153	\$ 3.00	\$30.3	288-11/01-8/15
1990/91	N/A	5.3	7,380	13	167	160,960	\$ 3.00	\$15.9	288-11/01-8/15
1991/92	N/A	6.1	7,635 ⁵	16	206	192,949	\$ 2.50	\$15.2	289-11/01-8/15
1992/93	N/A	4.8	8236	18	128	162,303	N/A	N/A	288-11/01-8/15

¹No preseason GHL's.

²Millions of pounds.

³No separate registration from red king crab.

⁴Millions of dollars.

⁵Gear of vessels landing brown king crab.

Table 10. Historic Bering Sea *C. bairdi* Tanner crab economic performance.

Year	GHL ¹	Season Total ¹	Number Pots Registered	Number Vessels	Number Landings	Number Pota Pulled	Ex-Vessel Value	Total Value ²	Season Length Days/Dates
1979/80	28-36	36.5	40,273	152	804	488,434	\$.52	\$ 19.0	189 - 11/01-5/14
1981	28-36	29.6	42,910	165	761	559,626	\$.58	\$ 17.2	88 - 01/15-4/18
1981/82	12-16	10.9	36,396	125	791	490,099	\$ 1.06	\$ 11.5	118 - 02/15-6/15
1983	5.6	5.2	15,255	108	448	282,006	\$ 1.20	\$ 6.2	118 - 02/15-6/15
1984	7.1	1.2	9,851	41	134	61,357	\$.95	\$ 1.1	118 - 02/15-6/15
1985	3.0	3.1	15,325	44	166	104,707	\$ 1.40	\$ 4.3	149 - 01/15-6/15
1986			NO COMMERCIAL FISHERY						
1987			NO COMMERCIAL FISHERY						
1988	5.6	2.2	38,765	98	248	112,334	\$ 2.17	\$ 4.8	93 - 01/15-4/20
1989	13.5	7.0	43,607	109	359	184,892	\$ 2.90	\$ 20.3	110 - 01/15-5/07
1990 ¹	29.5	24.5	46,440	179	1,032	711,137	\$ 1.85	\$ 45.3	89 - 01/15-4/24
1990/91	42.8	39.7	75,356	255	1,756	883,391	\$ 1.12	\$ 44.5	126 - 11/20-3/25
1991/92	32.8	31.5	85,401	285	2,339	1,244,633	\$ 1.50	\$ 47.3	137 - 11/15-3/31
1992/93	39.2	34.8	71,481	294	2,084	1,200,885	\$ 1.60	\$ 55.7	137 - 11/15-3/31

¹Millions of pounds.

²Millions of dollars.

¹Winter fishing.

Table 11. Historic Bering Sea *C. opilio* Tanner crab economic performance.

Year	GHL ¹	Season Total ¹	Number Pots Registered ²	Number Vessels	Number Landings	Number Pots Pulled	Ex-Vessel Value	Total Value ³	Season Length Days/Dates
1979/80	N/A	39.3	35,503	134	597	255,022	\$.21	\$ 83.0	307-11/1-9/03
1980/81	39.5-91	50.5	39,789	153	867	435,742	\$.26	\$ 13.1	229-1/15-9/01
1981/82	16-22	28.3	35,522	122	803	469,091	\$.73	\$ 20.7	167-2/15-8/01
1982/83	15.8	24.8	15,396	109	462	287,127	\$.35	\$ 8.7	120-2/15-6/01
1983/84 ⁴	49.0	26.0	12,493	52	367	173,591	\$.30	\$ 7.8	320-2/15-12/3
1984/85 ⁴	98.0	64.9	15,325	75	718	372,045	\$.30	\$ 19.5	333-1/15-9/22 AND10/9-12/31
1985/86 ⁴	57.0	96.6	13,750	88	992	543,744	\$.60	\$ 60.0	252-1/15-9/24
1986/87	56.4	100.9	19,386	103	1,038	616,113	\$.75	\$ 75.7	158-1/15-6/22
1987/88	110.7	130.8	38,765	171	1,285	766,907	\$.77	\$100.7	120-1/15-3/29 AND 5/15-6/30
1988/89	132.0	147.6	43,607	168	1,341	663,442	\$.75	\$110.7	112-1/15-5/07
1989/90	139.8	161.8	46,440	189	1,565	911,613	\$.64	\$102.3	148-1/15-6/12
1990/91	315.0	325.2	76,056	228	2,788	1,391,583	\$.50	\$162.6	159-1/15-6/23
1991/92	333.0	313.0	77,858 ⁵	250	2,763	1,281,796	\$.50	\$156.5	97-1/15-4/22
1992/93	207.2	220.0	65,018	254	1,836	971,046	\$.65	\$148.2	59-1/15-3/15

Source: ADF&G

¹Millions of pounds.²Same gear as *C. bairdi* fishery.³Millions of dollars.⁴Partial closures only.⁵Gear of *C. opilio* vessels only.

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Table 12. Norton Sound red king crab guideline harvest levels and commercial harvests, 1981-1993.

YEAR	#VSSLS	#DAYS	GHL	(MILLIONS OF POUNDS)		
				COMM' HARVEST	OVER/UNDER	
1981	36	38	1.5	1.38	-	8%
1982	11	23	0.25	0.23	-	8%
1983	23	3	0.3	0.37	23%	-
1984	8	14	0.4	0.39	-	3%
1985	6	22	0.45	0.43	-	5%
1986	3	13	0.43	0.48	12%	-
1987	9	11	0.29	0.33	14%	-
1988	2	10	0.2	0.24	20%	-
1989	10	3	0.2	0.25	25%	-
1990	4	4	0.2	0.19	-	5%
1991			CLOSED, NO SEASON			
1992	27	2	0.3	0.07	-	77%
1993	14	58	0.34	0.33	1.5%	-

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Source: ADF&G

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Table 13. 1993 Norton Sound king crab vessel participation with 1992 percentage by fishery type.

VESSEL	1993 % NORTON SOUND CRAB	1992 % SALMON	1992 % CRAB & SHELLFISH	1992 % HERRING	1992 % GROUND FISH	1992 % HALIBUT
1	43.4	-	-	-	56.6	-
2	100.0	-	-	-	-	-
3	75.5	-	-	-	2.7	21.8
4	100.0	-	-	-	-	-
5	100.0	-	-	-	-	-
6	27.4	-	-	-	44.8	27.8
7	31.0	-	-	-	57.5	11.5
8	100.0	-	-	-	-	-
9	100.0	-	-	-	-	-
10	14.7	48.9	-	36.4	-	-
11	100.0	-	-	-	-	-
12	100.0	-	-	-	-	-
13	100.0	-	-	-	-	-
14	100.0	-	-	-	-	-

Source: ADF&G fish tickets

Table 14 Norton Sound Vessel Participation and Percent Landed By King and Tanner Crab Fishery for 1990 and 1992

Year/ Vessel	Norton Sound	Saint Matthew	Bristol Bay	Adak	Dutch Harbor	Bering Sea Tanner
<u>1990</u> Vessel 1	0.9	-	1.8	19.5	5.2	72.6
2	1.4	1.4	3.5	-	-	93.7
3	1.4	0.8	2.2	-	-	95.6
4	1.6	1.0	4.6	-	-	92.8
<u>1992</u> Vessel 1	0.7	-	-	-	99.3	-
2	0.2	0.4	2.2	-	-	97.2
3	0.5	1.3	3.8	-	-	94.4
4	0.1	0.5	1.7	-	-	97.7
5	0.1	2.3	2.4	4.2	-	91.0
6	0.5	0.7	0.8	-	-	98.0
7	0.1	1.2	0.9	-	-	97.8
8	0.1	0.5	1.7	-	-	97.7
9	0	2.3	7.6	-	-	90.1
10	0.1	0.9	1.7	-	-	97.3
11	0.1	1.5	4.0	-	-	94.4
12	0.3	0.8	1.7	-	-	97.2
13	100.0	-	-	-	-	-

Table 14 (cont'd) Norton Sound Vessel Participation and Percent Landed By King and Tanner Crab Fishery for 1990 and 1992

Year/ Vessel	Norton Sound	Saint Matthew	Bristol Bay	Adak	Dutch Harbor	Bering Sea Tanner
<u>1992</u> Vessel 14	0.1	-	3.1	-	-	96.8
15	0.2	3.2	2.2	-	-	94.4
16	0.3	0.4	3.3	0.7	-	95.3
17	0.4	0.7	2.2	-	-	96.7
18	0.4	0.9	1.2	-	-	97.5
19	0.1	1.3	2.2	-	-	96.4
20	0.4	0.1	-	21.5	-	78.0
21	0.1	1.6	-	-	-	98.3
22	0.1	-	3.2	-	96.7	-
23	0.5	0.3	1.9	-	-	97.3
24	0.5	1.1	1.3	-	-	97.1
25	0.3	1.0	3.3	-	-	95.4
26	0.2	1.7	2.5	-	-	95.6
27	0.1	-	4.1	-	-	95.8

Source: ADF&G fish tickets

Table 15. 1993 Norton Sound vessel length and permit residency.

<u>Vessel</u>	<u>Vessel length</u>	<u>Permit Residency</u>
1	53	Emmonak, AK.
2	86	Nome, AK.
3	32	Nome, AK.
4	25	Nome, AK.
5	41.6	Alaska
6	32	Alaska
7	32	Alaska
8	49	Alaska
9	49	Alaska
10	32.7	Oregon
11	32	Washington
12	31	Washington
13	32	Washington
14	32	Washington

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Table 16. 1992 Norton Sound vessel length and permit residency.

Vessel	Vessel length	Permit Residency
8	110	Alaska
17	172	Alaska
13	32	Alaska
18	156	Alaska
20	110	Alaska
23	150	Alaska
25	100	Alaska
2	79	Idaho
1	166	Washington
3	110	Washington
4	108	Washington
5	75	Washington
6	106	Washington
7	127	Washington
9	78	Washington
10	108	Washington
11	101	Washington
12	132	Washington
14	107	Washington
15	97	Washington
16	115	Washington
19	155	Washington
21	180	Washington
22	171	Washington
24	105	Washington
26	124	Washington
27	161	Washington

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Table 17. Comparison of some cost factors between large and small crab vessels, Norton Sound king crab fishery.

<u>Description</u>	<u>Variable</u>	<u>Large</u>	<u>Small</u>
Fuel costs (\$/gal) ¹	c	\$1.00	\$1.66
Bait costs (\$/lb) ²	b	\$0.45	\$0.55
Bait/pot (lbs) ³	w	10	10
Pots/boat ⁴	p	44	40
Mileage (roundtrip) ⁵			
Dutch Harbor to Nome	d,m	1,440	1,440
Bristol Bay to Nome	d,m	NA	1,360
Emmonak to Nome	d,m	NA	240
Rest area to grounds	g	0	50 ⁶
Crew share (% of gross) ⁷	z	33%	33%
Fuel usage			
travel (gal/mi)	t	3.3 ⁸	1 ⁹
fishing (gal/hr)	f	10 ¹⁰	5 ¹¹
Fishing time/trip (hrs)	l	15 ¹²	6 ¹³
Soak time (hrs)	k	15 ¹⁴	30 ¹⁵
CPUE	u	8.2 ¹⁶	16.4 ¹⁷
Crab weight (lbs/crab) ¹⁸	y	3.0	3.0
Ex-vessel value ¹⁹	v	\$1.75	\$1.28

Notes:

1. Fuel costs from Delta Western in Dutch Harbor (large) and Bonanza Fuel in Nome (small). Fuel costs in Seattle are reported to be \$0.80/gal.
2. It is assumed that large vessels bring their own bait and that the cost difference is due solely to assumed freight from Dutch Harbor to Nome. The large vessel bait cost is based on conversations with large vessel crab fishermen.
3. Based on conversations with crab fishermen. All vessel size classes use the same bait containers.
4. Pot regulations in 1993 limit vessels < 125' to 40 pots and vessels > 125' are allowed 50 pots. Based on the ratio of 'large' vessels > 125' in 1992 (10) to the number < 125' (16), the average allowable use is 44 pots.
5. Mileages are estimated.
6. Distance is assumed to be an average from harbor to the fishing grounds. In 1993 it was reported by fishermen and managers to be between 10 and 30 miles one way.
7. Reported to vary widely between vessels depending on crew size, ownership patterns, etc. The 33% represents an approximation for large vessels. On small vessels, which are often owner operated, the 33% represents some wages to the owner in addition to crew.
8. Assumes 800 gal/hr at 10 knots based on conversations with large vessel crab fishermen.
9. Assumes 10 gal/hr at 10 knots based on conversations with fishermen.
10. Assumes 240 gal/day when fishing and 24 hr/day engine use based on conversations with fishermen.
11. Assumes that 50% of time is spent pulling pots.
12. Set equal to the soak time since vessel runs engines at all times.
13. Based only on actual fishing time since vessels are reported to return to port or anchor up when not fishing.
14. Based on the shortened soak times exhibited by large vessels fishing with significantly restrictive pot limits in other BSAI crab fisheries. Also assumes a change to slightly longer soak time than the 12 hr. which occurred in 1992.
15. Reported soak time in 1993 ranged from 24 hrs (ADF&G) to 36 hrs (fishermen) so an average of 30 is used.
16. Since the soak time is less, the CPUE is adjusted downward in a proportional manner. While this is not a documented relationship it is widely acknowledged.
17. This is the 1993 CPUE which corresponds to a lengthy soak time.
18. Average weight reported in 1992. The weight in 1993 was 2.9 lbs.
19. Average price reported by ADF&G in 1992 (large) and 1993 (small).

Table 18.

Determination of selected comparative operating costs for two different vessel size classes.

Selected operating costs consisting of fuel, bait and crew expenses:

$$SOC_{s_1} = ((\sum_m n_m d_m t c) + X_{bwp} + X_{fcl} + X_{tcg} + zAv)_{s_1}$$

$$SOC_{s_2} = ((\sum_m n_m d_m t c) + X_{bwp} + X_{fcl} + X_{tcg} + zAv)_{s_2}$$

Harvest times:

$$\text{Fleet harvest (crab per hour)} = H = \left(\frac{nupy}{k}\right)_{s_1} + \left(\frac{nupy}{k}\right)_{s_2}$$

$$\text{Season length} = \frac{\frac{GHL}{H}}{24}$$

The number of trips:

$$\text{Number of trips : } X_{s_1} = \frac{\left(\frac{GHL}{H} * n_{s_1}\right)}{k_{s_1}} ; X_{s_2} = \frac{\left(\frac{GHL}{H} * n_{s_2}\right)}{k_{s_2}}$$

The harvest totals:

$$\text{Harvest amount (lbs) : } A_{s_1} = (Xupy)_{s_1} ; A_{s_2} = (Xupy)_{s_2}$$

$$\text{Gross revenues : } GR_{s_1} = (Av)_{s_1} ; GR_{s_2} = (Av)_{s_2}$$

$$\text{Net revenues : } NR_{s_1} = GR_{s_1} - SOC_{s_1} ; NR_{s_2} = GR_{s_2} - SOC_{s_2}$$

where:

n = number of vessels: THIS VARIABLE MUST BE SPECIFIED BY VESSEL SIZE AND LOCATION OF ORIGIN.

m = vessel starting location (Dutch Harbor, Bristol Bay, Emmonak or Nome): THIS VARIABLE MUST BE SPECIFIED.

s = vessel size class (s_1 = large and s_2 = small)

d = the distance from location m to Nome

t = the per mile travel fuel consumption

c = fuel cost

b = the cost of bait

w = the pounds of bait per pot

p = the number of pots fished per trip (legal limit)

f = the fuel use per trip hour

l = trip length (time spent going through gear one time)

z = crew share

v = ex-vessel value per pound

u = number of retainable crab per pot

y = average weight per retainable crab

k = soak time

Table 19. Back casts for 1992 and 1993 of the selected operating cost model.

	Large Vessels	Small Vessels	Total
Scenario A: Back cast of 1992 performance.	26 large vessels	1 small vessel	27 vessels
Crab harvest per hour (H)	2,600	40	2,640
Number of trips (X)	60.8	2.3	63.1
Harvest amount (A)	72,907 lbs	1,122 lbs	74,029 lbs
Gross revenues (GR)	\$127,588	\$1,963	\$129,551
Selected operating costs (SOC)	\$200,287	\$1,492	\$201,779
Net revenues (NR)	(\$72,699)	\$471	(\$72,228)
Season length			1.2 days
Scenario B: Back cast of 1992 with full GHJ harvest.	26 large vessels	1 small vessel	27 vessels
Crab harvest per hour (H)	2,600	40	2,640
Number of trips (X)	279.0	10.7	289.8
Harvest amount (A)	334,848 lbs	5,152 lbs	340,000 lbs
Gross revenues (GR)	\$585,985	\$9,015	\$595,000
Selected operating costs (SOC)	\$475,980	\$6,850	\$482,830
Net revenues (NR)	\$110,005	\$2,165	\$112,170
Season length			5.4 days
Scenario C: Back cast of 1993 performance, adjusted for realistic performance.	0 large vessels	9 small vessels (4 N, 3 E, 0 BB, 2 DH)	9 vessels
Crab harvest per hour (H)		476	476
Number of trips (X)		176.5	176.5
Harvest amount (A)		335,790 lbs	335,790 lbs
Gross revenues (GR)		\$429,811	\$429,811
Selected operating costs (SOC)		\$238,327	\$238,327
Net revenues (NR)		\$191,484	\$191,484
Season length			29.4 days

Table 20. Sensitivity analysis for Norton Sound king crab model.

	Selected operating costs (SOC)	Net revenues (NR)	Season length
<u>Large vessels:</u> Base case (soak 15 hrs, CPUE = 8, \$1.75/lb)	\$313,147	\$281,853	201.2
Soak 30 hrs	\$361,443 (15% up)	\$233,557 (17 % down)	402.5 (100% up)
CPUE = 16	\$257,125 (18% down)	\$337,875 (20% up)	100.6 (50% down)
Soak 30 hrs & CPUE=16	\$281,272 (10% down)	\$313,728 (11% up)	201.2 (0% change)
Ex-vessel \$1.28 (27% down)	\$260,413 (17% down)	\$174,787 (38% down)	NA
<u>Small vessels:</u> Base case (fish trip 6 hrs, CPUE = 16.4, \$1.28/lb)	\$204,567	\$230,633	216.0
Trip length 12 hrs	\$213,171 (4% up)	\$222,029 (4% down)	216.0 (0% change)
CPUE = 8.2	\$265,518 (30% up)	\$169,682 (26% down)	431.9 (100% up)
Trip 12 hrs & CPUE = 8.2	\$282,726 (38% up)	\$152,474 (34% down)	431.9 (100% up)
Ex-vessel \$1.75 (36% up)	\$257,301 (26% up)	\$337,699 (46% up)	NA

Table 21. Model output for Alternative 1, status quo, in the Norton Sound king crab fishery.

	Large Vessels	Small Vessels	Total
	26 large vessels	1 small vessel	27 vessels
Crab harvest per hour (H)	1,876	66	1,942
Number of trips (X)	303.5	11.7	315.2
Harvest amount (A)	328,514 lbs	11,486 lbs	340,000 lbs
Gross revenues (GR)	\$574,899	\$20,101	\$595,000
Selected operating costs (SOC)	\$418,888	\$10,752	\$429,640
Net revenues (NR)	\$156,010	\$9,350	\$165,360
Season length			7.3 days

Table 22. Model output for three scenarios of participation under Alternative 2, superexclusive registration, in the Norton Sound red king crab fishery.

	Large Vessels	Small Vessels	Total
Scenario 2: Future superexclusive registration.	0 large vessels	20 small vessels (6N, 6 E, 6 BB, 2 DH)	20 vessels
Crab harvest per hour (H)		1,312	1,312
Number of trips (X)		172.8	172.8
Harvest amount (A)		340,000 lbs	340,000 lbs
Season length			10.8 days
Scenario 2A: Ex-vessel price of \$1.28/lb			
Gross revenues (GR)		\$435,200	
Selected operating costs (SOC)		\$225,284	
Net revenues (NR)		\$209,916	\$209,916
Scenario 2B: Ex-vessel price of \$1.50/lb			
Gross revenues (GR)		\$510,000	
Selected operating costs (SOC)		\$249,968	
Net revenues (NR)		\$260,032	\$260,032
Scenario 2C: Ex-vessel price of \$1.75/lb			
Gross revenues (GR)		\$595,000	
Selected operating costs (SOC)		\$278,018	
Net revenues (NR)		\$316,982	\$316,982
Scenario 2D: Ex-vessel price of \$2.00/lb			
Gross revenues (GR)		\$680,000	
Selected operating costs (SOC)		\$306,068	
Net revenues (NR)		\$373,930	\$373,930

Table 23. Model output for two scenarios of participation under Alternative 3, exclusive registration, in the Norton Sound red king crab fishery.

	Large vessels	Small Vessels	Total
Scenario 3A: Future exclusive registration, mixed fleet: Different soak and CPUE.	10 large vessels	14 small vessels (6 N, 3 E, 3 BB, 2 DH)	24 vessels
Crab harvest per hour (H)	722	918	1,640
Number of trips (X)	138.2	96.7	235
Harvest amount (A)	149,600 lbs	190,400 lbs	340,000 lbs
Gross revenues (GR)	\$261,800	\$333,200	\$595,000
Selected operating costs (SOC)	\$182,012	\$156,837	\$338,849
Net revenues (NR)	\$79,788	\$176,363	\$256,151
Season length			8.6 days
Scenario 3B: Exclusive registration fishery with mixed fleet: same soak and CPUE.	10 large vessels	14 small vessels (6 N, 3 E, 3 BB, 2 DH)	24 vessels
Crab harvest per hour (H)	722	918	1,640
Number of trips (X)	69.1	96.7	165.9
Harvest amount (A)	149,600 lbs	190,400 lbs	340,000 lbs
Gross revenues (GR)	\$261,800	\$333,200	\$595,000
Selected operating costs (SOC)	\$168,329	\$156,837	\$325,166
Net revenues (NR)	\$93,471	\$176,363	\$269,834
Season length			8.6 days

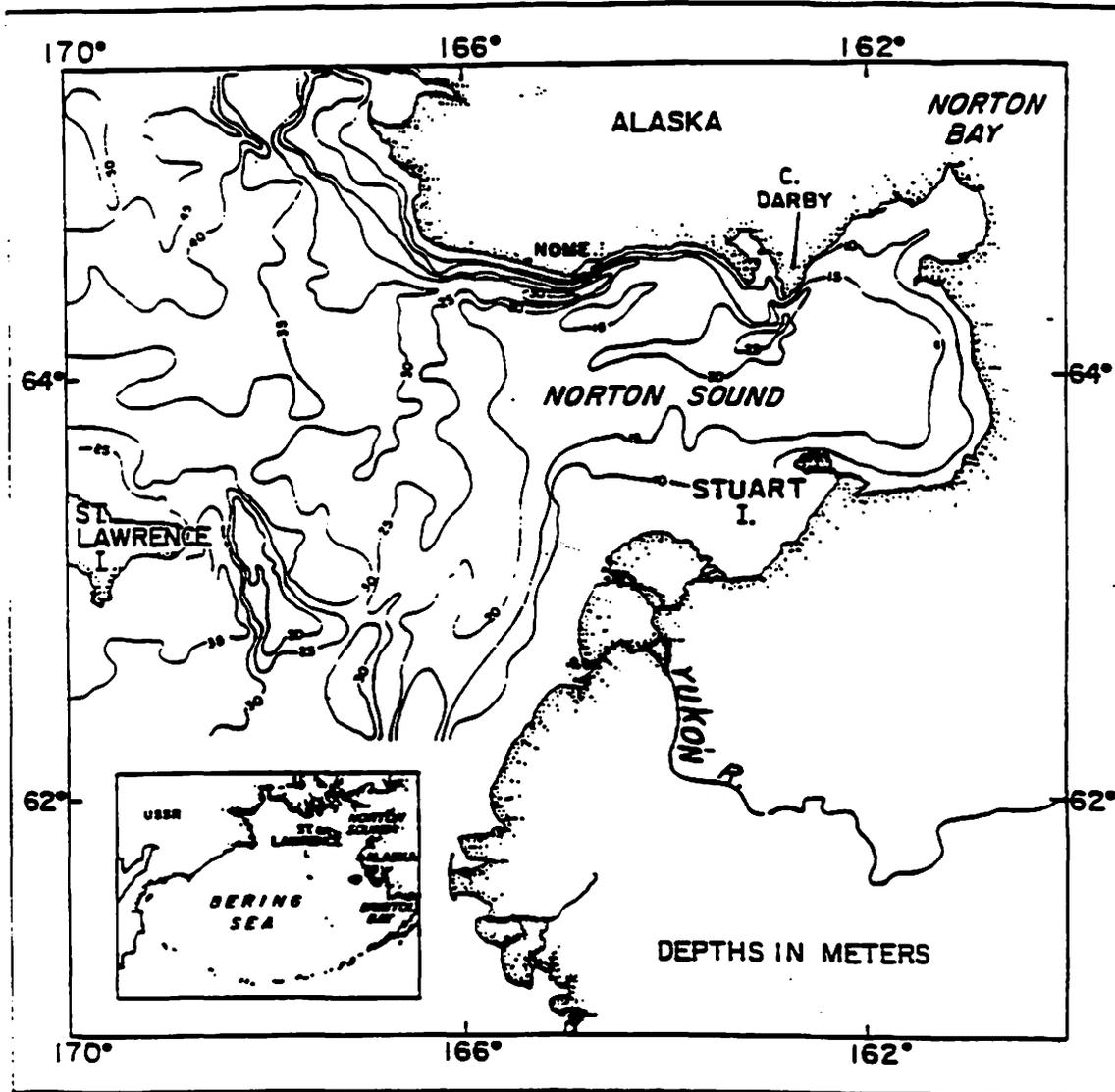


Figure 1. Geographical location and bathymetry of the Norton Sound region.

Source: Muench, R.D., R.B. Tripp, and J.D. Cline 1981. Circulation and hydrography of Norton Sound. In: The Eastern Bering Sea Shelf: Oceanography and Resources Vol. 1, eds. D.W. Hood and J.A. Calder, U.S. Dept. of Commerce, NOAA, Office of Marine Pollution Assessment, University of Washington Press, Seattle, Washington, p. 78.

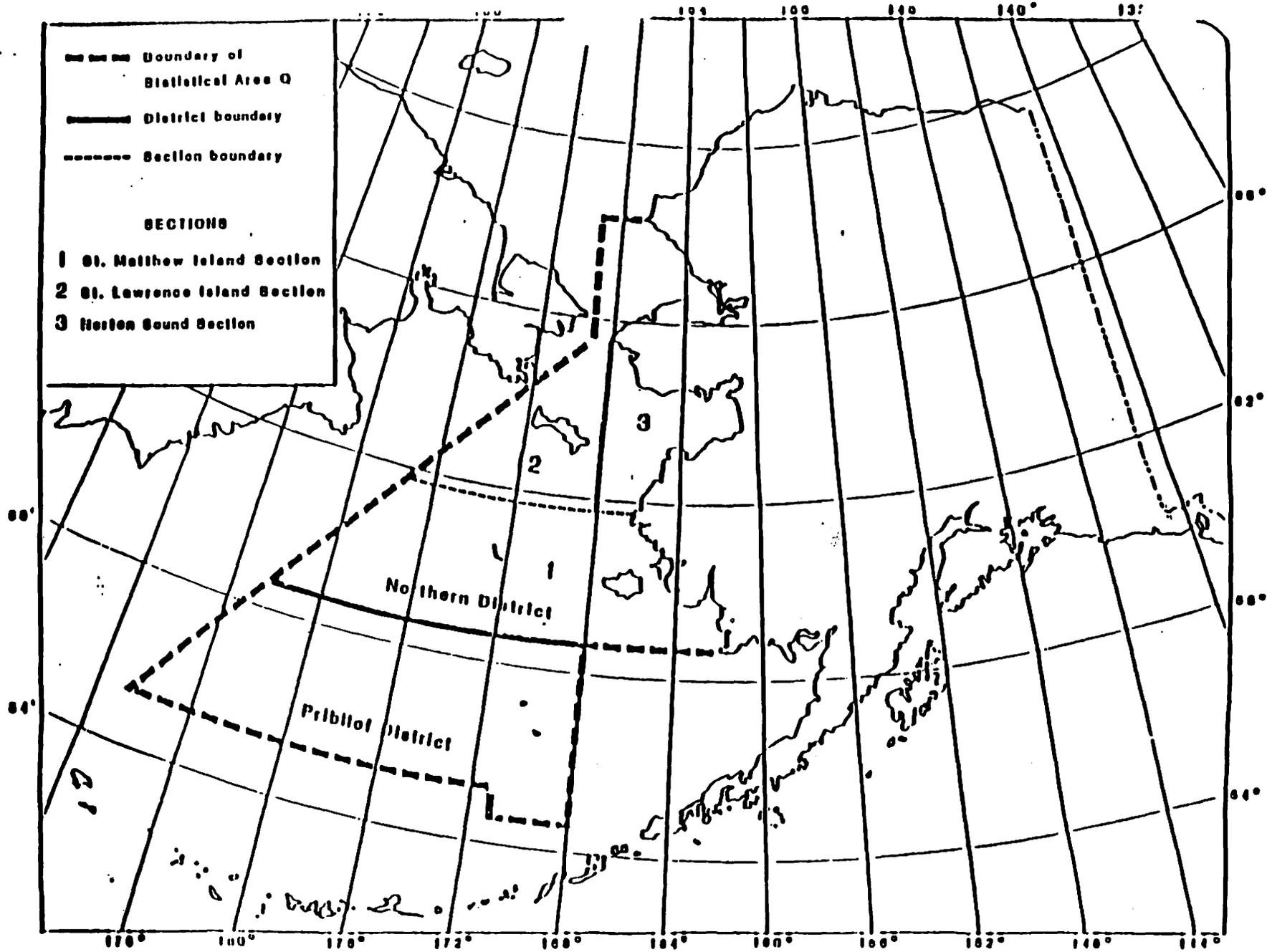
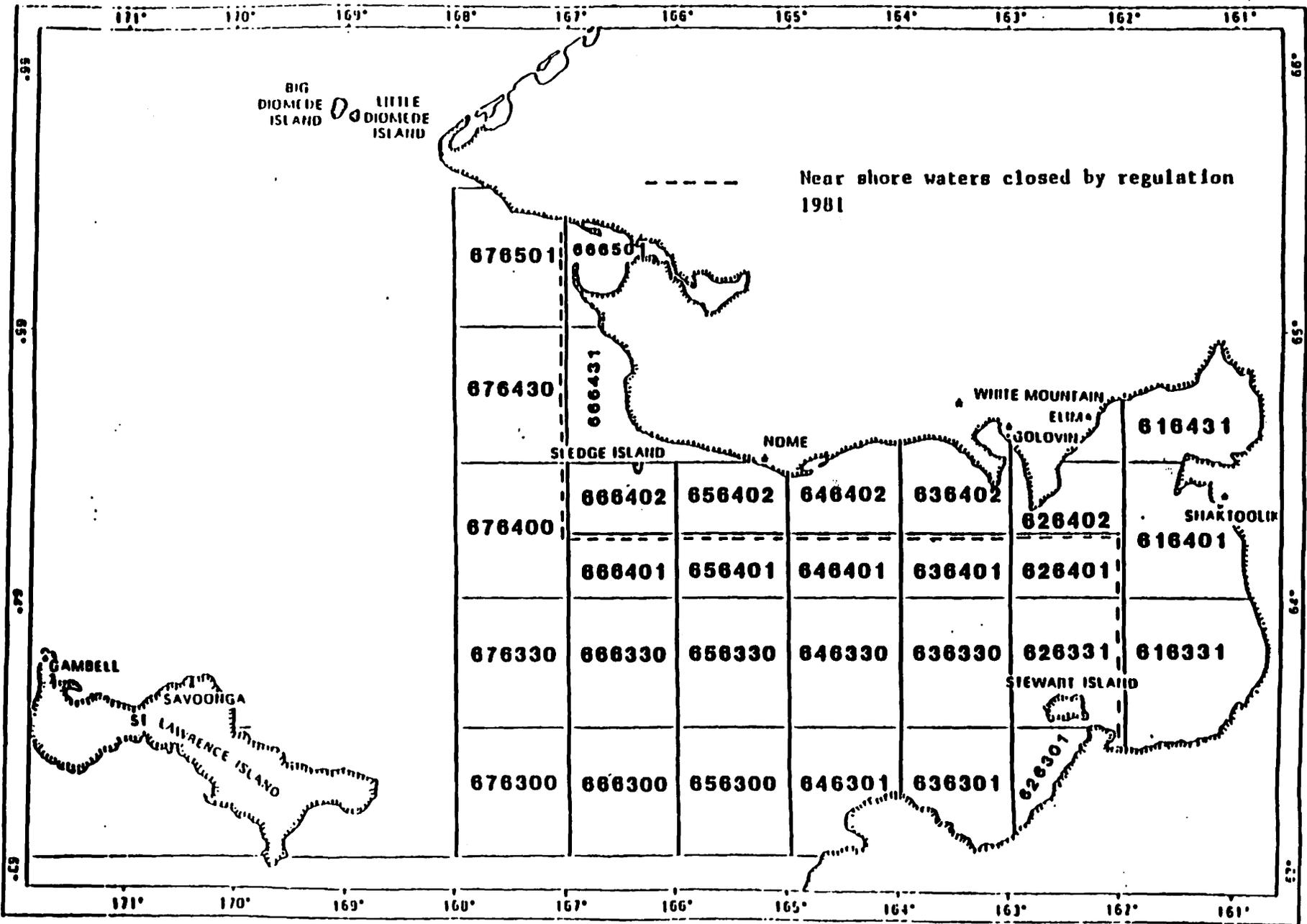


Figure 2. King crab fishing districts and sections of Statistical Area Q

Figure 3. Statistical areas for the Norton Sound Red King Crab Fishery.



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