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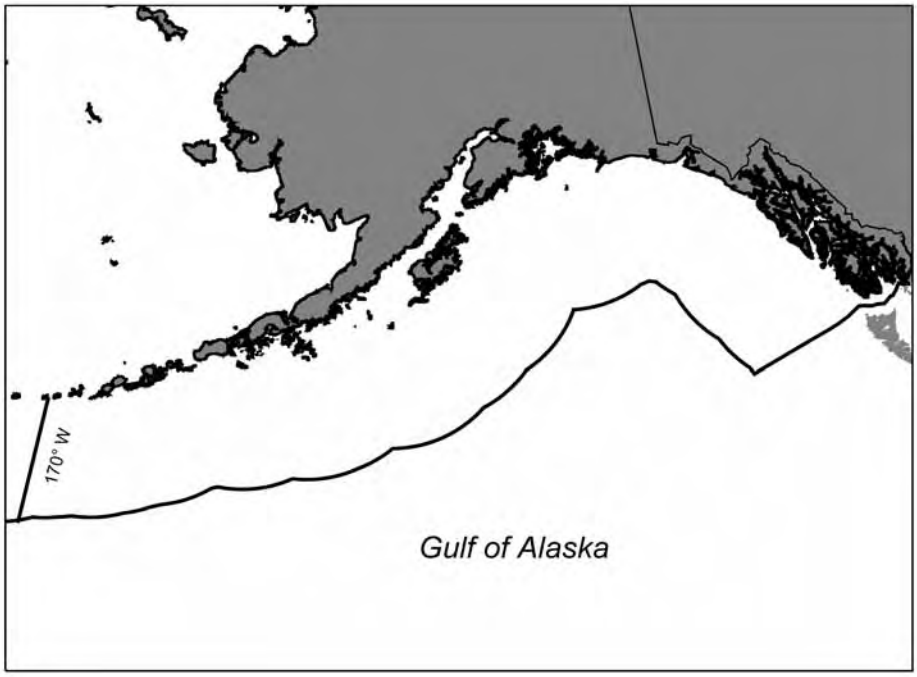
GULF OF ALASKA GROUNDFISH FISHERY MANAGEMENT PLAN



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Executive Summary

This Fishery Management Plan (FMP) governs groundfish fisheries of the Gulf of Alaska (GOA). The FMP management area is the United States (U.S.) exclusive economic zone (EEZ) of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170° W. longitude and Dixon Entrance at 132°40' W. longitude. The FMP covers fisheries for all stocks of finfish except salmon, steelhead, Pacific halibut, Pacific herring, and tuna.

This FMP was implemented on December 1, 1978. Since that time, it has been amended over sixty times, and its focus has changed from the regulation of mainly foreign fisheries to the management of fully domestic groundfish fisheries. This new version of the FMP has been revised to remove or update obsolete references to foreign fishery management measures, as well as outdated catch data and other scientific information. The FMP has also been reorganized to provide readers with a clear understanding of the GOA groundfish fishery and conservation and management measures promulgated by the FMP.

ES.1 Management Policy

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) is the primary domestic legislation governing management of the nation's marine fisheries. In 1996, the United States Congress reauthorized the Magnuson-Stevens Act to include, among other things, a new emphasis on the precautionary approach in U.S. fishery management policy. The Magnuson-Stevens Act contains ten national standards, with which all FMPs must conform and which guide fishery management. Besides the Magnuson-Stevens Act, U.S. fisheries management must be consistent with the requirements of other regulations including the Marine Mammal Protection Act, the Endangered Species Act, the Migratory Bird Treaty Act, and several other Federal laws.

Under the Magnuson-Stevens Act, the North Pacific Fishery Management Council (Council) is authorized to prepare and submit to the Secretary of Commerce for approval, disapproval or partial approval, a FMP and any necessary amendments, for each fishery under its authority that requires conservation and management. The Council conducts public hearings so as to allow all interested persons an opportunity to be heard in the development of FMPs and amendments, and reviews and revises, as appropriate, the assessments and specifications with respect to the optimum yield from each fishery (16 U.S.C. 1852(h)).

The Council has developed a management policy and objectives to guide its development of management recommendations to the Secretary of Commerce. This management approach is described in Table ES-1.

Table ES-1 GOA Groundfish Fisheries Management Approach

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

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

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

ES.2 Summary of Management Measures

The management measures that govern the Gulf of Alaska groundfish fishery are summarized in Table ES-2.

Pursuant to Title II of the Magnuson-Stevens Act, there is no allowable level of foreign fishing for the groundfish fisheries covered by this FMP. Fishing vessels and fish processors of the U.S. have the capacity to harvest and process up to the level of optimum yield of all species subject to this FMP.

Table ES-2 Summary of Management Measures for the GOA Groundfish Fishery

Management Area	U.S. exclusive economic zone (EEZ) of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170° W. longitude and Dixon Entrance at 132°40' W. longitude. **Regulatory areas**: Three regulatory areas are defined in the Gulf of Alaska: Eastern, extending from Dixon Entrance to 147° W. longitude; Central, extending between 147° W. and 159° W. longitude, and Western, extending between 159° W. and 170° W. longitude.
Stocks	All finfish, except salmon, steelhead, halibut, herring, and tuna, which are distributed or exploited in the management area, and are listed in Table 3-1. Those stocks and stock complexes that are commercially important and for which an annual TAC is established include: walleye pollock, Pacific cod, sablefish, shallow and deep water flatfish, rex sole, flathead sole, arrowtooth flounder, Pacific ocean perch, shortraker/rougheye rockfish, northern rockfish, "other slope" rockfish, pelagic shelf rockfish, demersal shelf rockfish, thornyhead rockfish, Atka mackerel, and skates. **State management**: Demersal shelf rockfish are managed by the State of Alaska under Council oversight. The Council retains the responsibility of setting the demersal shelf rockfish harvest level.
Optimum Yield (OY) and Maximum Sustainable Yield (MSY)	The OY of the GOA groundfish complex (consisting of stocks listed in the 'target species' and 'other species' categories, as listed in Table 3-1) is 116,000 to 800,000 mt. The upper end of the range is derived from MSY information.
Procedure to set Total Allowable Catch (TAC)	Based on the annual Stock Assessment and Fishery Evaluation (SAFE) report, the Council will recommend to the Secretary of Commerce TACs and apportionments thereof for each target species. TAC for the "other species" category will be set at 5% of the summed target species TACs. Up to two years of TACs may be established for certain species. **Reserve**: 20% of the TAC for pollock, Pacific cod, flatfish, and the "other species" category is set aside to form the reserve, which may be reapportioned to these fisheries at any time and in any amount by the Regional Administrator.
Apportionment of TAC	Harvest allocations and management are based on the calendar year. TACs are apportioned by regulatory area, and by district for some stocks. Areas or districts may also be managed together. **Pollock**: the Western and Central regulatory areas are combined, and annual TACs are divided into seasonal allowances. 100% of the TAC is allocated to the inshore sector. **Pacific cod**: TAC shall be allocated 90% to the inshore sector and 10% to the offshore sector. **Sablefish**: the Eastern regulatory area is divided into two districts, West Yakutat and Southeast Outside. In the Eastern regulatory area, vessels using hook and line gear will be permitted to take up to 95% of the TAC, and vessels using trawl gear up to 5%. In the Western and Central regulatory areas, vessels using hook and line gear will be permitted to take up to 80% of the TAC, and vessels using trawl gear up to 20%. **Rockfish**: the Eastern regulatory area is divided into two districts, West Yakutat and Southeast Outside.
Permit	All vessels participating in the GOA groundfish fisheries, other than fixed gear sablefish and demersal shelf rockfish in Southeast Outside district, require a Federal groundfish license, except for: vessels fishing in State of Alaska waters and vessels less than 26' LOA. Licenses are endorsed with area, gear, and vessel type and length designations. Fishing permits may be authorized, for limited experimental purposes, for the target or incidental harvest of groundfish that would otherwise be prohibited.
Participation Restrictions	**American Fisheries Act** (AFA): Vessels or processors participating in the Bering Sea and Aleutian Islands pollock fishery authorized under the AFA are subject to harvesting and processing sideboard restrictions on GOA groundfish.
Authorized Gear	Gear types authorized by the FMP are trawls, hook-and-line, pots, jigs, and other gear as defined in regulations. **Sablefish**: Legal gear for taking sablefish in the GOA is hook and line and trawl gear.

Table ES-2 Summary of Management Measures for the GOA Groundfish Fishery

Time and Area Restrictions	**Fishing Year**: January 1-December 31. **All vessels**: Fishing or anchoring within the Sitka Pinnacles Marine Reserve is prohibited at all times. **Non-pelagic trawl**: Three types of closure areas are designated around Kodiak Island. Type I areas prohibit non-pelagic trawling year-round; Type II prohibit non-pelagic trawl from February 15 to June 15; adjacent areas designated as Type III may be reclassified by the Regional Administrator as Type I or Type II following a recruitment event. The use of non-pelagic trawl is prohibited in Cook Inlet. **Marine mammal measures**: Regulations implementing the FMP may include conservation measures that temporally and spatially limit fishing effort around areas important to marine mammals. **Gear test area exemption**: Specific gear test areas for use when the fishing grounds are closed to that gear type, are established in regulations that implement the FMP.
Prohibited Species	Pacific halibut, Pacific herring, Pacific salmon, steelhead trout, king crab, and Tanner crab are prohibited species and must be returned to the sea with a minimum of injury except when their retention is authorized by other applicable law. Groundfish species and species under this FMP for which the quota has been achieved shall be treated in the same manner as prohibited species.
Prohibited Species Catch (PSC) Limits	**Pacific halibut**: Halibut mortality PSC limits are established annually in regulation; may be apportioned by season, regulatory area, gear type, and/or target fishery.
Retention and Utilization Requirements	**Pollock**: Roe-stripping is prohibited; see also Improved Retention/Improved Utilization Program (IR/IU). **IR/IU**: All pollock, Pacific cod, and shallow-water flatfish must be retained and processed.
Fixed Gear Sablefish Fishery	The directed fixed gear sablefish fisheries are managed under an Individual Fishing Quota program. The FMP specifies requirements for the initial allocation of quota share in 1995, as well as transfer, use, ownership, and general provisions. **Annual Allocation**: The ratio of a person's quota share to the quota share pool is multiplied by the fixed gear TAC (adjusted for the community development quota allocation - see below), to arrive at the annual individual fishing quota. **Community Quota Share Purchases**: Specified GOA coastal communities are eligible to hold commercial catcher boat sablefish quota share under the IFQ program.
Flexible Authority	The Regional Administrator of NMFS is authorized to make inseason adjustments through gear modifications, closures, or fishing area/quota restrictions, for conservation reasons, to protect identified habitat problems, or to increase vessel safety.
Recordkeeping and Reporting	Recordkeeping that is necessary and appropriate to determine catch, production, effort, price, and other information necessary for conservation and management may be required. May include the use of catch and/or product logs, product transfer logs, effort logs, or other records as specified in regulations. **Processors**: Shall report necessary information for the management of the groundfish fisheries as specified in regulations. **At-sea processor vessels**: Catcher/processor vessels and mothership processors vessels may be required to check in and check out of any Federal statistical areas or the U.S. EEZ.
Observer Program	U.S. fishing vessels that catch groundfish in the EEZ, or receive groundfish caught in the EEZ, and shoreside processors that receive groundfish caught in the EEZ, are required to accommodate NMFS-certified observers as specified in regulations, in order to verify catch composition and quantity, including at-sea discards, and collect biological information on marine resources.
Evaluation and Review of the FMP	**Management Policy**: Objectives in the management policy statement will be reviewed annually. **Essential Fish Habitat (EFH)**: The Council will conduct a complete review of EFH once every 5 years, and in between will solicit proposals on Habitat Areas of Particular Concern and/or conservation and enhancement measures to minimize potential adverse effects from fishing. Annually, EFH information will be reviewed in the "Ecosystems Considerations" chapter of the SAFE.

ES.3 Organization of the FMP

The FMP is organized into six chapters. Chapter 1 contains an introduction to the FMP, and Chapter 2 describes the policy and management objectives of the FMP.

Chapter 3 contains the conservation and management measures that regulate the GOA groundfish fisheries. Section 3.1 denotes the area and stocks governed by the FMP, and describes the five categories of species or species groups likely to be taken in the groundfish fishery. Section 3.2 specifies the procedures for determining harvest levels for the groundfish species, and includes the maximum sustainable yield and optimum yield of the groundfish complex. Sections 3.3 to 3.6 contain permit and participation, gear, time and area, and catch restrictions for the groundfish fisheries, respectively. Section 3.7 describes the specific management measures for the quota share program in place in the fixed gear sablefish fishery. Measures that allow flexible management authority are addressed in Section 3.8, and Section 3.9 designates monitoring and reporting requirements for the fisheries. Section 3.10 describes the schedule and procedures for review of the FMP or FMP components.

Chapter 4 contains a description of the stocks and their habitat (including essential fish habitat definitions), fishing activities, the economic and socioeconomic characteristics of the fisheries and communities, and ecosystem characteristics. Additional descriptive information is also contained in the appendices. Chapter 5 specifies how relationship of the FMP with applicable law and other fisheries. Chapter 6 references additional sources of material on the groundfish fisheries, and includes the bibliography.

Appendices to the FMP include supplemental information. Appendix A contains a history of the GOA groundfish FMP, including a summary of its amendments. Appendix B describes the geographical coordinates for the areas specified in the FMP. Appendix C incorporates sections of the American Fisheries Act that are referenced in the GOA groundfish fishery management measures. Appendices D, E, and F include, respectively, habitat information by life stage for managed species, maps of essential fish habitat, and a discussion of adverse effects on essential fish habitat. Appendix G summarizes FMP impacts on fishery participants and fishing communities. Appendix H examines research needs in the GOA groundfish fisheries. Appendix I includes information about marine mammals and seabirds interacting with the GOA groundfish fisheries, including species listed under the Endangered Species Act.

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Acronyms and Abbreviations Used in the FMP

‘	minutes
%	percent
ABC	acceptable biological catch
AFA	American Fisheries Act
AI	Aleutian Islands
ALT	Alaska Local Time
B	biomass
BSAI	Bering Sea and Aleutian Islands
$B_{x\%}$	biomass that results from a fishing mortality rate of $F_{x\%}$
C	Celsius or Centigrade
C.F.R.	Code of Federal Regulations
CDP	community development plan
CDQ	community development quota
cm	centimeter(s)
COBLZ	*C. Opilio* Bycatch Limitation Zone
Council	North Pacific Fishery Management Council
CVOA	catcher vessel operational area
DAH	domestic annual harvest
DAP	domestic annual processed catch
E.	East
EEZ	exclusive economic zone
EFH	essential fish habitat
EY	equilibrium yield
F	fishing mortality rate
FMP	fishery management plan
FOCI	Fisheries-Oceanography Coordinated Investigations
ft	foot/feet
$F_{x\%}$	fishing mortality rate at which the SPR level would be reduced to *X%* of the SPR level in the absence of fishing
GHL	guideline harvest level
GMT	Greenwich mean time
HAPC	habitat area of particular concern
IFQ	individual fishing quota
IPHC	International Pacific Halibut Commission
IR/IU	Improved Retention/Improved Utilization Program
JVP	Joint venture processed catch
kg	kilogram(s)
km	kilometer(s)
lb	pound(s)
LLP	licence limitation program
LOA	length overall
m	meter(s)
M	natural mortality rate
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
mm	millimeter(s)
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSY	maximum sustainable yield
mt	metric ton(s)
N.	North
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
OFL	overfishing level
OY	optimum yield
pdf	probablity density function
POP	Pacific ocean perch
ppm	part(s) per million
ppt	part(s) per thousand
PSC	prohibited species catch
QS	quota share(s)
RKCSA	Red King Crab Savings Area
S.	South
SAFE	Stock Assessment and Fishery Evaluation
SPR	spawning per recruit
SSC	North Pacific Fishery Management Council’s Scientific and Statistical Committee
TAC	total allowable catch
TALFF	total allowable level of foreign fishing
U.S.	United States
U.S.C.	United States Code
USSR	United Soviet Socialist Republics
W.	West
°	degrees

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Chapter 1 Introduction

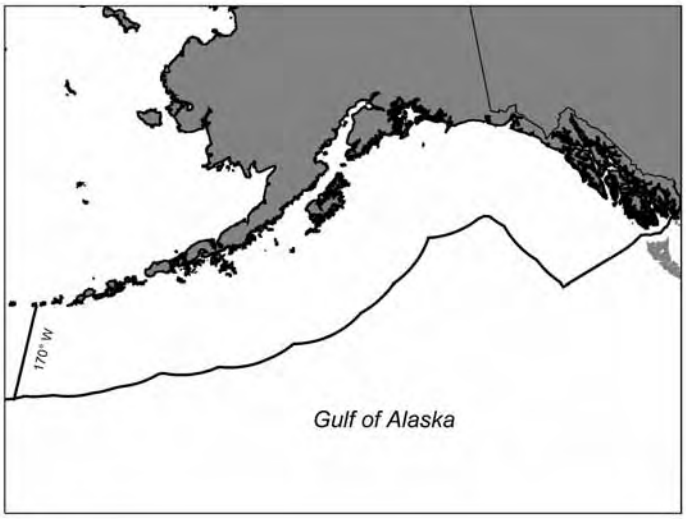
This Fishery Management Plan (FMP) governs groundfish fisheries of the Gulf of Alaska (GOA). The geographical extent of the FMP management unit is the United States (U.S.) Exclusive Economic Zone (EEZ) of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170° W. longitude and Dixon Entrance at 132°40' W. longitude (Figure 1-1).

This FMP was implemented on December 1, 1978. Since that time, it has been amended over sixty times, and its focus has changed from the regulation of mainly foreign fisheries to the management of fully domestic groundfish fisheries.

The FMP covers fisheries for all stocks of finfish except salmon, steelhead, Pacific halibut, Pacific herring, and tuna. In terms of both the fishery and the groundfish resource, the GOA groundfish fishery forms a distinct management unit. The history of fishery development, target species and species composition of the commercial catch, bathymetry, and oceanography are all much different in the Gulf of Alaska than in the adjacent Bering Sea and Aleutian Islands (BSAI) management area or British Columbia to California regions. Although many species occur over a broader range than the GOA management area, with only a few exceptions (e.g., sablefish), stocks of common species in this region are believed to be different from those in the adjacent BSAI.

The International Pacific Halibut Commission is responsible for management of the North American Pacific halibut fishery, under the authority of the Convention for the Preservation of the Halibut Fishery of the North Pacific Ocean and the Bering Sea. The potential adverse impact on halibut from the groundfish fisheries is such that it must be taken into account in the management of the groundfish fishery. Therefore, certain pertinent aspects of the halibut resource and the directed fishery it supports are described in this FMP. Throughout this document, the term “groundfish” excludes Pacific halibut.

Figure 1-1 Management Unit for the Fishery Management Plan for Groundfish of the Gulf of Alaska.



1.1 Foreign Fishing

Title II of the Magnuson-Stevens Act establishes the system for the regulation of foreign fishing within the U.S. EEZ. These regulations are published in 50 CFR 600. The regulations provide for the setting of a total allowable level of foreign fishing (TALFF) for species based on the portion of the optimum yield that will not be caught by U.S. vessels. At the present time, no TALFF is available for the fisheries covered by this FMP, because the U.S. has the capacity to harvest up to the level of optimum yield of all species subject to this FMP. Also, U.S. fish processors have the capacity to process all of the optimum yield of GOA groundfish.

Chapter 2 Management Policy and Objectives

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) is the primary domestic legislation governing management of the nation's marine fisheries. In 1996, the United States Congress reauthorized the Magnuson-Stevens Act to include, among other things, a new emphasis on the precautionary approach in U.S. fishery management policy. The Magnuson-Stevens Act contains ten national standards, with which all fishery management plans (FMPs) must conform and which guide fishery management. The national standards are listed in Section 2.1, and provide the primary guidance for the management of the groundfish fisheries.

Under the Magnuson-Stevens Act, the North Pacific Fishery Management Council (Council) is authorized to prepare and submit to the Secretary of Commerce for approval, disapproval or partial approval, a FMP and any necessary amendments, for each fishery under its authority that requires conservation and management. The Council conducts public hearings so as to allow all interested persons an opportunity to be heard in the development of FMPs and amendments, and reviews and revises, as appropriate, the assessments and specifications with respect to the optimum yield from each fishery (16 U.S.C. 1852(h)).

The Council has developed a management policy and objectives to guide its development of management recommendations to the Secretary of Commerce for the Gulf of Alaska (GOA) groundfish fisheries. This management approach is described in Section 2.2.

2.1 National Standards for Fishery Conservation and Management

The Magnuson-Stevens Fishery Conservation and Management Act, as amended, sets out ten national standards for fishery conservation and management (16 U.S.C. § 1851), with which all fishery management plans must be consistent.

1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.
2. Conservation and management measures shall be based upon the best scientific information available.
3. To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.
4. Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be A) fair and equitable to all such fishermen; B) reasonably calculated to promote conservation; and C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.
5. Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

7. Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

8. Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to A) provide for the sustained participation of such communities, and B) to the extent practicable, minimize adverse economic impacts on such communities.

9. Conservation and management measures shall, to the extent practicable, A) minimize bycatch and B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

10. Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

2.2 Management Approach for the GOA Groundfish Fisheries

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

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

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

2.2.1 Management Objectives

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

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

Prevent Overfishing:

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

Promote Sustainable Fisheries and Communities:

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

Preserve Food Web:

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

Manage Incidental Catch and Reduce Bycatch and Waste:

14. Continue and improve current incidental catch and bycatch management program.
15. Develop incentive programs for bycatch reduction including the development of mechanisms to facilitate the formation of bycatch pools, vessel bycatch allowances, or other bycatch incentive systems.

16. Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits, as information becomes available.
17. Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce bycatch which includes economic discards.
18. Continue to manage incidental catch and bycatch through seasonal distribution of total allowable catch and geographical gear restrictions.
19. Continue to account for bycatch mortality in total allowable catch accounting and improve the accuracy of mortality assessments for target, prohibited species catch, and non-commercial species.
20. Control the bycatch of prohibited species through prohibited species catch limits or other appropriate measures.
21. Reduce waste to biologically and socially acceptable levels.

Avoid Impacts to Seabirds and Marine Mammals:

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

Reduce and Avoid Impacts to Habitat:

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

Promote Equitable and Efficient Use of Fishery Resources:

31. Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources.
32. Maintain the licence limitation program, modified as necessary, and further decrease excess fishing capacity and overcapitalization by eliminating latent licences and extending programs such as community or rights-based management to some or all groundfish fisheries.

33. Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of access rights based on performance.
34. Develop management measures that, when practicable, consider the efficient use of fishery resources taking into account the interest of harvesters, processors, and communities.

Increase Alaska Native Consultation:

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

Improve Data Quality, Monitoring and Enforcement:

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

Chapter 3 Conservation and Management Measures

The Fishery Management Plan (FMP) for Groundfish of the Gulf of Alaska (GOA) Management Area authorizes the commercial harvest of species listed in Section 3.1 of this FMP. Commercial fishing is authorized during the fishing year unless otherwise specified in the FMP. Section 3.2 describes the procedures for determining harvest levels for the groundfish species. Sections 3.3 to 3.6 address permit and participation, authorized gear, time and area, and catch restrictions, respectively. Section 3.7 describes the specific management measures for the quota share program in place in the fixed gear sablefish fishery. Measures that allow flexible management authority are addressed in Section 3.8, and Section 3.9 designates monitoring and reporting requirements for the fisheries. Section 3.10 describes the schedule and procedures for review of the FMP or FMP components.

The groundfish resources off Alaska have been harvested and processed entirely by U.S.-flagged vessels since 1991. Conservation and management measures contained in this FMP apply exclusively to domestic fishing activities. No portion of the annual optimum yield is allocated to foreign harvesters or foreign processors.

3.1 Areas and Stocks Involved

The FMP and its management regime governs fishing in the GOA management area described in Section 3.1.1, for those stocks listed in Section 3.1.2.

3.1.1 Management Area

The Gulf of Alaska management area encompasses the U.S. Exclusive Economic Zone (EEZ) of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170° W. longitude and Dixon Entrance at 132°40' W. longitude (Figure 1-1).

The management area is divided into the following regulatory areas: Western, Central, and Eastern. The Central regulatory area is divided into two districts: Chirikof and Kodiak. The Eastern regulatory area is also divided into two districts: West Yakutat and Southeast Outside. The regulatory areas and districts are illustrated in Figure 3-1. Geographical coordinates for these areas are described in Appendix B.

Figure 3-1 Regulatory Areas and Districts of the Gulf of Alaska.

[PLACEHOLDER]

3.1.2 Stocks

Stocks governed by the FMP include all finfish, except salmon, steelhead, halibut, herring, and tuna, which are distributed or are exploited in the area described in Section 3.1.1, and which are listed in Table 3-1. Harvest allocations and management are based on the calendar year.

Five categories of species or species groups are likely to be taken in the groundfish fishery. Species may be split or combined within the "target species" category according to procedures set forth in Section 3.2.3.1 without amendments to this FMP, notwithstanding the designation listed in the FMP. The optimum yield concept is applied to all except the "prohibited species" category. These categories are tabulated in Table 3-1 and are described as follows:

1. Prohibited Species – are those species and species groups the catch of which must be avoided while fishing for groundfish, and which must be immediately returned to sea with a minimum of injury except when their retention is authorized by other applicable law (see also Prohibited Species Donation Program described in Section 3.6.1.1). Groundfish species and species groups under the FMP for which the quotas have been achieved shall be treated in the same manner as prohibited species.

2. Target species – are those species that support a single species or mixed species target fishery, are commercially important, and for which a sufficient data base exists that allows each to be managed on its own biological merits. Accordingly, a specific TAC is established annually for each target species. Catch of each species must be recorded and reported. This category includes walleye pollock, Pacific cod, sablefish, shallow and deep water flatfish, rex sole, flathead sole, arrowtooth flounder, Pacific ocean perch, shortraker/rougheye rockfish, northern rockfish, "other slope" rockfish, pelagic shelf rockfish, demersal shelf rockfish, thornyhead rockfish, Atka mackerel, and skates.

3. Other Species – are those species or species groups that currently are of slight economic value and not generally targeted upon. This category, however, contains species with economic potential or which are important ecosystem components, but insufficient data exist to allow separate management. Accordingly, a single TAC applies to this category as a whole. The TAC will be equal to 5% of the combined TACs for target species. Catch of this category as a whole must be recorded and reported. The category includes squid, sculpins, sharks, and octopus.

4. Forage fish species – are those species listed in Table 3-1, which are a critical food source for many marine mammal, seabird and fish species. The forage fish species category is established to allow for the management of these species in a manner that prevents the development of a commercial directed fishery for forage fish. Management measures for this species category will be specified in regulations and may include such measures as prohibitions on directed fishing, limitations on allowable bycatch retention amounts, or limitations on the sale, barter, trade or any other commercial exchange, as well as the processing of forage fish in a commercial processing facility.

5. Nonspecified species – are those species and species groups of no current economic value taken by the groundfish fishery only as an incidental catch in the target fisheries. Virtually no data exist which would allow population assessments. No record of catch is necessary. The allowable catch for this category is the amount that is taken incidentally while fishing for target and other species, whether retained or discarded.

Table 3-1 Species included in the FMP species categories

Prohibited Species[1]	Pacific halibut Pacific herring Pacific salmon Steelhead trout King crab Tanner crab
Target Species[2]	Walleye pollock Pacific cod Sablefish Flatfish (shallow-water flatfish, deep-water flatfish, rex sole, flathead sole, arrowtooth flounder) Rockfish (Pacific ocean perch, northern rockfish, shortraker and rougheye rockfish, other slope rockfish, pelagic shelf rockfish, demersal shelf rockfish[3], thornyhead rockfish) Atka mackerel Skates (big and longnose skates, other skates)
Other Species[4]	Squid Sculpins Sharks Octopus
Forage Fish Species[5]	Osmeridae family (eulachon, capelin, and other smelts) Myctophidae family (lanternfishes) Bathylagidae family (deep-sea smelts) Ammodytidae family (Pacific sand lance) Trichodontidae family (Pacific sand fish) Pholidae family (gunnels) Stichaeidae family (pricklebacks, warbonnets, eelblennys, cockscombs, and shannys) Gonostomatidae family (bristlemouths, lightfishes, and anglemouths) Order Euphausiacea (krill)

[1]Must be immediately returned to the sea
[2]TAC for each listing
[3]Management delegated to the State of Alaska
[4]Aggregate TAC for group
[5]Management measures for forage fish are established in regulations implementing the FMP

3.2 Determining Harvest Levels

This section of the FMP provides the basis for determining harvest levels in the groundfish fisheries. Section 3.2.1 defines terms used in the harvest specification process. The maximum sustainable yield and optimum yield of groundfish in the Bering Sea and Aleutian Islands are addressed in Sections 3.2.2 and 3.2.3. Criteria for determining overfishing are described in Section 3.2.4, followed by the procedures for setting total allowable catch in Section 3.2.5. Section 3.2.6 specifies those groundfish fisheries for which the total allowable catch is apportioned by gear type, area, or season. Section 3.2.7 identifies the consequences of attaining total allowable catch.

The Council harvest strategy was reviewed in 2002 by Goodman *et al.*.The report contains a historical overview of the Council's approach to fishery harvest management, and an analysis of single-species, multispecies and ecosystem issues relating to the harvest strategy. The report is available by request from the Council office.

3.2.1 Definition of Terms

Maximum sustainable yield (MSY) is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions.

Optimum yield (OY) is the amount of fish which–

a) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;
b) is prescribed as such on the basis of the MSY from the fishery, as reduced by any relevant economic, social, or ecological factor; and
c) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY in such fishery.

Overfishing level (OFL) is a limit reference point set annually for a stock or stock complex during the assessment process, as described in Section 3.2.4, Overfishing criteria. Overfishing occurs whenever a stock or stock complex is subjected to a rate or level of fishing mortality that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuing basis. Operationally, overfishing occurs when the harvest exceeds the OFL.

Acceptable biological catch (ABC) is an annual sustainable target harvest (or range of harvests) for a stock or stock complex, determined by the Plan Team and the Science and Statistical Committee during the assessment process. It is derived from the status and dynamics of the stock, environmental conditions, and other ecological factors, given the prevailing technological characteristics of the fishery. The target reference point is set below the limit reference point for overfishing.

Total allowable catch (TAC) is the annual harvest limit for a stock or stock complex, derived from the ABC by considering social and economic factors.

In addition to definitional differences, OY differs from ABC and TAC in two practical respects. First, ABC and TAC are specified for each stock or stock complex within the "target species" and "other species" categories, whereas OY is specified for the groundfish fishery (comprising target sepcies and other species categories) as a whole. Second, ABCs and TACs are specified annually whereas the OY range is constant. The sum of the stock-specific ABCs may fall within or outside of the OY range. If the sum of annual TACs falls outside the OY range, TACs must be adjusted or the FMP amended.

3.2.2 Maximum Sustainable Yield of the Groundfish Complex

The groundfish complex and its fishery are a distinct management unit of the Gulf of Alaska. This complex forms a large subsystem of the Gulf of Alaska ecosystem with intricate interrelationships between predators and prey, between competitors, and between those species and their environment. Ideally, concepts such as productivity and MSY should be viewed in terms of the groundfish complex as a unit rather than for individual species or species groups. Due to the difficulty of estimating the parameters that govern interactions between species, however, estimates of MSY for the groundfish complex have sometimes been computed by summing MSY estimates for the individual species and species groups.

Early studies estimated MSY for the Gulf of Alaska groundfish complex ranging from 804,950 mt in 1983 to 1,018,750 mt for the 1987 fishing year. This range was obtained by summing the MSY ranges for each target species excluding the "other species" category. However, current multi-species models suggest that

the sum of single-species MSYs provides a poor estimate of MSY for the groundfish complex as a whole (Walters et al., in press) because biological reference points for single stocks, such as F_{MSY}, may change substantially when multi-species interactions are taken into account (Gislason 1999; Collie and Gislason 2001). Fishing mortality rates for prey species that are consumed by other marine predators should be conditioned on the level of predation mortality, which may change over time depending on predator population levels.

An ecosystem perspective suggests that the MSY of the groundfish complex may change if an environmental regime shift occurs or if the present mix of species is altered substantially. Also, as new data are acquired and as statistical methodology evolves over time, it is to be expected that estimates of MSY will change, even if the ecosystem has remained relatively stationary. Therefore, estimates of MSY contained in this section should be viewed in context, as historical estimates that guided development of the FMP but not necessarily as reflective of the best scientific information available currently.

3.2.3 Optimum Yield of the Groundfish Complex

The range of optimum yield specified in the FMP is 116,000-800,000 mt of groundfish for the target species and the "other species" categories, to the extent this can be harvested consistently with the management measures specified in this FMP. This range was established in 1987 based on the examination of historical and recent catches, recent determinations of ABC, and recent and past estimates of MSY for each major groundfish species. This derivation from historical estimates of MSY and fishery performance reflects the combined influence of biological, ecological, and socioeconomic factors. The end points of the range were derived as described below.

For the minimum value, 116,000 mt was approximately equal to the lowest historical groundfish catch during the 21-year period 1965-1985 (116,053 mt in 1971, Table 4.1 GOA FMP October, 1994). In that year catches of pollock, Pacific cod and Atka mackerel were all at very low levels. Given the status of the groundfish resources and the present management regime, it was considered extremely unlikely that future total harvest would fall below this level. Thus, the TACs must be established so as to result in a sum of at least 116,000 mt.

The upper end of the OY range, 800,000 mt, was derived from MSY information. The MSY for all species of groundfish (excluding the other species category) between 1983 and 1987 ranged from 804,950 mt in 1983 to 1,137,750 mt for the 1987 fishing year. The average MSY over the five-year period was 873,070 mt. Therefore, the upper end of the range is approximately equal to 92% of the mean MSY for the five-year period. The ABC summed for all species ranged from 457,082 mt in 1985 to 814,752 mt in 1987. Most of the variation in the ABC and catch over the five-year interval resulted from changes in the status of two species: pollock and flounder. Pollock ABC ranged from 112,000 mt in 1987 to 516,600 mt in 1984; while flounder ABC ranged from 33,500 mt in 1985 to 537,000 mt in 1987. Therefore, the 800,000 mt upper end of the OY range was selected in consideration of the volatility in pollock and flounder ABC, and the potential for harvesting at MSY.

The OY range is not likely to have any significant detrimental impact on the industry. On the contrary, specification of OY as a constant range helps to create a stable management environment in which the industry can plan its activities consistently, with an expectation that each year's total groundfish catch will be at least 116,000 mt. The OY range encompasses the annual catch levels taken in the period immediately prior to its implementation, during which the fishery operated profitably.

OY may need to be respecified in the future if major changes occur in the estimate of MSY for the groundfish complex. Likewise, OY may need to be respecified if major changes occur in the ecological, social, or economic factors governing the relationship between OY and MSY.

3.2.4 Overfishing Criteria

Overfishing is defined as any amount of fishing in excess of a prescribed maximum allowable rate. This maximum allowable rate is prescribed through a set of six tiers which are listed below in descending order of preference, corresponding to descending order of information availability. The Council's Science and Statistical Committee (SSC) will have final authority for determining whether a given item of information is "reliable" for the purpose of this definition, and may use either objective or subjective criteria in making such determinations.

For tier (1), a "pdf" refers to a probability density function. For tiers 1 and 2, if a reliable pdf of B_{MSY} is available, the preferred point estimate of B_{MSY} is the geometric mean of its pdf. For tiers 1 to 5, if a reliable pdf of B is available, the preferred point estimate is the geometric mean of its pdf. For tiers 1 to 3, the coefficient α is set at a default value of 0.05. This default value was established by applying the 10% rule suggested by Rosenberg et al. (1994) to the 1/2 B_{MSY} reference point. However, the SSC may establish a different value for a specific stock or stock complex as merited by the best available scientific information. For tiers 2 to 4, a designation of the form "$F_{X\%}$" refers to the F associated with an equilibrium level of spawning per recruit equal to $X\%$ of the equilibrium level of spawning per recruit in the absence of any fishing. If reliable information sufficient to characterize the entire maturity schedule of a species is not available, the SSC may choose to view spawning per recruit calculations based on a knife-edge maturity assumption as reliable. For tier 3, the term $B_{40\%}$ refers to the long-term average biomass that would be expected under average recruitment and $F=F_{40\%}$.

Tier 1 Information available: Reliable point estimates of B and B_{MSY} and reliable pdf of F_{MSY}.

1a) Stock status: $B/B_{MSY} > 1$
$F_{OFL} = m_A$, the arithmetic mean of the pdf
$F_{ABC} \leq m_H$, the harmonic mean of the pdf

1b) Stock status: $a < B/B_{MSY} \leq 1$
$F_{OFL} = m_A \times (B/B_{MSY} - a)/(1 - a)$
$F_{ABC} \leq m_H \times (B/B_{MSY} - a)/(1 - a)$

1c) Stock status: $B/B_{MSY} \leq a$
$F_{OFL} = 0$
$F_{ABC} = 0$

Tier 2 Information available: Reliable point estimates of B, B_{MSY}, F_{MSY}, $F_{35\%}$, and $F_{40\%}$.

2a) Stock status: $B/B_{MSY} > 1$
$F_{OFL} = F_{MSY}$
$F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%})$

2b) Stock status: $a < B/B_{MSY} \leq 1$
$F_{OFL} = F_{MSY} \times (B/B_{MSY} - a)/(1 - a)$
$F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%}) \times (B/B_{MSY} - a)/(1 - a)$

2c) Stock status: $B/B_{MSY} \leq a$
$F_{OFL} = 0$
$F_{ABC} = 0$

Tier 3 Information available: Reliable point estimates of B, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$.

3a) Stock status: $B/B_{40\%} > 1$

$F_{OFL} = F_{35\%}$

$F_{ABC} \leq F_{40\%}$

3b) Stock status: $a < B/B_{40\%} \leq 1$

$F_{OFL} = F_{35\%} \times (B/B_{40\%} - a)/(1 - a)$

$F_{ABC} \leq F_{40\%} \times (B/B_{40\%} - a)/(1 - a)$

3c) Stock status: $B/B_{40\%} \leq a$

$F_{OFL} = 0$

$F_{ABC} = 0$

Tier 4 Information available: Reliable point estimates of B, $F_{35\%}$, and $F_{40\%}$.

$F_{OFL} = F_{35\%}$

$F_{ABC} \leq F_{40\%}$

Tier 5 Information available: Reliable point estimates of B and natural mortality rate M.

$F_{OFL} = M$

$F_{ABC} \leq 0.75 \times M$

Tier 6 Information available: Reliable catch history from 1978 through 1995.

OFL = the average catch from 1978 through 1995, unless an alternative value is established by the SSC on the basis of the best available scientific information

ABC $\leq$ 0.75 × OFL

3.2.5 Procedures for Setting Total Allowable Catch

The Secretary, after receiving recommendations from the Council, will determine up to 2 years of TACs and apportionments thereof, and reserves for each stock or stock complex in the "target species" and "other species" categories, by January 1 of the new fishing year, or as soon as practicable thereafter, by means of regulations implementing the FMP. Notwithstanding designated stocks or stock complexes listed by category in Table 3-1, the Council may recommend splitting or combining stocks or stock complexes in the "target species" category for purposes of establishing a new TAC if such action is desirable based on commercial importance of a stock or stock complex and whether sufficient biological information is available to manage a stock or stock complex on its own merits.

Prior to making final recommendations to the Secretary, the Council will make available to the public for comment as soon as practicable after its October meeting, proposed specifications of ABC and TAC for each target stock or stock complex and the "other species" category, and apportionments thereof, and reserves.

The Council will provide proposed recommendations for harvest specifications to the Secretary after its October meeting, including detailed information on the development of each proposed specification and any future information that is expected to affect the final specifications. As soon as practicable after the October meeting, the Secretary will publish in the *Federal Register* proposed harvest specifications based on the Council's October recommendations and make available for public review and comment, all information regarding the development of the specifications, identifying specifications that are likely to change, and possible reasons for changes, if known, from the proposed to final specifications. The prior public review and comment period on the published proposed specifications will be a minimum of 15 days.

At its December meeting, the Council will review the final SAFE reports, recommendations from the Groundfish Plan teams, SSC, AP, and comments received. The Council will then make final harvest

specifications recommendations to the Secretary for review, approval, and publication. New final annual specifications will supercede current annual specifications on the effective date of the new annual specifications.

3.2.5.1 Framework for Setting Total Allowable Catch

A procedure has been developed whereby the Council may set annual harvest levels by specifying a total allowable catch for each groundfish fishery on an annual basis. The procedure is used to determine TACs for every groundfish stock and stock complex managed by the FMP with the exception of the stocks listed in the "other species" management category. The "other species" category will be managed by a single TAC equal to 5% of the combined TACs for all stocks in the "target species" category. The percentage, determined in 1987, is intended to amply provide for the anticipated incidental catch of these species.

The procedure for setting TAC consists of the following steps:

1. Determine the ABC for each managed stock or stock complex. ABCs are recommended by the Council's SSC based on information presented by the Plan Team.
2. Determine a TAC based on biological and socioeconomic information. The TAC may be lower than the ABC if bycatch considerations or socioeconomic considerations cause the Council to establish a lower harvest.
3. Sum TACs for "target species" and "other species" to assure that the sum is within the optimum yield range specified for the groundfish complex in the FMP. If the sum falls outside this range the TACs must be adjusted or the FMP amended.

3.2.5.2 Stock Assessment and Fishery Evaluation

For purposes of supplying scientific information to the Council for use in specifying TACs, a *Stock Assessment and Fishery Evaluation* report is prepared annually (or biennially for some species).

Scientists from the Alaska Fisheries Science Center, the Alaska Department of Fish and Game, and other agencies and universities prepare *Stock Assessment and Fishery Evaluation* (SAFE) documents annually (see Section 3.2.5.2 for further information). These documents are first reviewed by the Groundfish Plan Team, and then by the Council's SSC and AP, and the Council. Reference point recommendations are made at each level of assessment. Usually, scientists recommend values for ABC and OFL, and the AP recommends values for TAC. The Council has final authority to approve all reference points, but focuses on setting TACs so that OY is achieved and OFLs are not exceeded.

The SAFE report will, at a minimum, contain or refer to the following:

1. current status of Gulf of Alaska management area groundfish resources, by major species or species group;
2. estimates of maximum sustainable yield and acceptable biological catch;
3. estimates of groundfish species mortality from nongroundfish fisheries, subsistence fisheries, and recreational fisheries, and difference between groundfish mortality and catch, if possible;
4. fishery statistics (landings and value) for the current year;
5. the projected responses of stocks and fisheries to alternative levels of fishing mortality;

6. any relevant information relating to changes in groundfish markets;
7. information to be used by the Council in establishing prohibited species catch limits for prohibited species with supporting justification and rationale (further detail in Section 3.6.2); and
8. any other biological, social, or economic information that may be useful to the Council.

The Council will use the following to develop its own preliminary recommendations: 1) recommendations of the Plan Team and Council's SSC and information presented by the Plan Team and SSC in support of these recommendations; 2) information presented by the Council's Advisory Panel and the public; and 3) other relevant information.

3.2.5.3 Reserves

Reserves are set at 20% of the TAC of pollock, Pacific cod, flatfish, and "other species". At any time, the Regional Administrator may assess these fisheries and apportion to them any amounts from the reserves that is determined will be harvested.

Any additional in-season allocation from reserves may carry with it an additional PSC limit amount proportional to that reserve release and the respective bycatch rates in the affected fisheries.

3.2.6 Apportionment of Total Allowable Catch

3.2.6.1 Seasonal Allocations

Harvest allocations and management are based on the calendar year.

3.2.6.1.1 Pollock

The annual TAC established for pollock in the combined Western and Central regulatory areas shall be divided into seasonal allowances. Seasonal allowances of the pollock TAC will be established by regulation. The Council will consider the criteria described in Section 3.5.1 when recommending changes in seasonal allowances. Shortfalls or overages in one seasonal allowance shall be proportionately added to, or subtracted from, subsequent seasonal allowances.

3.2.6.2 Allocations by Geographical Area

TACs are apportioned by regulatory area, and may be further apportioned by district for certain stocks. Some of these districts may be managed together to improve management of these fisheries.

3.2.6.2.1 Pollock

For purposes of managing pollock, the Western and Central regulatory areas are combined to allow improved management and better conservation of the pollock resource.

3.2.6.2.2 Sablefish and Rockfish

The Eastern regulatory area is divided into two districts, West Yakutat and Southeast Outside, for purposes of managing sablefish and rockfish stocks. This division is intended to protect localized sablefish stocks and

demersal shelf rockfish stocks and is necessary to prevent overexploitation in the Eastern regulatory area. The Southeast Outside district delineates the primary rockfish fishing ground in this region.

3.2.6.3 Allocations by Gear Type and Sector

3.2.6.3.1 Sablefish

In the Eastern regulatory area, from 1986 forward, vessels using hook and longline gear shall be permitted to take up to 95% of the TAC for sablefish. Vessels using trawl gear shall be permitted to harvest up to 5% of the TAC for sablefish.

In the Central and Western regulatory areas, from 1987 and 1989 forward (respectively), vessels using hook and longline gear shall be permitted to take up to 80% of the sablefish TAC, and vessels using trawl gear shall be permitted to take up to 20% of the TAC.

3.2.6.3.2 Pacific Cod and Pollock

The GOA pollock and Pacific cod TACs will be allocated between the inshore and offshore components of industry in specific shares in order to lessen or resolve resource use conflicts and preemption of one segment of the groundfish industry by another, to promote stability between and within industry sectors and affected communities, and to enhance conservation and management of groundfish and other fish resources.

Definitions

Inshore is defined to consist of three components of the industry:

1. All shoreside processors as defined in federal regulations.
2. All catcher/processors less than 125' LOA that have declared themselves to be “inshore”.
3. All motherships or floating processors that have declared themselves to be “inshore”.

Offshore is defined as all processors not included in the definition of inshore component.

Inshore endorsements and operating restrictions

Annually before operations commence, each mothership, floating processing vessel and catcher/processor vessel that intends to process GOA pollock or GOA Pacific cod harvested in an inshore directed fishery for those species must apply for and receive an inshore processing endorsement on its Federal fisheries or Federal processor permit. All shoreside processors are by definition included in the inshore component and are not required to apply for an inshore processing endorsement. Once an inshore processing endorsement is issued it is valid for the duration of the fishing year and cannot be rescinded. Processors that lack an inshore processing endorsement are prohibited from processing GOA pollock or GOA Pacific cod harvested in a directed fishery for processing by the inshore component. Harvesting vessels that do not process pollock or Pacific cod do not need an inshore processing endorsement and may choose to deliver their catch to either or both components.

Catcher/processors that hold an inshore processing endorsement are prohibited from harvesting or processing more than 126 mt (round weight) of pollock or GOA Pacific cod in combination during any fishing week.

Motherships and floating processors that hold an inshore processing endorsement must process all GOA pollock and GOA Pacific cod harvested in a directed fishery for those species in a single geographic location inside the waters of the State of Alaska during a fishing year.

Motherships and floating processors that hold an inshore processing endorsement are prohibited from:

1. operating as catcher/processors in the BSAI during the same fishing year.
2. operating as AFA motherships in the BSAI directed pollock fishery during the same fishing year.

Allocations

One hundred percent of the allowed harvest of pollock is allocated to inshore catcher/processors or to harvesting vessels which deliver their catch to the inshore component, with the exception that offshore catcher/processors, and vessels delivering to the offshore component, will be able to take pollock incidentally as bycatch in other directed fisheries. All pollock caught as bycatch in other fisheries will be attributed to the sector which processes the remainder of the catch.

Ninety percent of the allowed harvest of Pacific cod is allocated to inshore catcher/processors or to harvesting vessels which deliver to the inshore component and to inshore catcher/processors; the remaining ten percent is allocated to offshore catcher/processors and harvesting vessels which deliver to the offshore component. All Pacific cod caught as bycatch in other fisheries will be attributed to the sector which processes the remainder of the catch.

These allocations shall be made by subarea and period as provided in federal regulations implementing this FMP.

Reapportionment of unused allocations

If during the course of the fishing year it becomes apparent that a component will not process the entire amount of the allocation, the amount which will not be processed shall be released to the other components for that year. This shall have no impact upon the allocation formula.

3.2.7 Attainment of Total Allowable Catch

The attainment of a TAC for a species will result in the closure of the target fishery for that species. That is, once the TAC is taken further retention of that species will be prohibited. Other fisheries targeting on other species could be allowed to continue as long as the non-retainable bycatch of the closed species is found to be non-detrimental to that stock.

3.3 Permit and Participation Restrictions

Certain permits are required of participants in the GOA groundfish fisheries. The framework of the License Limitation Program (Section 3.3.1) and the exempted fishing permit program (Section 3.3.2) is set out below, however specific requirements are found in regulations implementing the FMP. Additionally restrictions on participation by vessels participating in other rationalization programs are detailed in Section 3.3.3.

3.3.1 License Limitation Program

Beginning on January 1, 2002, a Federal groundfish license is required for harvesting vessels (including harvester/processors) participating in all directed GOA groundfish fisheries, other than fixed gear sablefish throughout the Gulf of Alaska and Demersal Shelf Rockfish in the Southeast Outside area (east of 140° W. longitude). Vessels fishing in State of Alaska waters (0-3 miles offshore) will be exempt, as will vessels less than 26' LOA. Vessels exempted from the Gulf of Alaska groundfish license program, will be limited to the use of legal fixed gear in the Southeast Outside area.

3.3.1.1 Elements of the License Limitation Program

1. Nature of Licenses. General licenses will be issued for the entire Gulf of Alaska area based on historical landings. Vessels that qualify for both a Bering Sea and Aleutian Islands and Gulf of Alaska general licenses will be issued both as a non-severable package. Area endorsements will be issued along with the general license for the Southeast Outside, Central Gulf including West Yakutat, and/or Western Gulf areas. General licenses and endorsements will remain a non-severable package.

2. License Recipients. Licenses will be issued to owners (as of June 17, 1995) of qualified vessels. The owners as of this date must be “persons eligible to document a fishing vessel” under Chapter 121, Title 46, U.S.C. In cases where the vessel was sold on or before June 17, 1995, and the disposition of the vessel's fishing history for license qualification was not mentioned in the contract, the license qualification history would go with the vessel. If the transfer occurred after June 17, 1995, the license qualification history would stay with the seller of the vessel unless the contract specified otherwise.

3. License Designations. Licenses and endorsements will be designated as Catcher Vessel or Catcher Processor and with one of three vessel length classes (<60', ≥60' but < 125', or ≥ 125' LOA). Vessels less than 60' LOA with a catcher vessel designation may process up to 1 mt (round weight) of fish per day. Southeast Outside endorsements will be designated for use by legal fixed gear only.

   General licenses will also contain a gear designation (trawl gear, non-trawl gear, or both) based on landings activity in any area through June 17, 1995. Vessels that used both trawl and non-trawl gear during the original qualification period would receive both gear designations, while vessels that used only trawl gear or only non-trawl gear during the original qualification period (general or endorsement period) would receive one or the other. For vessels that used only one gear type (trawl/non-trawl) in the original qualification period, and then used the other gear type between June 18, 1995 and February 7, 1998, the license recipient may choose one or the other gear designation, but will not receive both. For vessels that used only one gear type (trawl/non-trawl) in the original qualification period, but made a significant financial investment towards conversion to the other gear type or deployment of such gear on or before February 7, 1998, and made landings on that vessel with the new gear type by December 31, 1998, the license recipient may choose which gear designation to receive, but not both. A significant financial commitment is defined as a minimum purchase of $100,000 worth of equipment specific to trawling or having acquired groundline, hooks or pots, and hauling equipment for the purpose of prosecuting the non-trawl fisheries on or by February 7, 1998.

4. Who May Purchase Licenses. Licenses may be transferred only to “persons” defined as those “eligible to document a fishing vessel” under Chapter 121, Title 46, U.S.C. Licenses may not be leased.

5. Vessel/License Linkages. Licenses may be transferred without a vessel, i.e., licenses may be applied to vessels other than the one to which the license was initially issued. However, the new vessel is still subject to the license designations, vessel upgrade provisions, "20% upgrade rule" (defined in provision seven), and the no leasing provision. Licenses may be applied to vessels shorter than the maximum LOA allowed by the license regardless of the vessel's length designation. Vessels may also use catcher processor licenses on catcher vessels. However, the reverse is not allowed.

   Notwithstanding the above, licenses earned on vessels that did not hold a Federal fisheries permit prior to October 9, 1998, may be transferred only if the vessel originally assigned the license is transferred along with the license, unless a fishing history transfer occurred prior to February 7, 1998, in which case the vessel does not have to accompany the license earned from that fishing history; however, any future transfer of that license would have to include that vessel.

6. Separability of General Licenses and Endorsements. General licenses may be issued for the BSAI groundfish, GOA groundfish, and BSAI crab fisheries. Those general licenses initially issued to a person based on a particular vessel's catch history are not separable and shall remain as a single "package". General licenses transferred after initial allocation shall remain separate "packages" in the form they were initially issued, and will not be combined with other general groundfish or crab licenses the person may own. Area endorsements are not separable from the general license they are initially issued under, and shall remain as a single "package", which includes the assigned catcher vessel/catcher processor and length designations.

7. Vessel Replacements and Upgrades. Vessels may be replaced or upgraded within the bounds of the vessel length designations and the "20% rule". This rule was originally defined for the vessel moratorium program. The maximum LOA with respect to a vessel means the greatest LOA of that vessel or its replacement that may qualify it to conduct directed fishing for groundfish covered under the license program, except as provided at § 676.4(d). The maximum LOA of a vessel with license qualification will be determined by the Regional Administrator as follows:

   a. For a vessel with license qualification that is less than 125' LOA, the maximum LOA will be equal to 1.2 times the vessel's original qualifying length or 125', whichever is less; and

   b. For a vessel with license qualification that is equal to or greater that 125', the maximum LOA will be equal to the vessel's original qualifying length.

   If a vessel upgrades under the "20% rule" to a length which falls into a larger license length designation after June 17, 1995, then the vessel owner would be initially allocated a license and endorsement(s) based on the vessels June 17, 1995 length. Those licenses and endorsements could not be used on the qualifying vessel, and the owner would be required to obtain a license for that vessel's designation before it could be fished.

8. License Ownership Caps. No more than 10 general groundfish licenses may be purchased or controlled by a "person", with grandfather rights to those persons who exceed this limit in the initial allocation. Persons with grandfather rights from the initial allocation must be under the 10 general license cap before they will be allowed to purchase any additional licenses. A "person" is defined as those eligible to document a fishing vessel under Chapter 121, Title 46, U.S.C. For corporations, the cap would apply to the corporation and not to share holders within the corporation.

9. Vessel License Use Caps. There is no limit on the number of licenses (or endorsements) that may be used on a vessel.

10. Changing Vessel Designations. If a vessel qualifies as a catcher processor, it may select a one time (permanent) conversion to a catcher vessel designation.

11. Implement a Skipper Reporting System. NMFS will implement a skipper reporting system that requires groundfish license holders to report skipper names, addresses, and service records.

12. Vessels Targeting Non-groundfish Species. Vessels targeting non-groundfish species that are allowed to land incidentally taken groundfish species without a Federal permit before implementation of the groundfish license program, will be allowed to continue to land bycatch amounts of groundfish without having a valid groundfish license. Additionally, vessels targeting sablefish and halibut under the IFQ program will continue to be allowed to retain bycatch amounts of groundfish species.

13. CDQ Vessel Exemption. Vessels < 125' LOA obtained under an approved CDQ plan to participate in both CDQ and non-CDQ fisheries will be allowed to continue to fish in the GOA groundfish fisheries without a license, provided such vessel was under construction or operating in an existing community development plan as of October 9, 1998. If the vessel is sold outside the CDQ plan, the vessel will no longer be exempt from the rules of the license program.

14. Lost Vessels. Vessels that qualified for the moratorium and were lost, damaged, or otherwise out of the fishery due to factors beyond the control of the owner and which were replaced or otherwise reentered the fishery in accordance with the moratorium rules, and which made a landing any time between the time the vessel left the fishery and June 17, 1995, will be qualified for a general license and endorsement for that area.

15. Licenses Represent a Use Privilege. The Council may alter or rescind this program without compensation to license holders; further, licenses may be suspended or revoked for (serious and/or multiple) violations of fisheries regulations.

3.3.2 Exempted Fishing Permits

The Regional Administrator, after consulting with the Director of the Alaska Fisheries Science Center and with the Council, may authorize for limited experimental purposes, the target or incidental harvest of groundfish that would otherwise be prohibited. Exempted fishing permits might be issued for fishing in areas closed to directed fishing, for continued fishing with gear otherwise prohibited, or for continued fishing for species for which the quota has been reached. Exempted fishing permits will be issued by means of procedures contained in regulations.

As well as other information required by regulations, each application for an exempted fishing permit must provide the following information: 1) experimental design (e.g., staffing and sampling procedures, the data and samples to be collected, and analysis of the data and samples), 2) provision for public release of all obtained information, and 3) submission of interim and final reports.

The Regional Administrator may deny an exempted fishing permit for reasons contained in regulations, including a finding that:

a. according to the best scientific information available, the harvest to be conducted under the permit would detrimentally affect living marine resources, including marine mammals and birds, and their habitat in a significant way;

b. issuance of the exempted fishing permit would inequitably allocate fishing privileges among domestic fishermen or would have economic allocation as its sole purpose;

c. activities to be conducted under the exempted fishing permit would be inconsistent with the intent of the management objectives of the FMP;

d. the applicant has failed to demonstrate a valid justification for the permit;

e. the activity proposed under the exempted fishing permit could create a significant enforcement problem; or

f. the applicant failed to make available to the public information that had been obtained under a previously issued exempted fishing permit.

3.3.3 Access limitation

The Council may wish to limit access in the fisheries in the GOA in order to maintain an orderly fishery and prevent overcapitalization in the harvesting sector. An objective for fisheries management as stated in the Magnuson-Stevens Act is to maximize the benefit to the nation derived from fisheries. This implies efficient use of our nation's resources, including labor and capital.

When an industry that harvests a common-property resource becomes overcapitalized, as is often the case in the commercial fisheries, society's resources are not used in their most efficient manner. This will make it difficult to maximize the fishery's benefit to the nation. Other factors besides efficiency are considered by the Council and may make access limitation less attractive in certain situations; however, limiting access in a fishery is an important management tool and the option to use it should be made available to managers.

Access limitation may take the form of a limit on the number of licenses issued for a fishery, individual shares of the annual quota, taxes on catch, or high license or landing fees. Taxes and fees may be used in conjunction with license limitation or individual quotas. Should the Council wish to implement an access limitation program, the FMP will require amendment providing the supporting rationale and specific details of the measure.

3.3.4 Sideboards

3.3.4.1 American Fisheries Act

On October 21, 1998, the President signed into law the American Fisheries Act (AFA) which mandated sweeping changes to the conservation and management program for the pollock fishery of the Bering Sea and Aleutian Islands and to a lesser extent, affected the management programs for the other groundfish fisheries of the BSAI, the groundfish fisheries of the GOA, the king and Tanner crab fisheries of the BSAI, and the scallop fishery off Alaska.

While the AFA primarily affects the management of the BSAI pollock fishery, the Council is also directed to develop and recommend harvesting and processing sideboard restrictions for AFA catcher vessels, AFA catcher/processors, AFA motherships, and AFA inshore processors that are fishing for or processing groundfish harvested in the GOA. Section 211 of the AFA addresses harvesting and processing sideboards for the GOA and this entire section of the AFA is incorporated into the FMP by reference (see Appendix C). GOA harvesting and processing sideboard restrictions that are consistent with section 211 of the AFA will be implemented through regulation. Any measure recommended by the Council that supersedes section 211 of the AFA must be implemented by FMP amendment in accordance with the provisions of section 213 of the AFA and the Magnuson-Stevens Act.

3.4 Gear Restrictions

3.4.1 Authorized Gear

Gear types authorized by the FMP are trawls, hook-and-line, pots, jigs, and other gear as defined in regulations. Further restrictions on gear that are necessary for conservation and management of fishery resources and which are consistent with the goals and objectives of the FMP are found at 50 CFR part 679. Additional gear limitations by specific target fishery are described in Section 3.4.2.

3.4.2 Target Fishery Specific

Sablefish

Legal gear for the taking of sablefish in any regulatory area of the GOA are trawls and hook-and-lines.

3.5 Time and Area Restrictions

Management measures in place in the GOA groundfish fisheries constrain fishing both temporally and spatially. In Section 3.5.1, the fishing year is defined and criteria for determining fishing seasons are described. Area restrictions by gear type are described in Section 3.5.2. The FMP also authorizes the use of either temporal or spatial restrictions for marine mammal conservation, as detailed in Section 3.5.3. Section 3.5.4 addresses exemptions to the time and area restrictions in the FMP or its implementing regulations.

3.5.1 Fishing Seasons

The fishing year is defined as January 1 through December 31.

Fishing seasons are defined as periods when harvesting groundfish is permitted. Fishing seasons will normally be within a calendar year, if possible, for statistical purposes, but could span two calendar years if necessary. Changes to fishing seasons can be recommended by the Council at any time. In consultation with the Council, the Secretary will establish all fishing seasons by regulations that implement the FMP, to accomplish the goals and objectives of the FMP, the Magnuson-Stevens Act, and other applicable law. Season openings will remain in effect unless amended by regulations implementing the FMP.

The Council will consider the following criteria when recommending regulatory amendments:

- biological: spawning periods, migration, and other biological factors;
- bycatch: biological and allocative effects of season changes;
- exvessel and wholesale prices: effects of season changes on prices;
- product quality: producing the highest quality product to the consumer;
- safety: potential adverse effects on people, vessels, fishing time, and equipment;
- cost: effects on operating costs incurred by the industry as a result of season changes;
- other fisheries: possible demands on the same harvesting, processing, and transportation systems needed in the groundfish fishery;

- coordinated season timing: the need to spread out fishing effort over the year, minimize gear conflicts, and allow participation by all elements of the groundfish fleet;
- enforcement and management costs: potential benefits of seasons changes relative to agency resources available to enforce and manage new seasons; and
- allocation: potential allocation effects among users and indirect effects on coastal communities.

3.5.2 Area Restrictions

3.5.2.1 All Vessels

3.5.2.1.1 Sitka Pinnacles Marine Reserve

The Sitka Pinnacles Marine Reserve encompasses an area totalling 2.5 square nautical miles off Cape Edgecumbe. Vessels holding a Federal fisheries permit are prohibited at all times from fishing for groundfish or anchoring in the Sitka Pinnacles Marine Reserves. The area is illustrated in Figure 3-2 and its coordinates are described in Appendix B.

Figure 3-2 Sitka Pinnacles Marine Reserve.

[PLACEHOLDER]

3.5.2.2 Trawl Gear Only

3.5.2.2.1 King Crab Closure Areas around Kodiak Island

A time/area closure scheme has been developed to help protect and rebuild the Kodiak king crab resource. The number of red king crab in the waters around Kodiak Island is at a historically low level. Most of these crab are old and sexually mature. There has been no sign of significant recruitment since 1979. As a result, the Kodiak king crab fishery has been closed since 1983 in an attempt to rebuild the stocks. While the cause for the decline of king crab is not known, most researchers believe that the decline can be attributed to a variety of environmental factors which independently or in combination led to the depressed condition of the resource. The extent to which the king crab decline is due to commercial fishing, either directed or incidental, is unknown.

King crab are known to concentrate in certain areas around Kodiak Island during the year. In the spring they migrate inshore to molt and mate. Approximately 70% of the female red king crab stocks are estimated to congregate in two areas, known as the Alitak/Towers and Marmot Flats. The Chirikof Island and Barnabas areas also possess concentrations of king crab but in lesser amounts. Past studies have shown that most king crab around Kodiak molt and mate in the March-May period, although some molting crab can be found during late-January through mid-June. Adult female king crabs must molt to mate and extrude eggs. After molting, their exoskeleton (shell) is soft, and crabs in this stage are known as soft-shell crabs. The new exoskeletons take two to three months to harden fully. During the soft-shell period, the crabs are particularly susceptible to injury and mortality from handling and from encounters with fishing gear. Because many of the present and potential groundfish trawling grounds overlap with the mating grounds of king crab, the potential exists for substantial king crab mortality.

While it is generally assumed that mortality of soft-shelled king crab can be high with any gear type, incidental mortality of hard-shell crab as a result of encounters with fishing gear is not known. Bottom trawl fishing could kill or injure king crab in two ways. First, crabs caught in the net can be crushed during the tow or injured as the catch is unloaded in the fishing vessel. Second, crabs might be struck with parts of the gear (e.g., trawl doors, towing cables, groundlines, roller gear) as the trawl is towed along the bottom.

Areas around Kodiak Island have been established to protect king crab stocks. These areas are designated as Type I, II, or III areas, according to the definitions listed in Table 3-2. For purposes of implementing a Type III area, a "recruitment event" is defined as the appearance of female crab in substantially increased numbers. A substantially increased number is defined as occurring when the total number of females estimated for a given district equals the number of females established as a threshold criteria for opening that district to commercial crab fishing. In any given year, a recruitment event may occur in one or more of the Kodiak management districts as indicated by the standardized Kodiak crab survey conducted by the Alaska Department of Fish and Game. A Type III area recruitment event closure will continue until either (1) a commercial crab fishery opens for that district, or (2) the number of crab drops below the threshold level established for that district. Implementation of the Type III area closures would be accomplished by regulatory amendment.

The areas are illustrated in Figure 3-3 and coordinates are described in Appendix B.

Table 3-2 Names and definitions of Type I, II, and III king crab closure areas around Kodiak Island

Area Type	Name	Definition
I	• Alitak Flats and Towers Areas • Marmot Flats Area	Type I areas are those king crab stock rebuilding areas where a high level of protection will be provided to the king crab by closing the area year-round to bottom trawling. Fishing with other gear would be allowed.
II	• Chirikof Island Area • Barnabas Area	Type II areas are those areas that are sensitive for king crab populations and in which bottom trawling will be prohibited during the soft-shell season (February 15 - June 15). Fishing with other gear would be allowed and fishing with bottom trawl gear would be allowed from January 1 - February 14 and June 16 - December 31.
III	• Outer Marmot Bay • Barnabas • Horse's Head • Chirikof	Type III areas are those geographic areas adjacent to a Type I or Type II areas that have been identified as important juvenile king crab rearing or migratory areas. These areas only become operational following a determination that the "recruitment event criteria" have occurred. The NMFS Regional Administrator will classify the expanded area as either Type I or II depending on the information available.

3.5.2.2.2 Cook Inlet non-Pelagic Trawl Closure Area

The use of non-pelagic trawl gear is prohibited in Cook Inlet north of a line extending between Cape Douglas and Point Adam. This prohibition is intended to reduce crab bycatch and assist in the rebuilding of crab stocks. The area is illustrated in Figure 3-4 and its coordinates are described in Appendix B.

3.5.2.2.3 Southeast Outside Trawl Closure

Use of any gear other than non-trawl gear is prohibited at all times in the Southeast Outside district. The area is illustrated in Figure 3-5 and its coordinates are described in Appendix B.

Figure 3-3 King Crab Closure Areas around Kodiak Island.

[PLACEHOLDER]

Figure 3-4 Cook Inlet non-pelagic trawl closure area.

[PLACEHOLDER]

Figure 3-5 Southeast Outside trawl closure.

[PLACEHOLDER]

3.5.3 Marine Mammal Conservation Measures

Regulations implementing the FMP may include special groundfish management measures intended to afford species of marine mammals additional protection other than that provided by other legislation. These regulations may be especially necessary when marine mammals species are reduced in abundance. Regulations may be necessary to prevent interactions between commercial fishing operations and marine mammal populations when information indicates that such interactions may adversely affect marine mammals, resulting in reduced abundance and/or reduced use of areas important to marine mammals. These areas include breeding and nursery grounds, haul out sites, and foraging areas that are important to adult and juvenile marine mammals during sensitive life stages.

Regulations intended to protect marine mammals might include those that would limit fishing effort, both temporarily and spatially, around areas important to marine mammals. Examples of temporal measures are seasonal apportionments of TAC specifications. Examples of spatial measures could be closures around areas important to marine mammals. The purpose of limiting fishing effort would be to prevent harvesting excessive amounts of the available TAC or seasonal apportionments thereof at any one time or in any one area.

3.5.4 Exemptions

The Council may promulgate regulations establishing areas where specific types of fishing gear may be tested, to be available for use when the fishing grounds are closed to that gear type. Specific gear test areas contained in regulations that implement the FMP, and changes to the regulations, will be done by regulatory amendment. These gear test areas would be established in order to provide fishermen the opportunity to ensure that their gear is in proper working order prior to a directed fishery opening. The test areas must conform to the following conditions:

1. depth and bottom type must be suitable for testing the particular gear type;
2. must be outside State waters;
3. must be in areas not normally closed to fishing with that gear type;
4. must be in areas that are not usually fished heavily by that gear type; and
5. must not be within a designated Steller sea lion protection area at any time of the year.

3.6 Catch Restrictions

This section describes the retention and utilization restrictions for the groundfish fisheries, including prohibited species restrictions and incentive programs to reduce bycatch.

3.6.1 Prohibited Species

Prohibited species identified in this FMP are Pacific halibut, Pacific herring, Pacific salmon, steelhead trout, king crab, and Tanner crab. Species identified as prohibited must be avoided while fishing groundfish and must be immediately returned to the sea with a minimum of injury when caught and brought aboard, except when their retention is authorized by other applicable law.

Groundfish species and/or species groups under this FMP for which the quota has been reached shall be treated in the same manner as prohibited species.

3.6.1.1 Prohibited Species Donation Program

The Prohibited Species Donation Program authorizes the distribution of specified prohibited species, taken as bycatch in the groundfish trawl fisheries off Alaska, to economically disadvantaged individuals through a NMFS-authorized distributor selected by the Regional Administrator in accordance with regulations that implement the FMP. The program is limited to the following species:

1. Pacific salmon
2. Pacific halibut

3.6.1.2 Time and Area Closures to Reduce Bycatch Rates of Prohibited Species

The Secretary, after consulting with the Council, may identify and establish, by regulatory amendment, time/area closures to reduce bycatch rates of prohibited species. Closures of all or part of an area would require a determination by the Secretary that the closure is based on the best available scientific information concerning the seasonal distribution and abundance of prohibited species and bycatch rates of prohibited species associated with various directed groundfish fisheries or gear types. A time/area closure will be limited to the minimum size and duration, which the Secretary determines are reasonably necessary to accomplish the intent of the closure. Any time/area closure would be based upon a determination that it is necessary to prevent:

1. a continuation of relatively high bycatch rates of prohibited species with an area;
2. the take of an excessive share of prohibited species catch limits or bycatch allowances by vessels fishing within an area;
3. the closure of one or more directed fisheries for groundfish due to excessive prohibited species bycatch rates that occur in a specified fishery operating within an area; or
4. the premature attainment of specified prohibited species catch limits or bycatch allowances and associated foregone opportunity for vessels to harvest available groundfish.

3.6.2 Prohibited Species Catch Limits

Prohibited species catch (PSC) is nonretainable catch. It can take the form of a prohibited or nongroundfish species and/or a groundfish species for which TAC has been achieved that is captured incidentally in groundfish fisheries. A PSC limit is an apportioned, nonretainable amount of fish provided to a fishery for bycatch purposes. The attainment of a PSC limit for a species will result in the closure of the appropriate fishery.

3.6.2.1 Pacific Halibut

The Council believes that discarding incidental catches of fish is wasteful and should be minimized. However, recognizing that in the groundfish fisheries halibut incidentally caught are managed outside this FMP, the treatment of halibut as a prohibited species is appropriate in the short term. Except as provided under the prohibited species donation program, retention of prohibited species captured while harvesting groundfish is prohibited to prevent covert targeting on these species. The prohibition removes the incentive that groundfish fishers might otherwise have to target on the relatively high valued prohibited species, and thereby, results in a lower incidental catch. It also eliminates the market competition that might otherwise exist between halibut fishers and groundfish fishers who might land halibut in the absence of the prohibition.

Halibut that are taken as bycatch in the trawl and fixed gear fisheries result in fishing mortality even though the FMP requires that these species be discarded. Bycatch survival rates of halibut are typically less than 100% and may approach zero for some fisheries and some gear.

When a PSC limit is reached, further fishing with specific types of gear or modes of operation during the year is prohibited in an area by those who take their PSC limit in that area. All other users and gear would remain unaffected.

However, when the fishery to which a PSC limit applies has caught an amount of prohibited species equal to that PSC limit, the Secretary may, by notice, permit some or all of those vessels to continue to engage in fishing for groundfish in the applicable regulatory area, under specified conditions. These conditions may include the avoidance of certain areas of prohibited species concentrations and will be determined on a case-by-case basis.

3.6.2.1.1 Apportionment and Seasonal Allocation of Pacific Halibut

Apportionments of PSC limits, and seasonal allocations thereof, will be determined annually by the Secretary of Commerce in consultation with the Council. Separate PSC limits may be established for specific gear.

PSC limits, apportionments, and seasonal allocations will be determined using the following procedure:

1. Prior to the October Council meeting. The Plan Team will prepare for the Council a preliminary Stock Assessment and Fishery Evaluation Section 3.2.3 which provides the best available information on estimated halibut bycatch and mortality rates in the target groundfish fisheries, estimates of halibut PSCs and apportionments thereof needed by target fisheries and gear types, and an economic analysis of the effects of the apportionments.
2. October Council meeting. While setting preliminary groundfish harvest levels under Section 3.2.3, the Council will also review the need to control the bycatch of halibut and will, if necessary, recommend preliminary halibut PSC mortality limits and apportionments thereof. The Council will also review the need for seasonal allocations of the halibut PSC mortality limits.

   The Council will make preliminary recommendations to the Secretary about some or all of the following:

   a. the regulatory areas and districts for which PSC mortality limits might be established;
   b. PSC mortality limits for particular target fisheries and gear types;
   c. seasonal allocations by target fisheries, gear types, and/or regulatory areas and district;

d. PSC mortality limit allocations to individual operations; and

e. types of gear or modes of fishing operations that might be prohibited once a PSC mortality limits is reached.

The Council will consider the best available information in doing so, including that contained in the preliminary SAFE report prepared by the Plan Team. Types of information that the Council will consider relevant to recommending preliminary PSC mortality limits, and which may be found in the SAFE report, include:

a. estimated change in biomass and stock condition of halibut;

b. potential impact on halibut stocks;

c. potential impacts on the halibut fisheries;

d. estimated bycatch in years prior to that for which the halibut PSC mortality limit is being established;

e. expected change in target groundfish catch;

f. estimated change in target groundfish biomass;

g. methods available to reduce halibut bycatch;

h. the cost of reducing halibut bycatch; and

i. other biological and socioeconomic factors that affect the appropriateness of specific bycatch measures in terms of objectives.

Types of information that the Council will consider in recommending seasonal allocations of halibut include:

a. seasonal distribution of halibut;

b. seasonal distribution of target groundfish species relative to halibut distribution;

c. expected halibut bycatch needs on a seasonal basis relevant to changes in halibut biomass and expected catches of target groundfish species;

d. expected bycatch rates on a seasonal basis;

e. expected changes in directed groundfish fishing seasons;

f. expected start of fishing effort; and

g. economic effects of establishing seasonal halibut allocations on segments of the target groundfish industry.

The Council will release the recommended preliminary PSC mortality limits and seasonal allocations, if any, for a minimum 30-day public review.

3. As soon as practicable after the Council's October meeting, the Secretary will publish the Council's recommendations as a notice in the *Federal Register*. Information on which the recommendations are based will also be published in the *Federal Register* or otherwise made available by the Council. Public comments will be invited by means specified in regulations implementing the FMP.

4. Prior to the December Council meeting. The Plan Team will prepare for the Council a final SAFE report under Section 3.2.3 which provides the best available information on estimated halibut bycatch rates in the target groundfish fisheries, recommendations for halibut PSCs and

apportionments thereof among target fisheries and gear types, and an economic analysis of the effects of the apportionments.

5. December Council meeting. While recommending final groundfish harvest levels, the Council reviews public comments, takes public testimony, and makes final decisions on apportionments of PSC limits among fisheries and seasons, using the factors set forth under (2) above concerning PSC limits, and concerning seasonal allocations of PSC limits. The Council will provide recommendations, including no change for the new fishing year, to the Secretary of Commerce for review and implementation.

6. As soon as practicable after the Council's December meeting, the Secretary will publish the Council's final recommendations as a notice of final harvest specifications in the *Federal Register*. Information on which the final harvest specifications are based will also be published in the *Federal Register* or otherwise made available by the Council.

3.6.3 Retention and Utilization Requirements

3.6.3.1 Utilization of Pollock

Roe-stripping of pollock is prohibited, and the Regional Administrator is authorized to issue regulations to limit this practice to the maximum extent practicable. It is the Council's policy that the pollock harvest shall be utilized to the maximum extent possible for human consumption.

3.6.3.2 Improved Retention/Improved Utilization Program

Minimum retention requirements

All vessels participating in the GOA groundfish fisheries are required to retain all catch of pollock and Pacific cod when directed fishing for those species is open, regardless of gear type employed and target fishery. When directed fishing for pollock and Pacific cod is prohibited, retention of those species is required up to any maximum retainable amount in effect for these species, and these retention requirements are superseded if retention of pollock and Pacific cod is prohibited by other regulations.

No discarding of whole fish of these species is allowed, either prior to or subsequent to that species being brought on board the vessel. At-sea discarding of any processed product from pollock and Pacific cod is also prohibited, unless required by other regulations.

Minimum utilization requirements

All pollock and Pacific cod caught in the GOA must be either 1) processed at sea subject to minimum product recovery rates and/or other requirements established by regulations implementing the FMP, or 2) delivered in their entirety to onshore processing plants for which similar processing requirements are implemented by State regulations.

3.6.3.3 Size Limits

A commercial size limit for a particular species group may be necessary to afford the opportunity for the species to reproduce or to direct fishing toward an optimal size given existing markets and processing capabilities. Should the Council desire a size limit, the FMP will require an amendment specifying a specific length and the supporting rationale for the limit.

3.6.4 Bycatch Reduction Incentive Programs

3.6.4.1 Prohibited Species Catch

The Secretary of Commerce, after consultation with the Council, may implement by regulation measures that provide incentives to individual vessels to reduce bycatch rates of prohibited species for which PSC limits are established under Section 3.6.2. The intended effect of such measures is to increase the opportunity to harvest groundfish TACs before established PSC limits are reached by encouraging individual vessels to maintain average bycatch rates within acceptable performance standards and discourage fishing practices that result in excessively high bycatch rates.

3.6.4.2 Shallow Water Flatfish Bycatch

The Council will annually review the GOA fisheries that exceed a bycatch rate of 5% for shallow water flatfish. At its discretion, the Council may propose to the Secretary new management measures to reduce bycatch, if a fishing sector exceeds this rate.

3.7 Share-based Programs

This section describes the share-based program in place for the fixed gear sablefish fishery in the Gulf of Alaska.

3.7.1 Fixed Gear Sablefish Fishery

The directed fixed gear sablefish fishery is managed under an Individual Fishing Quota (IFQ) program, implemented in 1994-1995. This form of limited entry replaced the open access fisheries for sablefish in the GOA.

3.7.1.1 Definitions

For purposes of Section 3.7.1, the following definitions of terms apply:

Person means any individual who is a citizen of the United States or any corporation, partnership, association, or other entity (whether or not organized or existing under the laws of any state) that meets the requirements set forth in 46 CFR Part 67.03, as applicable.

An Individual means a natural person who is not a corporation, partnership, association, or other entity.

Quota shares (QS) are equal to a person's fixed gear landings (qualifying pounds) for each area fished.

Quota Share Pool is the total amount of quota share in each management area. The quota share pool may change over time due to appeals, enforcement, or other management actions.

Individual Fishing Quota (IFQ) means the annual poundage of fish derived by dividing a person's quota share into the quota share pool and multiplying that ratio by the annual fixed gear TAC for each management area.

Fixed Gear is defined to include all hook and line fishing gears (longlines, jigs, handlines, troll gear, and pot gear). For purposes of initial allocation, legal pot gear will be counted.

Catcher boat or catcher vessel means any vessel that delivers catch or landing in an unfrozen state.

Freezer longliner means any vessel engaged in fishing in the fixed gear fishery which, during a given trip, utilizes freezer capacity and delivers some or all of its groundfish catch in a frozen state.

Qualified crewmember is defined as any person that has acquired commercial fish harvesting time at sea (i.e. fish harvesting crew) equal to 5 months of any commercial fish harvesting activity in a fishery in state or federally managed waters of the U.S.. Additionally, any individual who receives an initial allocation of quota share will be considered a bona fide crew member.

3.7.1.2 Management Areas

Quota shares and IFQs are made available for each of the management areas identified for the GOA: the Western Gulf, Central Gulf, West Yakutat, and the East Yakutat/Southeast Outside management areas.

3.7.1.3 Initial Allocation of Quota Shares

3.7.1.3.1 Initial Recipients

1. Initial assignments of quota shares are made to:
    a. a qualified person who is a vessel owner who meets the requirements in this section; or
    b. a qualified person who meets the requirements of this section engaged in a lease of a fishing vessel (written or verbal) or other “bare-boat charter” arrangement in order to participate in the fishery. (For instances identified under this section, the qualified person shall receive full credit for deliveries made while conducting the fishery under such a lease or arrangement.)
2. Initial quota shares for sablefish are assigned only to persons who meet all other requirements of this section and who have landed those species in any one of the following years: 1988, 1989, or 1990. These three years shall be known as the quota share qualifying years.
3. Quota shares are assigned initially for each management subarea to qualified persons based on recorded landings, as documented through fish tickets or other documentation for fixed gear landings. Historical catch of sablefish is counted from 1985 through 1990. This historical period is known as the quota share base period. For each management subarea, NMFS will select a person's best five (5) years (subject to approval of the person involved) from the quota share base period to calculate their quota shares.
4. The sum of the catch in each person's five (5) selected years for each area shall equal that person's quota shares for that area. All quota share in any area are added together to form the "Quota Share Pool" for that area.

3.7.1.3.2 Vessel Categories

Quota shares and IFQs shall be assigned by vessel category as follows:

1. Freezer Longliner Shares:

   A vessel is determined to be a freezer longliner in any year, if during that year it processed (froze) fixed gear (as defined above) caught groundfish. If a vessel is determined to be a freezer longliner and that vessel was used in the most recent calendar year of participation by the owner, through September 25, 1991, then all qualifying pounds landed by that vessel owner during the qualifying years shall be assigned as freezer longliner shares, unless the owner also participated in the most recent year through September 25, 1991, operating only as a catcher vessel, then shares will be assigned to separate categories, in proportion to the catch made aboard each of the vessels.

2. Catcher Boat Shares:

   a. All landings made during the quota share base period by a vessel owner, whose last vessel that participated in a fixed gear fishery through September 25, 1991, is determined to be a catcher vessel, shall be allocated catcher boat quota shares.

   b. There are two categories of catcher boat shares for the sablefish QS/IFQ fishery:

      i. vessels less than or equal to 60 ft in length overall, and

      ii. vessels greater than 60 ft in length overall.

   c. For initial allocation of catcher boat quota shares:

      i. if, during the last year of participation in a fixed gear fishery through September 25, 1991, a quota share recipient simultaneously owned or leased two or more vessels on which sablefish were landed, and those vessels were in different vessel categories, then the quota share allocation is for each vessel category and may not be combined into a single category.

      ii. if a quota share recipient bought or sold vessels in succession during the qualifying period, and to the extent the quota share recipient operations were in one vessel category during one year and the next vessel owned was in another vessel category, the quota share is combined and applied to the latest vessel category of ownership as of September 25, 1991.

3.7.1.3.3 Quota Share Blocks

1. All initial allocations of sablefish regular quota share and community development quota compensation quota share initially issued in area(s) where he/she also receives regular quota share, which would result in IFQs of less than 20,000 pounds in the first year of the program are issued as quota share “Blocks,” except for (3) below.

2. All initial allocations of sablefish quota share which would result in IFQs of 20,000 pounds or more in the first year of the program are issued as normal quota share.

3. All initial allocations of sablefish community development quota compensation quota share issued in areas where he/she did not also receive regular quota share are issued as normal unblocked quota share.

3.7.1.4 Transfer Provisions

1. Any person owning freezer longliner quota shares may sell or lease those quota shares to any other qualified person for use in the freezer longliner category.

2. Any person owning catcher boat quota shares may sell those quota shares to any person meeting the provisions outlined in this section. Ten percent of a person's catcher boat quota shares may be leased during the first three years following implementation.

3. Any person owning CDQ compensation quota share may transfer those quota shares to any other qualified person for IFQ quota share across catcher vessel categories. These transfers may occur through March 15, 1996. Further, regular unblocked qutoa share as set forth in Section 3.7.1.3.3(3) above may be transferred across catcher vessel categories.

4. In order to purchase or lease quota share, the purchaser must be an individual who is a U.S. citizen and a bona fide fixed gear crew member. Additionally, persons who received an initial allocation of catcher boat quota share may purchase catcher boat quota share and/or IFQs.

5. Quota shares, or IFQs arising from those quota shares, for any management area may not be transferred to any other management area or between the catcher boat and the freezer boat categories. Quota shares, or IFQs arising from those quota shares, initially issued to Category B vessels may be used on Category C vessels, except in the Southeast management area where only blocked Category B quota share equivalent to less than 5,000 lbs IFQ (based on 1996 quotas) may be used on Category C vessels.

6. The Secretary may, by regulation, designate exceptions to this section to be employed in case of personal injury or extreme personal emergency which allow the transfer of catcher boat QS/IFQs for limited periods of time.

7. Quota share designated as a “block” may only be traded in its entirety and may not be divided into smaller quota share units. Blocks of quota share representing IFQs of less than 5,000 lbs in the initial allocation may be combined or “swept-up”, to form larger blocks, as long as the consolidated block does not result in IFQs greater than 5,000 lbs.

3.7.1.5 Use and Ownership Provisions

1. Fish caught with freezer longliner IFQs may be delivered frozen or unfrozen.

2. Fish caught with catcher boat quota shares may not be frozen aboard the vessel utilizing those quota shares.

3. Sablefish IFQ resulting from quota share assigned to vessel categories B and C may be used on a vessel with processing capacity as long as processed sablefish or halibut is not on the vessel during that same trip. Further, non-IFQ species may be processed on a vessel using sablefish IFQ resulting from quota share assigned to vessel categories B and C.

4. In order to use catcher boat IFQs the user must: 1) own or lease the quota share, 2) be a U.S. citizen, 3) be a bona fide crew member, 4) be aboard the vessel during fishing operations, and 5) sign the fish ticket upon landing except as noted in (5) below, or in emergency situations.

5. Persons, as defined in Section 3.7.1.1, who receive initial catcher vessel quota share may utilize a hired skipper to fish their quota providing the person owns the vessel upon which the quota share will be used, or the vessel is owned by a person with whom the quota share holder is affiliated through membership in a corporation or partnership. These initial recipients may purchase up to the total share allowed for the area. There shall be no leasing of such catcher vessel quota share other than as provided for in Section 3.7.1.4 above. For the sablefish fishery east of 140° W. longitude and for the halibut fishery in Area 2C, the above allowance for hired skippers applies only to corporations, partnerships, and other collective entities. *(Additional shares purchased by these*

corporations, partnerships, or other entities for the are east of 140° W. longitude will not be exempted from the provisions of this section, nor does this exception apply to individuals using catcher vessel IFQs east of 140° W. longitude.)

This provision will cease upon the sale or transfer of quota share or upon any change in the identity of the corporation, partnership, or estate as defined below:

a. Corporation: Any corporation that has no change in membership, except a change caused by the death of a corporate member providing the death did not result in any new corporate member. Additionally, corporate membership is not deemed to change if a corporate member becomes legally incapacitated and a trustee is appointed to act on his behalf, nor is corporate membership deemed to have changed if the ownership shares among existing members change, nor is corporate membership deemed to have changed if a member leaves the corporation.

b. Partnership: Any partnership that has no change in membership, except a change caused by the death of a partner providing the death did not result in any new partners. Additionally, a partnership is not deemed to have changed if a partner becomes legally incapacitated and a trustee is appointed to act on his behalf, nor is a partnership deemed to have changed if the ownership shares among existing partners change, nor is a partnership deemed to have changed if a partner leaves the partnership.

c. Estate: Any estate that has not been disposed to a legal heir.

d. Individual: Any individual as defined in Section 3.7.1.1.

6. For sablefish each qualified person or individual may own, hold, or otherwise control, individually or collectively, but may not exceed, 3,229,721 units of quota share for the GOA and BSAI; additionally, quota share holdings in the areas east of 140° W. longitude (East Yakutat and Southeast Outside) shall not exceed 688,485 units of quota share for that management area.

7. Any person who receives an initial assignment of quota shares in excess of the limits set forth in (6) of this section shall:

   a. be prohibited from purchasing, leasing, holding or otherwise controlling additional quota shares until that person's quota share falls below the limits set forth in (6) above, at which time each such person shall be subject to the limitations of paragraph (6) above; and

   b. be prohibited from selling, trading, leasing or otherwise transferring any interest, in whole or in part, of an initial assignment of quota share to any other person in excess of the limitations set forth in (6) above.

8. For sablefish, no more than 1% of the combined GOA and BSAI quota may be taken on any one vessel, and no more than 1% of the TAC east of 140° W. longitude (East Yakutat/Southeast Outside), may be landed on the same vessels, except that persons who received an initial allocation of more than 1% overall ownership level (or 1% in the area east of 140° W. longitude) may continue to fish their quota share on a single vessel.

9. Persons must control IFQs for the amount to be caught before a trip begins, with the exception that limited overages will be allowed as specified in an overage program approved by NMFS and the International Pacific Halibut Commission.

10. Quota Share Block Provisions

   a. A person may own and use up to two Blocks in each management area.

b. Persons owning two Blocks in a given management area may not use normal quota share in that area.

c. Persons who own less than two Blocks in an area may own and use normal quota share up to the limits specified under this program, noting that the limit applies to both normal quota share and quota share embedded in Blocks.

3.7.1.6 Annual Allocation of Quota Share/Individual Fishing Quota

Individual fishing quotas are determined for each calendar year for each person by applying the ratio of a person's quota share to the quota share pool for an area to the annual fixed gear total allowable catch for each management area, after adjusting for the CDQ program. In mathematical terms, IFQs = (QS / QS pool) x fixed gear TAC.

3.7.1.7 General Provisions

1. For IFQ accounting purposes:

   a. The sale of catcher vessel caught sablefish or halibut to other than a legally registered buyer is illegal, except that direct sale to dockside customers is allowed provided the fisher is a registered buyer and proper documentation of such sales is provided to NMFS.

   b. Frozen product may only be off-loaded at sites designated by NMFS for monitoring purposes;

   c. Persons holding IFQs and wishing to fish must check-in with NMFS or their agents prior to entering any relevant management area, additionally any person transporting IFQ caught fish between relevant management areas must first contact NMFS or their agents.

2. Quota shares and IFQs arising from those quota shares may not be applied to: (1) trawl-caught sablefish; or (2) sablefish harvested using pots in the GOA.

3. Quota shares are a harvest privilege, and good indefinitely. However, they constitute a use privilege which may be modified or revoked by the Council and the Secretary at any time without compensation.

4. Discarding of sablefish is prohibited by persons holding sablefish IFQs and those fishing under the CDQ program.

5. Any person retaining sablefish or halibut with commercial fixed gear must own or otherwise control IFQs.

6. Persons holding IFQs may utilize those privileges at any time during designated seasons. Retention of fixed-gear caught sablefish or any halibut is prohibited during closed seasons. Seasons will be identified by the Council and the International Pacific Halibut Commission on an annual basis.

3.7.1.8 Community Quota Share Purchases

Specified GOA coastal communities are eligible to hold commercial catcher boat sablefish quota share under the IFQ Program as defined and described in this section. Communities are subject to the provisions of the IFQ Program as described in Section 3.7.1 unless otherwise described in this section.

3.7.1.8.1 Eligible Communities

Eligible communities are those that meet the following qualifying criteria: 1) populations of less than 1,500; 2) no road access to larger communities; 3) direct access to saltwater; and 4) a documented historic participation in the halibut or sablefish fisheries and are listed in Federal regulation. Communities not listed in Federal regulation must apply to the Council to be approved for participation in the program and will be evaluated using the above criteria.

The administrative entity permitted to hold the quota share for eligible communities must be a: 1) new non-profit entity; or 2) a new non-profit entity formed by an aggregation of several eligible communities. Eligible communities may also designate a new regional or Gulf-wide administrative entity to act as a trustee to manage quota share for individual eligible communities.

3.7.1.8.2 Management Areas

Eligible communities may purchase and hold quota shares and IFQs in each of the following management areas identified for the GOA: Western Gulf, Central Gulf, West Yakutat, and East Yakutat/ Southeast Outside.

3.7.1.8.3 Use and Ownership Provisions

1. Individual and Cumulative Community Use Caps

    a. For sablefish, each qualified administrative entity representing an eligible community or communities may own, hold, or otherwise control, but may not exceed, 1% of the combined quota share for the GOA and Bering Sea and Aleutian Islands on behalf of that community; additionally quota share holdings in the area east of 140° W. longitude (East Yakutat/Southeast Outside) shall not exceed 1% of the quota share or IFQs for that management area.

    b. For sablefish, all administrative entities representing eligible communities may own, hold, or otherwise control, collectively, but may not exceed, 3% of the Southeast, West Yakutat, Central Gulf, or Western Gulf quota share in each of the first seven years of the program, with a 21% total in each IFQ regulatory area, unless modified by Council review by 2009.

2. Quota Share Block Provisions

    a. Each eligible community may own and use up to five quota share blocks in each management area;

    b. Eligible communities are restricted to owning and using blocks of quota share which exceed 5,000 lbs IFQ (based on 1996 quotas). This is equivalent to: 33,270 QS units in Southeast; 43,490 QS units in West Yakutat; 46,055 QS units in Central Gulf; and 48,410 QS units in the Western Gulf management area.

3. Vessel Size Provisions

    The vessel size category designations for catcher vessel quota shares (Category B and C) do not apply to the quota share when it is owned and used by eligible communities.

3.7.1.8.4 Transfer Provisions

1. Eligible communities owning quota shares may lease the IFQs arising from those quota shares only to residents of the ownership community.
2. Any eligible community owning catcher vessel quota shares may lease, but may not exceed, 50,000 pounds of sablefish IFQs per lessee annually. The 50,000 pound limit is inclusive of any quota owned by the individual (lessee).
3. No more than 50,000 pounds of any IFQs leased by an eligible community may be taken on any one vessel annually, inclusive of any IFQ owned by the individual leasing the IFQs.
4. Eligible communities owning catcher vessel quota shares may sell those quota shares to any other eligible community or any person meeting the provisions outlined in Section 3.7.1.4.
5. Eligible communities may only sell their quota share for one of the following purposes:

   a. generating revenues to sustain, improve, or expand the program

   b. liquidating the entity's quota share assets for reasons outside the program

   Should an eligible community sell its quota share for purposes consistent with (b) above, an administrative entity would not be qualified to purchase and own quota share on behalf of that community for a period of three years.

3.8 Delegated and Flexible Management Authority

3.8.1 Regulation Delegated to the State of Alaska

3.8.1.1 Demersal Shelf Rockfish Assemblages

The TAC for demersal shelf rockfish in the Eastern regulatory area is specified by the Council each year. The State of Alaska will manage State registered vessels fishing for demersal shelf rockfish in the Eastern regulatory area with Council oversight. Under this oversight, the State's management regime for demersal shelf rockfish in the Eastern regulatory area will be directed at managing these rockfish stocks within the TAC specified by the Council. Such State regulations are in addition to and stricter than Federal regulations. They are not in conflict with the FMP as long as they are (1) consistent with specific provisions of the goals and objectives of the FMP, and (2) result in a total harvest of demersal shelf rockfish in the Eastern regulatory area at a level no greater than that provided by the FMP. Such State regulations will apply only to vessels registered under the laws of the State of Alaska.

Regulatory changes proposed by the Alaska Board of Fisheries, which are related to the management of demersal shelf rockfish, will be reviewed by NMFS and the Council prior to their adoption to assure that any such proposed changes are consistent with the goals and objectives of the FMP.

Under Council oversight, the following categories of regulations are authorized by the FMP to be applied by the State to vessels in the demersal shelf rockfish fishery:

- directed fishing standard for demersal shelf rockfish,
- inseason adjustments,

- seasons,
- seasonal apportionments of quotas,
- gear specifications,
- trip limits,
- directed fishing quotas, and
- management areas.

The following categories of regulations will be maintained as Federal regulations, unless specifically exempted, that must be complied with by Federally permitted vessels in this fishery:

- notices establishing preliminary and final TACs,
- definitions (except the directed fishing standard) for demersal shelf rockfish,
- relation to other laws,
- permits,
- recordkeeping and reporting,
- general prohibition,
- penalties,
- harvest limits,
- prohibited species catch limits,
- measures to manage designated prohibited species, and
- observer requirements.

3.8.2 Flexible Management Authority

3.8.2.1 Inseason Adjustments

Harvest levels for each groundfish species or species group that are set by the Council for a new fishing year are based on the best biological, ecological, and socioeconomic information available. The Council finds, however, that new information and data relating to stock status may become available to the Regional Administrator and/or the Council during the course of a fishing year which warrant inseason adjustments to a fishery.

Such changes in stock status might not have been anticipated or were not sufficiently understood at the time harvest levels were being set. Such changes may become known from events within the fishery as it proceeds, or they may become known from analysis of scientific survey data. Certain changes warrant swift action by the Regional Administrator to protect the resource from biological harm by instituting gear modifications or adjustments through closures or restrictions. Other changes warrant action to provide greater fishing opportunities for the industry by instituting time/area adjustments through openings or extension of a season beyond a scheduled closure.

The need for inseason action may be related to several circumstances. For instance, certain target or bycatch species may have decreased in abundance. When new information indicates that a species has decreased in abundance, allowing a fishery to continue to a harvest level now known to be too high could increase the risk of overfishing that species. Conservation measures limited to establishing prohibited species catch limits for such prohibited species may be necessary during the course of the fishery to prevent jeopardizing the well-being of prohibited species stocks.

Similarly, current information may indicate that a prohibited species is more abundant than was anticipated when limits were set. Closing a fishery on the basis of the preseason PSC limit that is proven to be too low would impose unnecessary costs on the fishery. Increasing the PSC limits may be appropriate if such additional mortality inflicted on the prohibited species of concern would not impose detrimental effects on the stock or unreasonable costs on a fishery that utilize the prohibited species. However, adjustments to TAC or PSC limits that are not initially specified on the basis of biological stock status is not appropriate.

The Council finds that inseason adjustments are accomplished most effectively by management personnel who are monitoring the fishery and communicating with those in the fishing industry who would be directly affected by such adjustments. Therefore, the Council authorizes the Secretary, by means of his or her delegation to the Regional Administrator of NMFS, to make inseason adjustments to conserve fishery resources on the basis of all relevant information. Using all available information, he or she may extend, open, or close fisheries in all or part of a regulatory area, or restrict the use of any type of fishing gear as a means of conserving the resource. He or she may also change any previously specified TAC or PSC limit if such are proven to be incorrectly specified on the basis of the best available scientific information or biological stock status. Such inseason adjustments must be necessary to prevent one of the following occurrences:

a. the overfishing of any species or stock of fish, including those for which PSC limits have been set; and/or

b. the harvest of a TAC for any groundfish, the taking of a PSC limit for any prohibited species, or the closure of any fishery based on a TAC or PSC limit that, on the basis of currently available information, is found by the Secretary to be incorrectly specified.

The types of information that the Regional Administrator must consider in determining whether conditions exist that require an inseason adjustment or action are described as follows, although he or she is not precluded from using information not described but determined to be relevant to the issue:

a. the effect of overall fishing effort within an area;

b. catch per unit of effort and rate of harvest;

c. relative abundance of stocks within an area;

d. the condition of a stock in all or part of a regulatory area; and

e. any other factor relevant to the conservation and management of groundfish species or any incidentally-caught species that are designated as a prohibited species or for which a PSC limit has been specified.

The Regional Administrator is constrained, however, in his or her choice of management responses to prevent potential overfishing by having to first consider the least restrictive adjustments to conserve the resource. The order in which the Regional Administrator must consider inseason adjustments to prevent overfishing are specified as: (1) any gear modification that would protect the species in need of conservation

protection, but that would still allow fisheries to continue for other species; (2) a time/area closure that would allow fisheries for other species to continue in non-critical areas and time periods; and (3) total closure of the management area and season.

The procedure that the Secretary must follow requires that the Secretary publish a notice of proposed adjustments in the *Federal Register* before they are made final, unless the Secretary finds for good cause that such notice is impracticable or contrary to the public interest. If the Secretary determines that the prior comment period should be waived, he or she is still required to request comments for 15 days after the notice is made effective, and respond to any comments by publishing in the *Federal Register* either notice of continued effectiveness or a notice modifying or rescinding the adjustment.

To effectively manage each groundfish resource throughout its range, the Regional Administrator must coordinate inseason adjustments, when appropriate, with the State of Alaska to assure uniformity of management in both State and Federal waters.

Any inseason time/area adjustments made by the Regional Administrator will be carried out within the authority of this FMP. Such action is not considered to constitute an emergency that would warrant a plan amendment within the scope of section 305(e) of the Magnuson-Stevens Act. Any adjustments will be made by the Regional Administrator by such procedures provided under existing law. Any inseason adjustments that are beyond the scope of the above authority will be accomplished by emergency regulations as provided for under section 305(e) of the Magnuson-Stevens Act.

3.8.2.2 Measures to Address Identified Habitat Problems

The Secretary, upon the recommendation of the Council, may:

a. propose regulations establishing gear, timing, or area restrictions for purposes of protecting particular habitats of species in the GOA groundfish fishery;

b. propose regulations establishing area or timing restrictions to prevent the harvest of fish in contaminated areas; and/or

c. propose regulations restricting disposal of fishing gear by vessels.

3.8.2.3 Vessel Safety

The Council will consider, and may provide for, temporary adjustments regarding access to the fishery for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the safety of the vessels, after consultation with the Coast Guard and persons utilizing the fishery.

3.9 Monitoring and Reporting

3.9.1 Recordkeeping and Reporting

The Council and NMFS must have the best available biological and socioeconomic information with which to carry out their responsibilities for conserving and managing groundfish resources, as well as other fish resources, such as crab, halibut, and salmon, that are incidentally caught in the groundfish fishery. This information is used for making inseason and inter-season management decisions that affect these resources

as well as the fishing industry that utilize them. This information is also used to judge the effectiveness of regulations guiding these decisions. The Council will recommend changes to regulations when necessary on the basis of such information.

The need for the Council and NMFS to consider the best available information is explicit in the goals and objectives as established by the Council and contained in the FMP. They are also explicit in the Magnuson-Stevens Act, Executive Order 12866, the Regulatory Flexibility Act, the National Environmental Policy Act, and other applicable law. The Secretary, therefore, will require segments of the fishing industry to keep and report certain records as necessary to provide the Council and NMFS with the needed information to accomplish these goals and objectives. The Secretary may implement and amend regulations at times to carry out these requirements after receiving Council recommendations to do so, or at other times as necessary to accomplish these goals and objectives. Regulations will be proposed and implemented in accordance with the Administrative Procedure Act, the Magnuson-Stevens Act, and other applicable law.

Information on catch and production, effort, and price

In consultation with the Council, the Secretary may require recordkeeping that is necessary and appropriate to determine catch, production, effort, price, and other information necessary for conservation and management of the fisheries. Such requirements may include the use of catch and/or product logs, product transfer logs, effort logs, or other records. The Secretary may require the industry to submit periodic reports or surveys of catch and fishery performance information derived from the logs or other recordkeeping requirements. Recordkeeping and reporting would be required of operators of catcher vessels, catcher/processor vessels, mothership processor vessels, and by responsible officers of shoreside processor plants. Such requirements will be contained in regulations implementing this FMP.

Information on catching and/or processing activity

The Secretary may require catcher/processor vessels and mothership processor vessels to submit check-in and check-out reports for any Federal statistical area and the U.S. exclusive economic zone. Such requirements will be contained in regulations implementing this FMP.

3.9.2 Observer Program

The Council and NMFS must have the best available biological and socioeconomic information with which to carry out their responsibilities for conserving and managing groundfish resources. To address management and scientific information needs, NMFS, in consultation with the Council, will require U.S. fishing vessels that catch groundfish from the EEZ or receive groundfish from the EEZ, and shoreside processors that receive groundfish caught in the EEZ, to accommodate observers certified by NMFS. Provisions of the North Pacific Groundfish Observer Program will be developed in consultation with the Council and established in regulations. The purpose of the groundfish observer program is to verify catch composition and quantity, including those discarded at sea, and collect biological information on marine resources.

3.10 Council Review of the Fishery Management Plan

3.10.1 Ongoing Actions

The following is a list of "real time" possible actions or strategies the Council may wish to take in the future, based on concerns expressed and data presented or referenced in this FMP. Actions taken must also be consistent with the goals and objectives of the FMP.

- Hold hearings to gather information or opinions about specific proposed projects having a potentially adverse effect on habitats of species in the GOA groundfish fishery.
- Write comments to regulatory agencies during project review periods to express concerns or make recommendations about issuance or denial of particular permits.
- Respond to "Calls for Information" from the State of Alaska Minerals Management Service regarding upcoming oil and gas lease areas affecting the GOA/Cook Inlet areas.
- Identify research needs and recommend funding for studies related to habitat issues of new or continuing concern and for which the data are limited.
- Establish review panels or an ad hoc task force to coordinate or screen habitat issues.
- Propose to other regulatory agencies additional restrictions on industries operating in the fisheries management area, for purposes of protecting the habitat against loss or degradation.
- Joint as *amicus* in litigation brought in furtherance of critical habitat conservation, consistent with FMP goals and objectives.

3.10.2 Review of Management Approach

Adaptive management requires regular and periodic review. Objectives identified in the management policy statement (Section 2.2) will be reviewed annually by the Council. The Council will also review, modify, eliminate, or consider new issues, as appropriate, to best carry out the goals and objectives of the management policy.

3.10.3 Review of Essential Fish Habitat Components

To incorporate the regulatory guidelines requirement for review and revision of essential fish habitat (EFH) FMP components, the Council will conduct a complete review of all the EFH components of each FMP once every 5 years and will amend those EFH components to include new information.

In between each five-year comprehensive review, the Council will utilize its annual FMP amendment cycle to solicit proposals on HAPCs and/or conservation and enhancement measures to minimize the potential adverse effects from fishing. Those proposals that the Council endorses should be developed independent of the five-year comprehensive EFH review cycle.

An annual review of existing and new EFH information will be conducted and this information will be provided to the GOA Groundfish Plan Team for their review during the annual SAFE report process. This information could be included in the "Ecosystems Considerations" chapter of the SAFE report.

Chapter 4 Description of Stocks and Fishery

A description of the stocks that are managed as part of the Fishery Management Plan (FMP) for the Groundfish of the Gulf of Alaska (GOA) is contained in Section 4.1, including their status and trends. Section 4.2 describes the habitat of the GOA management area, defines essential fish habitat (EFH) for each of the managed species and provides recommendations, and describes habitat areas of particular concern. Fishing activities that affect the groundfish stocks are addressed in Section 4.3, including the history of exploitation in the GOA, and a description of the commercial, subsistence, and recreational fisheries for groundfish. Section 4.4 examines the economic and socioeconomic characteristics of the groundfish fisheries, and Section 4.5 describes fishing communities.

4.1 Stocks

4.1.1 Description of groundfish stocks

The relative abundance of fishes in the cod family (Gadidae) is different in the GOA compared to the other regions. Pacific hake (*Merluccius productus*), the most abundant of the cod-like fishery off Washington-California, is present only in the southern portion of the GOA and generally not in commercial quantities. Pollock (*Theragra chalcogramma*), the dominant "cod" and largest element in the groundfish biomass of the Bering Sea, is much less abundant in the GOA and becomes progressively scarce to the south until it is practically absent off Oregon. However, the abundance of pollock in the GOA increased by perhaps an order of magnitude during the past decade coincident with a reduction in the abundance of Pacific ocean perch. The abundance of pollock declined to low levels in 1985-87, primarily as the result of poor recruitment from 1980 and 1981 year classes. Pollock currently comprises the largest exploitable biomass within the gadoid community in the GOA. Pacific cod (*Gadus macrocephalus*) may reach its greatest coastwide abundance in the GOA.

Another groundfish that is the target of fisheries in the GOA is sablefish (*Anoplopoma fimbria*). Sablefish, which was depressed as a result of intensive fishing by foreign fleets in the 1960s and 1970s, recovered to high levels of abundance through 1988 due to the strong 1977 year class and have declined each year through 1999. Weak recruitment has led to projections of continued decline. Sablefish are found from California waters northward into the GOA and Bering Sea, but this species reaches its greatest abundance in the GOA.

Many of the flounders present in the GOA also occur in the Bering Sea and Washington-California region; however, the relative abundance of different species varies greatly between areas. In the Bering Sea yellowfin sole (*Limanda aspera*) dominates the flounder community, but is comparatively scarce in the Gulf and absent off Washington-California. Petrale sole (*Eopsetta jordani*) and English sole (*Parophrys vetulus*) are important components of the flounder community off Washington-California, but they are scarce in the GOA and for all practical purposes absent in the Bering Sea. The arrowtooth flounder, or so-called turbot (*Atheresthes stomias*), is widely distributed along the Pacific and Bering Sea coasts of the United States and appears to comprise the largest part of the exploitable biomass of flounders in the GOA. Other abundant flounders in the GOA include Pacific halibut (*Hippoglossus stenolepis*), which reaches its greatest abundance there and off British Columbia (and which is not managed in this FMP); northern rocksole (*Lepidopsette polyxystra*) and southern rocksole (*L. bilineata*); starry flounder (*Platichthys stellatus*); flathead sole

(*Hippoglossoides elassodon*); rex sole (*Glyptocephalus zachirus*); and, in deep water, the Dover sole (*Microstomus pacificus*).

The most diverse species in the GOA is the rockfish group (genus *Sebastes* and *Sebastolobus*). Two species of *Sebastolobus* and at least 32 species of *Sebastes* have been identified in this area. Several species of rockfish are of significant commercial interest, including the Pacific ocean perch (*S. alutus*), shortraker rockfish (*S. borealis*), rougheye rockfish (*S. aleutianus*), dusky rockfish (*S. ciliatus*), northern rockfish (*S. polyspinus*), and yelloweye rockfish (*S. ruberrimus*). Pacific ocean perch was the subject of a substantial foreign and domestic trawl fishery from the 1960s through the mid-1980s. For management purposes, rockfish are classified into four distinct assemblages. Thornyhead rockfish are managed independently, and *Sebastes* rockfish are classified into three assemblages based on their habitat and distribution. These assemblages are:

Slope Assemblage	Demersal Shelf Assemblage	Pelagic Shelf Assemblage
Aurora rockfish (*S. aurora*)	Canary Rockfish (*S. pinniger*)	Dusky rockfish (*S. ciliatus*)
Blackgill rockfish (*S. melanostomus*)	China Rockfish (*S. nebulosus*)	Widow rockfish (*S. entomelas*)
Boccacio (*S. paucispinus*)	Copper rockfish (*S. caurinus*)	Yellowtail rockfish (*S. flavidus*)
Chilipepper rockfish (*S. goodei*)	Quillback rockfish (*S. maliger*)	
Darkblotch rockfish (*S. crameri*)	Redbanded rockfish (*S. babcocki*)	
Greenstriped rockfish (*S. elongatus*)	Rosethorn rockfish (*S. helvomaculatus*)	
Harlequin rockfish (*S. variegatus*)	Tiger Rockfish (*S. nigrocinctus*)	
Northern rockfish (*S. polyspinus*)	Yelloweye rockfish (*S. ruberrimus*)	
Pacific Ocean Perch (*S. alutus*)		
Pygmy rockfish (*S. wilsoni*)		
Redstripe rockfish (*S. proriger*)		
Rougheye rockfish (*S. aleutianus*)		
Sharpchin rockfish (*S. zacentrus*)		
Shortbelly rockfish (*S. jordani*)		
Shortraker rockfish (*S. borealis*)		
Silvergray rockfish (*S. brevispinus*)		
Splitnose rockfish (*S. diploproa*)		
Stripetail rockfish (*S. saxicola*)		
Vermilion rockfish (*S. miniatus*)		
Yellowmouth rockfish (*S. reedi*)		

The four most valuable slope species, Pacific ocean perch, shortraker, rougheye, and northern rockfish, have been managed separately from the remainder of the slope assemblage since the early 1990s, to prevent possible overfishing. A rebuilding plan was put into place in 1995 for Pacific ocean perch, to address population declines resulting in a biomass well below historical levels. The population has since increased in abundance and is now at a level above $B_{40\%}$.

Atka mackerel, a member of the greenling family (*Hexagrammidae*), supported a targeted foreign fishery in the Central regulatory area in the 1970s, but abundance of this species has declined to negligible quantities. The decreased abundance of Atka mackerel may be due to westward shift in the distribution of the stocks, to excessive fishing mortality, or to successive years of poor recruitment. Length frequency information suggests that the population consists mostly of large fish. The absence of catches in the Eastern and Central

regulatory areas indicates stocks are not sufficiently abundant to support a commercial fishery, although small amounts are caught incidentally during other groundfish fishing activities.

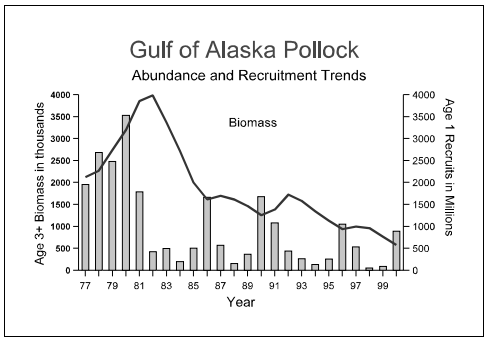
Along the slope of the continental shelf, grenadiers or rattails (*Coryphaenoides sp.*) are important components of the groundfish community, and are taken incidentally in the sablefish longline fisheries.

Elasmobranchs are represented in the GOA by several species of sharks and skates. Skates (*Rajidae*) are widely distributed throughout the GOA and are most abundant on the inner shelf. The spiny dogfish shark (*Squalus acanthias*), is much less abundant in the GOA than in waters off British Columbia and the Pacific Northwest where it is an important element within the groundfish community. Ratfish (*Hydrolagus collei*) are present in the GOA but are much less abundant there than in waters to the south. The abundance of all elasmobranchs appears to decrease progressing from east to west in the GOA toward the Alaska Peninsula.

4.1.2 Status of stocks

The following sections summarize the status of the various groundfish stocks of commercial importance in the GOA, and of Pacific halibut. More detailed assessments and current estimates of biomass and acceptable biological catches can be found in the *Stock Assessment and Fishery Evaluation* (SAFE) report, that is produced annually (or biennially for some stocks) by the Gulf of Alaska Groundfish Plan Team (available at www.fakr.noaa.gov/npfmc). The information in this section comes from the November 2003 SAFE report (NPFMC 2003). The SAFE report contains further details on fishery statistics, resource assessment surveys, and the analytical techniques applied to the assessment of the various species. Status information for Pacific halibut, developed by the International Pacific Halibut Commission (IPHC), is also available in the SAFE report.

4.1.2.1 Walleye Pollock



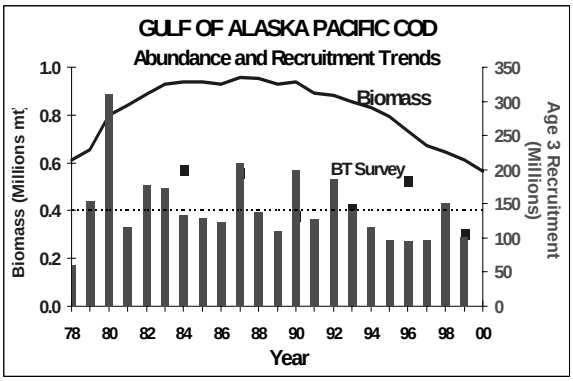
Pollock in the GOA are managed as a single stock that is separate from the Bering Sea and Aleutian Island pollock stocks. For 2004, exploitable biomass (age 3+) in the entire GOA is projected at 769,420 mt, an increase from 2003. The 2004 ABC is set at 71,260 mt (includes Western/Central and Eastern GOA ABCs). Biomass has declined since the mid 1980s. The 1994 and 1999 year-classes were above average, and have contributed to recent fisheries.

Projected biomass and ABC (mt) of GOA walleye pollock.

Year	Biomass	ABC
2002	755,310	58,250
2003	727,830	54,350
2004	769,420	71,260

In 1990, roe-stripping of pollock was prohibited. In 1993, the Council apportioned 100% of GOA pollock to the inshore sector. Since 1992, the pollock TAC has been apportioned seasonally and spatially to protect Steller sea lions. In December 1998, NMFS issued a biological opinion that the pollock fishery jeopardized the continued existence or adversely modified the critical habitat of Steller sea lions. In response, the Council prohibited pollock fishing within 10-20 nautical miles of numerous rookeries and haulouts, reduced the catch of pollock within critical habitat areas, and distributed fishing effort. Beginning in 1998, 100% retention is required for pollock under the improved retention/improved utilization (IR/IU) program.

4.1.2.2 Pacific Cod



The Pacific cod stock in the GOA has also declined since peaking in the late 1980s. The 2004 exploitable biomass (age 3+) was projected to be 484,000 mt. The 2004 ABC is 62,810 mt. The absolute biomass increased in 2004 compared to recent declines.

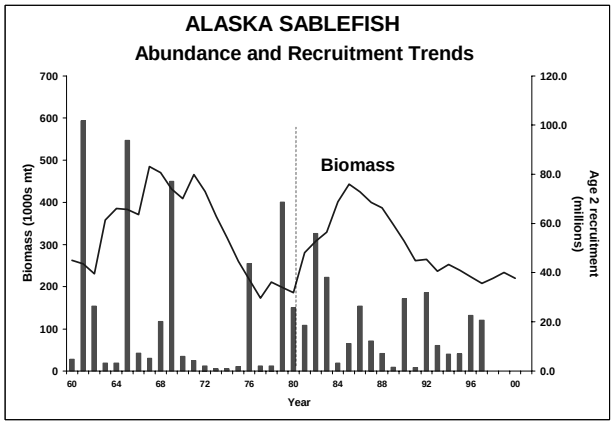
The Pacific cod stock is exploited by a multiple-gear fishery, principally by trawls and smaller amounts by longlines, jigs, and pots. For trawl fisheries in the EEZ, cod harvests have been constrained by halibut bycatch limits. A state water fishery for pot and jig gear began in 1997, and guideline harvest levels (GHLs) have since been set at between 10% and 25% of the federal GOA quota in each regulatory area. The state GHLs are not allowed to exceed 25% of the total federal quota.

Projected biomass and ABC (mt) of GOA Pacific cod.

Year	Biomass	ABC
2002	468,000	57,600
2003	428,000	52,800
2004	484,000	62,810

In 1993, the Council apportioned 90% of GOA Pacific cod TAC to the inshore sector and 10% to the offshore sector. Beginning in 1998, the IR/IU program was implemented, requiring full retention of all Pacific cod caught.

4.1.2.3 Sablefish



Sablefish in the Bering Sea, Aleutian Islands, and GOA are considered to be of one stock. The resource is managed by region in order to distribute exploitation throughout the range of the stock. Large catches of sablefish (up to 26,000 mt) were made in the Bering Sea during the 1960s, but have since declined in that area. Catch in the GOA peaked in 1972 at 36,776 mt, and rose again in the late 1980s. The projected 2004 exploitable biomass is 179,000 mt in the GOA, with an ABC of 16,550 mt. Biomass of the sablefish stock off Alaska appears low and stable.

Projected biomass and ABC (mt) of GOA sablefish.

Year	Biomass	ABC
2002	188,000	12,820
2003	182,000	14,890
2004	179,000	16,550

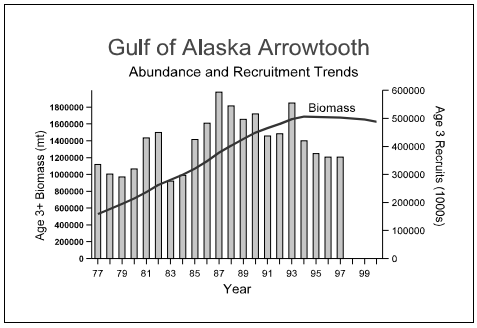
The TAC for sablefish is apportioned among gear types. Sablefish in the Western and Central GOA is allocated 80% to hook-and-line gear and 20% to trawl gear. In the Eastern GOA, the sablefish TAC is allocated 95% to hook-and-line gear and 5% to trawl gear. Longlined pots are not a legal gear type for sablefish in the GOA. The fixed gear apportionment of the sablefish TAC is managed under an individual fishing quota (IFQ) program, which began in 1995. Twenty percent of the fixed gear allocation is reserved for use by CDQ participants. Important state water sablefish fisheries occur in Chatham Strait, Clarence Strait, Prince William Sound, and the Aleutian Islands.

4.1.2.4 Flatfish

The flatfish assemblage has been divided into several categories for management purposes. Catch limits for flatfish are specified separately for the deep water flatfish complex (Dover sole, Greenland turbot, and deep-sea sole), rex sole, the shallow water flatfish complex (rock sole, yellowfin sole, Alaska plaice, and other flatfish), flathead sole, and arrowtooth flounder. Projected biomass and ABC estimations for 2004 are provided for the flatfish assemblage in the adjacent table.

Projected biomass and ABC (mt) of GOA flatfish, 2004.

Species	Biomass	ABC
deep water flatfish	99,620	6,070
rex sole	99,950	12,650
shallow water flatfish	375,950	52,070
flathead sole	292,670	51,720
arrowtooth flounder	2,453,390	194,930



Far and away the dominant flatfish species in the GOA is arrowtooth flounder. Arrowtooth flounder biomass in the GOA appears to be at peak levels. Recent trophic studies have suggested that they are an important component in the dynamics of the GOA benthic ecosystem. The resource is lightly exploited as it is presently of limited economic importance, although research has been conducted on their commercial utilization. Retention rates have increased steadily since the early 1990s.

4.1.2.5 Rockfish

Sebastes and *Sebastolobus* rockfish are found in the GOA. In 1979, thornyhead rockfish (genus *Sebastolobus*) were assigned to an independent management category.

Thornyhead rockfish – The thornyhead rockfish assemblage consists of two species: shortspine and longspine thornyheads. The species are abundant throughout the GOA and are commonly taken by bottom trawls and longline gear. Recent harvests have been between 50-70% of the ABC. Due to the long-lived nature of this species, the overall harvest rate recommendation is low at about 2% of the total age 5+ biomass.

Projected biomass and ABC (mt) of GOA thornyhead rockfish.

Year	Biomass	ABC
2002	77,840	1,990
2003	75,896	2,000
2004	86,200	1,940

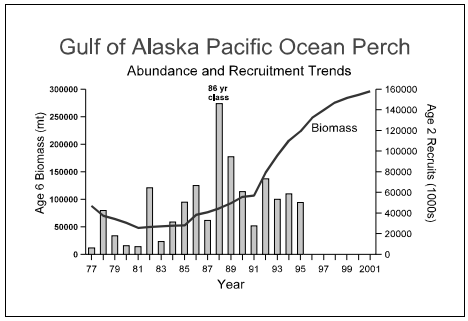
At least 32 rockfish species of the genus *Sebastes* occur in the GOA. Since 1988, these rockfish have been divided into three management assemblages based on their habitat and distribution: slope, pelagic shelf, and demersal shelf rockfish.

***Sebastes* rockfish assemblages in the GOA.**

Slope rockfish	Pelagic shelf rockfish	Demersal shelf rockfish
Pacific ocean perch	dusky	canary
shortraker/rougheye	widow	china
northern	yellowtail	copper
other rockfish (harlequin, sharpchin, redstripe, many others)		quillback
		rosethorn
		tiger
		yelloweye

In 1998, a prohibition on trawling in the part of the Eastern GOA regulatory area, east of 140° W. longitude affected *Sebastes* rockfish fisheries, which are primarily conducted with trawl gear. To prevent over-concentration of harvest, the Eastern GOA TACs have since been apportioned by district, between West

Yakutat and East Yakutat/Southeast Outside, for some species. Summary information for the slope, pelagic shelf, and demersal shelf rockfish assemblages is provided below.



Slope rockfish - In the early 1990s, the slope assemblage was divided into four management subgroups: Pacific ocean perch (POP), shortraker/rougheye rockfish, northern rockfish, and all other species of slope rockfish, in order to protect the most sought-after species in the assemblage from possible overfishing. The primary commercial rockfish species in the GOA is POP. A plan for rebuilding POP was implemented in 1995 after the population declines resulted in a biomass level at well below historical levels. Relatively strong recent year-classes appear to have contributed to increased abundance, and the spawning stock now exceeds the $B_{40\%}$ level. The majority of the exploitable biomass of the northern rockfish is located in the Central GOA. Gulf-wide catch has ranged from 2,947 mt to 5,760 over the last ten years, with annual ABCs and TACs remaining fairly constant (between 4,880 mt and 5,760 mt) over the same period. Shortraker and rougheye rockfish inhabit a narrow band along the upper continental slope at depths of 300-500m, and often co-occur in trawl or longline hauls. They are similar in appearance and can be difficult to distinguish visually, which is why they are grouped together as a management category. With the exception of harlequin rockfish, the 17 species that comprise the "other slope" rockfish assemblage are at the northern edge of their ranges, and are most abundant in the eastern GOA. Actual catch is considerably less than the ABC, particularly since the 1998 trawl closure east of 140° W. longitude.

Projected biomass and ABC (mt) of GOA slope rockfish, 2004.

Species	Biomass	ABC
Pacific ocean perch	299,960	13,340
shortraker/rougheye	73,000	1,318
northern	95,150	4,870
other slope	89,460	3,900

Pelagic shelf rockfish - The PSR assemblage in the GOA includes those rockfish on the continental shelf that typically exhibit a midwater, schooling behavior. A proposal is in preparation to separate dusky rockfish into two distinct species, an inshore, shallow water, dark-colored variety and an offshore, deeper water, light-colored variety. Most information is available on the light-colored dusky rockfish. In 1998, black rockfish and blue rockfish were removed from federal management as part of the pelagic shelf complex, and are now managed by the State of Alaska.

Projected biomass and ABC (mt) of GOA pelagic shelf rockfish.

Year	Biomass	ABC
2002	62,489	5,490
2003	62,489	5,490
2004	62,500	4,470

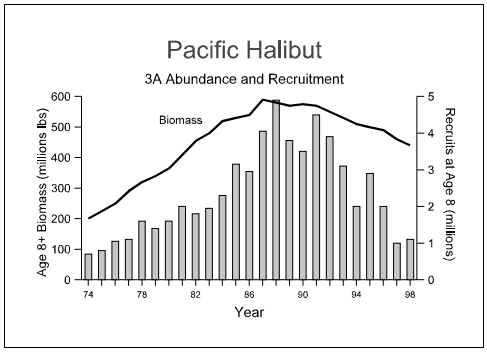
Demersal shelf rockfish - The DSR assemblage is comprised of seven species of shallow, nearshore, bottom-dwelling rockfishes. Yelloweye rockfish accounts for 90% of all DSR landings. ABC recommendations for the entire assemblage are keyed to adult yelloweye abundance. Since 1991, the DSR assemblage has been managed by the State of Alaska under Council oversight, although the harvest level is still set by the Council and NMFS. DSR were excluded from the Council license limitation program because ADF&G planned to initiate an analysis for a separate DSR license limitation program. As of 2004, full retention of all DSR caught off Southeast Alaska is required.

Projected biomass and ABC (mt) of GOA demersal shelf rockfish.

Year	Biomass	ABC
2002	15,615	350
2003	17,510	390
2004	20,168	450

4.1.2.6 Pacific Halibut Stock

Large year-classes produced in the late 1970s and into the mid-1980s resulted in a buildup of halibut biomass to current high levels. The 2000 total exploitable biomass was projected to be 395.7 million pounds. Over half of the biomass is found in areas 3A and 3B (central and western GOA). Recruitment of 8 year-olds appears to have fallen off after a strong 1987 year-class recruited in 1995.



The directed halibut longline fishery is prosecuted under the halibut/ sablefish individual fishing quota (IFQ) program, which began in 1995. The Pacific halibut stock is managed by the International Pacific Halibut Commission (IPHC), which sets the annual catch specifications for halibut off the coasts of California, Oregon, Washington, Canada, and Alaska. Alaska's IFQ allocations increased in Areas 2C and 3A in 2004 (corresponding to the eastern and central GOA), and were reduced in the western GOA and BSAI compared to 2003. During the years 2001 to 2004, 70-85% of the Alaskan halibut biomass occurred in the GOA.

Pacific halibut exploitable biomass, annual commercial allocation, and actual commercial catch (in millions of pounds) in Alaska.

Year	Exploitable biomass	Allocation	Catch
2001	481.3	61.5	58.6
2002	528.6	61.9	60.6
2003	580.9	61.9	59.6
2004	357.0	61.2	na

Limits are placed on halibut taken as bycatch in groundfish target fisheries. These limits are expressed in terms of halibut mortality, and discarded halibut mortality rates are set in regulation. The limits for the BSAI and the GOA are listed in the adjacent table.

Prohibited species catch limits (mt) for halibut mortality in the GOA and non-CDQ BSAI fisheries, 2001-2004.

Region	Trawl	Fixed gear
BSAI	3,400	833
GOA	2,000	300

4.2 Habitat

The following sections describe the habitat of the GOA management area, define essential fish habitat for each of the managed species, describe habitat areas of particular concern, and provide habitat conservation and enhancement recommendations.

4.2.1 Habitat Types

Marine habitats within the GOA include estuaries, tideland marshes, bays, fjords, sandy beaches, unprotected rocky shores, river deltas, and a variety of continental shelf, slope, seamounts, and deep ocean habitats. This section describes the physical environment of the GOA. More detailed information can be found in Morris et al., (1983), Sharma (1979), and Hood and Zimmerman (1986).

The GOA is a large body of water bordered by the Alaska coast from Dixon Entrance to Unimak Pass. This coast is unusually rugged and mountainous and deeply indented by numerous fjords and inlets. Tidewater glaciers flow down into the heads of many bays. Thousands of streams and rivers flow into these waters, including many that are glacier-fed and silt-laden.

The continental shelf parallels the southeastern Alaska coast and extends around the GOA (Figure 4-1). Total area of the continental shelf in the GOA is about 160,000 square km. Between Canada and Cape Spencer in the GOA, the continental shelf is narrow and rough. North and west of Cape Spencer it is broader and more suitable for trawling. As it curves westerly from Cape Spencer towards Kodiak Island it extends some 50 miles seaward, making it the most extensive shelf area south of the Bering Sea. West of Kodiak Island and proceeding along the Alaska Peninsula toward the Aleutian Islands, the shelf gradually becomes narrow and rough again. Although its width is less than 10 miles at some points, it is generally 30 to 60 miles wide. Off the Kenai Peninsula and Kodiak Island it is more than 100 miles broad.

The continental shelf reflects the rugged coastline; it is irregular and frequently interrupted by submarine valleys. These deepwater valleys, or troughs, separate broad bank areas such as Albatross and Portlock Banks near Kodiak Island and Davidson Bank south of Unimak Island. In the western GOA, these submarine banks are generally covered with sand and gravel, indicating a vigorous current flow in the overlying water. In contrast, the sea valleys adjacent to these banks are usually sediment-laden. Rock out-croppings occasionally occur along the edge of these banks and where the continental shelf meets the deeper water of the slope. A pronounced feature of the western portion of the GOA is a greater frequency and expansiveness of plateau-like banks and offshore islands than in the eastern part.

The continental shelf extends from the coast seaward to depths of approximately 200 m. At its edge, bottom depths increase rapidly toward the ocean basin or abyssal plain of the GOA. This region of rapidly increasing depth is known as the continental slope, which can be subdivided into an upper slope from 200 to 500 m in depth and a lower slope greater than 500 m. The 2,000 m depth line can be considered the boundary between the continental slope and the abyssal plain. In general, bottom sediment becomes finer with increasing depth so that in the lower slope and abyssal plain the sediment consists mainly of a mixture of clay and silt. The abyssal plain of the GOA contains submarine mountains that rise thousands of meters from the ocean floor. These seamounts, or guyots, are remnants of extinct volcanoes whose peaks have been eroded away to form flat-topped features.

Coastal waters overlying the continental shelf are subject to considerable seasonal influences. Winter cooling accompanied by turbulence and mixing due to major storms results in a uniform cold temperature in the upper 100 m.

Seaward of the continental shelf, there is a surface flow of water called the Alaska Current which moves in a northwesterly direction in the eastern GOA and swings to the west and southwest off Kodiak Island and westward toward Unimak Pass (Musgrave et al. 1992). Its rate of flow varies by season and is highest during the winter where, off Kodiak Island, its speed may exceed one knot. There is also evidence of an interannual eddy off the coast of southeast Alaska named the Sitka Eddy. This is a large (300 km in diameter) clockwise-rotating vortex that is observed in some years centered near 57° N. latitude, 138° W. longitude. Currents in the eddy can exceed one knot and could affect distribution of fish and larvae (Hamilton and Mysak 1985 and Tabata 1982).

Seasonal changes in temperature and salinity diminish with increasing depth and distance from shore. Along the outer shelf and upper slope, bottom water temperatures of 4 to 5° C persist year-round throughout the periphery of the GOA. With further increase in depth, water temperature shows no significant seasonal change but gradually decreases with depth, reaching 2° C or less at greater depths.

Most of the commercial fisheries on pelagic and demersal fishes take place in the habitats of the shelf and upper slope. Longline fisheries for sablefish extend deeper into the lower slope habitat to about 1,200 m. No

fisheries take place in the abyssal plain where commercial quantities of fishery resources are believed to be lacking. Fisheries of limited duration have taken place on selected seamounts.

Associated with seasonal temperature changes in the bottom water of the shelf habitat are bathymetric shifts in the distribution of many demersal fish and shellfish populations from shallow to deeper water during the winter cooling period and the reverse movement to shallower water during the summer warming period.

Figure 4-1 Bathymetric map of the Gulf of Alaska.

[PLACEHOLDER]

4.2.2 Essential Fish Habitat Definitions

For each groundfish species, the amount of information available on the distribution of a life stage is indicated by the level to which it is classified (Table 4-1). A summary of the habitat information levels for each species is listed in Table 4-2. A detailed description of life history features and habitat requirements of FMP species is contained in Appendix D. Appendix E includes the maps of EFH for the species described in this section.

Table 4-1 Classification of EFH levels

Level 0	No systematic sampling has been conducted for this species and life stage; may have been caught opportunistically in small numbers during other research.
Level 0_a	Some information on a species' life stage upon which to infer general distribution.
Level 0_b	No information on the life stage, but some information on a similar species or adjacent life stage from which to infer general distribution.
Level 0_c	No information on the actual species' life stage and no information on a similar species or adjacent life stages, or where complexity of a species stock structure prohibited inference of general distribution.
Level 1	Distribution data are available for some or all portions of the geographic range of the species.
Level 2	Habitat-related densities of the species are available
Level 3	Growth, reproduction, or survival rates within habitats are available
Level 4	Production rates by habitat are available

Table 4-2. Levels of essential fish habitat information currently available for GOA groundfish, by life history stage. Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Pollock	1	1	1	1	2
Pacific cod	0_a	0_a	0_a	1	2
Sablefish	0_a	0_a	0_a	1	2
Shallow water flatfish					
Yellowfin sole	0_a	0_a	0_a	1	2
Rock sole	0_a	0_a	0_a	1	2
Deep water flatfish	0_a	0_a	0_a	0_a	1
Rex sole	0_a	0_a	0_a	0_a	1
Flathead sole	0_a	0_a	0_a	1	2
Arrowtooth flounder	0_a	0_a	0_a	1	2
Pacific ocean perch	-	0_a	0_a	1	1
Northern rockfish	-	0_b	0_b	1	1
Shortraker rockfish	-	0_b	0_{a-b}	0_b	1
Rougheye rockfish	-	0_b	0_{a-b}	1	1
Pelagic shelf rockfish					
Dusky rockfish	-	0_b	0_b	0_a	1
Demersal shelf rockfish					
Yelloweye rockfish	-	0_b	0_a	1	1
Thornyhead rockfish	0_a	0_a	0_a	0_a	1
Atka mackerel	0_a	0_a	0_b	0_b	1
Skates	0_a	-	0_a	0_a	1
Other species					
squid	0_a	-	0_a	0_a	0_a
sculpins	0_a	0_a	0_a	0_a	1
sharks	-	-	0_a	0_a	0_a
octopus	0_a	-	0_a	0_a	0_a
Forage fish species					
eulachon and capelin	0_a	0_a	0_a	0_a	0_a
myctophids and bathylagids	0_c	0_c	0_a	0_a	0_a
sand lance	0_a	0_a	0_a	0_a	0_a
sand fish	0_a	0_c	0_a	0_a	0_a
pholids and stichaeids	0_c	0_c	0_a	0_a	0_a
gonostomatids	0_c	0_c	0_c	0_c	0_a
euphausiids	0_a	0_a	0_a	0_a	0_a

NOTE: "-" indicates a species that has internal fertilization and bears live young.

4.2.2.1 Walleye Pollock

Eggs (duration 14-25 days) - Level 1: Pelagic waters of the outer continental shelf and upper slope of the GOA from Dixon Entrance to 170° W. longitude. Spawning concentrations occur in Shelikof Strait (late March), in the Shumagin Islands (early March), the east side of Kodiak Island and near Prince William Sound. Oceanographic features that eggs may be associated with are gyres.

Larvae (duration 60 days) - Level 1: Epipelagic waters of the water column along the middle and outer continental shelf in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas are those that contain copepod, naupli and small euphausiids. Oceanographic features that larvae may be associated with are gyres and fronts.

Juveniles (up to 4 years) - Level 1: Pelagic waters along the inner, mid and outer continental shelf in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas are those that contain pelagic crustaceans, copepods and euphausiids. Oceanographic features that juveniles may be associated with are fronts and the thermocline.

Adults (4+ years old) - Level 2: Pelagic waters from 70-200 m along the outer continental shelf and basin in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas are those that contain pelagic crustaceans and fish. Oceanographic features that adults are associated with are fronts and upwelling. Spawning concentrations occur in Shelikof Strait, in the Shumagin Islands, the east side of Kodiak Island and near Prince William Sound in late winter. Area in GOA where greatest abundance occurs are between 147°W to 170°W at depths less than 300 m.

4.2.2.2 Pacific Cod

Eggs (duration 15-20 days) - Level 0_a: Areas of mud and sand on the inner, middle, and outer continental shelf and upper slope throughout the GOA from Dixon Entrance to 170° W. longitude in winter and spring.

Larvae (duration unknown) - Level 0_a: Epipelagic waters throughout the GOA from Dixon Entrance to 170° W. longitude in winter and spring.

Early Juveniles (up to 2 years) - Level 0_a: Areas of mud, sandy mud, muddy sand, and sand along the inner and middle continental shelf and the lower portion of the water column of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain small invertebrates(e.g., mysids, euphausiids, and shrimp).

Late Juveniles (2-5 years) - Level 1: Areas of mud, sandy mud, muddy sand, and sand along the inner and middle continental shelf and the lower portion of the water column of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain pollock, flatfish, and crab.

Adults (5+ years old) - Level 2: Areas of mud, sandy mud, muddy sand, and sand along the inner and middle continental shelf and the lower portion of the water column of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain pollock, flatfish, and crab. Spawning occurs in January-May.

4.2.2.3 Sablefish

Eggs (duration 14-20 days) - Level 0_a: Pelagic waters of the continental shelf and basin areas from 200-3000 m extending to the seaward boundaries of the EEZ of the GOA from Dixon Entrance to 170° W. longitude from late winter to early spring (December-April).

Larvae (duration up to 3 months) - Level 0_a: Epipelagic waters of the middle and outer continental shelf, the slope and basin areas in the GOA from Dixon Entrance to 170° W. longitude during late spring-early summer months (April-July).

Early Juveniles (up to 2 years) - Level 0_a: Pelagic waters, during first summer, along the outer, middle, and inner continental shelf of the GOA from Dixon Entrance to 170° W. longitude. Areas of soft-bottom in nearshore bays and island passes after the first summer until end of second summer.

Late Juveniles (2-5 years) - Level 1: Areas of soft bottom deeper than 100 m associated with the continental slope and deep shelf gulleys and fjords (presumably within the lower portion of the water column) of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain mesopelagic and benthic fishes, benthic invertebrates, and jellyfish.

Adults (5+years) - Level 2: Areas of soft bottom deeper than 200 m (presumably within the lower portion of the water column) associated with the continental slope and deep shelf gulleys and fjords (such as Prince William Sound and those in southeastern Alaska) of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain mesopelagic and benthic fishes, benthic invertebrates and jellyfish. A large portion of the adult diet is comprised of gadid fishes, mainly pollock.

4.2.2.4 Shallow-water Flatfish complex

Yellowfin sole

Eggs (duration unknown) - Level 0_a: Pelagic inshore waters of the central and western GOA during summer months.

Larvae (duration 2-3 months) - Level 0_a: Pelagic inshore waters and inner continental shelf regions of the central and western GOA during summer and autumn months.

Early Juveniles (to 5.5 years old) - Level 0_a: Demersal areas (bottom and lower portion of the water column) on the inner, middle and outer portions of the continental shelf (down to 250 m) and within nearshore bays of the central and western GOA.

Late Juveniles (5.5-9 years old) - Level 1: Areas of sandy bottom along with the lower portion of the water column within nearshore bays and on the inner, middle and outer portions of the continental shelf (down to 250 m) of the central and western GOA. Feeding areas would be those containing polychaetes, bivalves, amphipods and echiurids.

Adults (9+ years old) - Level 2: Areas of sandy bottom along with the lower portion of the water column on the inner, middle and outer portions of the continental shelf (down to 250 m) of the central and western GOA. Areas of known concentrations vary seasonally. Adult spawning areas known for the Bering Sea. Summer (June-October) feeding concentrations of adults known in the Bering Sea. Feeding areas would be those containing polychaetes, bivalves, amphipods and echiurids. In winter, yellowfin sole adults migrate to deeper waters of the shelf (100-200 m) south of 60° N. latitude to the Alaskan Peninsula.

Rock sole

Eggs (duration unknown) - Level 0_a: Areas of pebbles and sand at depths of 125-250m in winter (December-March) along the shelf-slope break in the of Alaska from Dixon Entrance to 170° W. longitude.

Larvae (duration 2-3 months) - Level 0_a: Pelagic waters of the of Alaska from Dixon Entrance to 170° W. longitude over the inner, middle and outer continental shelf and slope.

Early Juveniles (to 3.5 years old) - Level 0_a: Inner, middle and outer portions of the continental shelf (down to 250m) of the GOA and the lower portion of the water column from Dixon Entrance to 170° W. longitude. Feeding areas would be those containing polychaetes, bivalves, amphipods and crustaceans.

Late Juveniles (3.5-8 years old) - Level 1: Areas of pebbles and sand along with the lower portion of the water column within nearshore bays and on the inner, middle and outer portions of the continental shelf (down to 250 m) of the of Alaska from Dixon Entrance to 170° W. longitude. Feeding areas would be those containing polychaetes, bivalves, amphipods and crustaceans.

Adults (8+ years old) - Level 2: Areas of pebbles and sand along with the lower portion of the water column on the inner, middle and outer portions of the continental shelf (down to 250 m) of the of Alaska from Dixon Entrance to 170° W. longitude. Areas of known concentrations vary seasonally and include adult spawning areas in winter and feeding areas in summer (May-October) in the Bering Sea. Feeding areas would be those containing polychaetes, bivalves, amphipods and crustaceans.

4.2.2.5 Deep-water Flatfish Complex

Dover sole

Eggs (duration unknown) - Level 0_a: Pelagic waters along the inner, middle and outer continental shelf, during spring and summer, of the GOA from Dixon Entrance to 170° W. longitude.

Larvae (up to 2 years) - Level 0_a: Pelagic waters along the inner, middle, and outer continental shelf and upper slope of the GOA from Dixon Entrance to 170° W. longitude.

Early Juveniles (up to 3 years) - Level 0_a: Areas of sand and mud along the inner and middle continental slope and the lower portion of the water column of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain polychaetes, amphipods and annelids.

Late Juveniles (3-5 years old) - Level 0_a: Areas of sand and mud along the inner and middle continental slope and the lower portion of the water column of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain polychaetes, amphipods and annelids.

Adults (5+ years old) - Level 1: Areas of sand and mud along the middle to outer continental shelf and upper slope deeper than 300 m and the lower portion of the water column of the GOA from Dixon Entrance to 170° W. longitude. Winter and spring spawning and summer feeding on soft substrates (sand and mud) of the continental shelf and upper slope and a shallower summer distribution mainly on the middle to outer portion of the shelf and upper slope. Feeding areas contain polychaetes, amphipods, annelids and mollusks.

4.2.2.6 Rex Sole

Eggs - Level 0_a: Pelagic waters of the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude during the months between February and July.

Larvae - Level 0_a: Pelagic waters of the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude during the spring and summer months.

Juveniles (up to 2 years) - Level 0_a: Areas of gravel, sand, and mud along the inner, middle to outer continental shelf deeper than 300 m, and the lower portion of the water column, of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain polychaetes, amphipods, euphausiids and Tanner crab.

Adults (2+ years) - Level 1: Areas of gravel, sand and mud along the inner, middle to outer continental shelf deeper than 300 m, and the lower portion of the water column, of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain polychaetes, amphipods, euphausiids and Tanner crab. Spawning occurs from February through July along areas of sand, mud, and gravel substrates of the continental shelf.

4.2.2.7 Flathead Sole

Eggs (duration unknown) - Level 0_a: Pelagic waters (January-April) along the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude.

Larvae (duration unknown) - Level 0_a: Pelagic waters along the inner, middle, and outer continental shelf in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain phytoplankton and zooplankton.

Early Juveniles (up to 2 years) - Level 0_a: Areas of sand and mud along the inner, middle and outer continental shelf and upper slope and the lower portion of the water column in the Gulf of Alaska from Dixon Entrance to 170˚W. Feeding areas contain polychaetes, bivalves, ophiuroids, pollock and small tanner crab.

Late Juveniles (2-3 years old) - Level 1: Areas of sand and mud along the inner, middle and outer continental shelf and upper slope and the lower portion of the water column in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain polychaetes, bivalves, ophiuroids, pollock, and small tanner crab.

Adults (3+ years old) - Level 2: Areas of sand and mud along the inner, middle and outer continental shelf and upper slope and the lower portion of the water column in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas, primarily on the inner, middle, and outer shelf in spring, summer, and fall, contain polychaetes, bivalves, ophiuroids, pollock, small tanner crab and other crustaceans. Spawning areas in winter and early spring are located primarily on the outer shelf.

4.2.2.8 Arrowtooth Flounder

Eggs (duration unknown) - Level 0_a: Pelagic waters (November-March) along the inner, middle, and outer continental shelf GOA from Dixon Entrance to 170° W. longitude.

Larvae (duration 2-3 months) - Level 0_a: Pelagic waters along the inner and outer continental shelf and nearshore bays during the spring and summer in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas are those that contain phytoplankton and zooplankton.

Early Juveniles (to 2 years old) - Level 0_a: Areas of gravel, sand, and mud and the associated water column of the inner continental shelf and the adjacent nearshore bays in the GOA from Dixon Entrance to 170° W. longitude.

Late Juveniles (2-4 years old) - Level 1: Areas of gravel, sand and mud along the inner, middle, and other continental shelf and upper slope and the lower portion of the water column in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain euphausiids, crustaceans, amphipods, and pollock.

Adults (4+ years old) - Level 2: Areas of gravel, sand and mud along the inner, middle, and other continental shelf and upper slope and the lower portion of the water column in the GOA from Dixon Entrance to 170° W. longitude. Summer feeding areas on the middle and outer shelf contain gadids, euphausiids, and other fish. Spawning areas in winter are on the outer shelf and upper slope regions.

4.2.2.9 Pacific Ocean Perch and "Other Slope" Rockfish

Eggs (internal incubation, ~90days) - no EFH definition determined: Internal fertilization and incubation. Incubation is assumed to occur during the winter months.

Larvae (duration 60-180 days) - Level 0_a: Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope and the basin areas of the EEZ of the GOA from Dixon Entrance to 170° W. longitude, during the spring and summer months.

Early Juveniles (larval stage to 3 years) - Level 0_a: Initially pelagic, then demersal in very rocky areas of the inner continental shelf of the GOA from Dixon Entrance to 170° W. longitude.

Late Juveniles (3-10 years) - Level 1: Areas of cobble, gravel, mud, sandy mud, and muddy sand along the inner, middle, and outer continental shelf and upper slope areas, shallower than adults, middle to lower portions of the water column, of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain euphausiids.

Adults (10+ years) - Level 1: Areas of cobble, gravel, mud, sandy mud and muddy sand along the outer continental shelf and upper slope areas from 180-420m (actual depths sampled) of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain euphausiids. Areas of high concentrations tend to vary seasonally and may be related to spawning behavior. In summer, adults inhabit shallower depths (180-250m) and in the fall they migrate farther offshore (300-420m).

4.2.2.10 Northern Rockfish

Eggs - no EFH definition determined: Internal fertilization and incubation.

Larvae - Level 0_b: Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope and the basin areas extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170° W. longitude, during the spring and summer months.

Early juveniles (up to 25cm) - Level 0_b: Pelagic waters and substrate of the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude.

Late Juveniles (greater than 25 cm) - Level 1: Areas of cobble and rock along the shallower regions (relative to adults) of the outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude.

Adults (13+years) - Level 1: Areas of cobble and rock along the outer continental slope and upper slope regions and the middle and lower portions of the water column of the GOA from Dixon Entrance to 170° W. longitude. Areas of relatively shallow banks of the outer continental shelf have been found to have concentrated populations.

4.2.2.11 Shortraker and Rougheye Rockfish

Eggs - no EFH definition determined: Internal fertilization and incubation.

Larvae (duration unknown) - Level 0_b: Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope and the basin areas extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170° W. longitude, during the spring and summer months.

Early Juveniles (up to 20 cm)- Level 0_{a-b}: Between nearshore waters and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude.

Late Juveniles (greater than 20 cm) - Level 0_b and Level 1: Areas shallower than adult along the continental shelf of the GOA (includes substrate and water column) from Dixon Entrance to 170° W. longitude. Juvenile shortraker rockfish have been observed on only a few rare occasions. Presence presumed somewhere between nearshore and outer continental shelf between Dixon Entrance to 170° W. longitude.

Adults (15+ years) - Level 1: Areas of mud, sand, rock, sandy mud, cobble, muddy sand, and gravel at depths ranging from 200-500 m and the lower portion of the water column on the outer continental shelf and upper slope of the GOA from Dixon Entrance to 170° W. longitude. Fishery concentrations at 300-500 m. Feeding areas would be those areas where shrimps, squid and myctophids.

4.2.2.12 Pelagic Shelf Rockfish

Dusky rockfish

Eggs - no EFH definition determined: Internal fertilization and incubation.

Larvae - Level 0_b: Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope and the basin areas extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170° W. longitude, during the spring and summer months.

Early juveniles (less than 25cm) - Level 0_b: Pelagic waters of the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude.

Late Juveniles (greater than 25cm) - Level 0_a: Areas of cobble, rock, and gravel along the inner, middle, and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude. Location in water column is currently unknown.

Adults (up to 50 years) - Level 1: Areas of cobble, rock, and gravel along the outer continental shelf and upper slope region and the middle to lower portions of the water column of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain euphausiids. Also found in nearshore waters of Southeast Alaska along rocky shores at depths less than 50 m.

4.2.2.13 Demersal Shelf Rockfish

Yelloweye rockfish

Eggs - no EFH definition determined: Internal fertilization and incubation.

Larvae (< 6 months) - Level 0_b: Epipelagic areas of the water column of the GOA from Dixon Entrance to 170° W. longitude during the spring and summer months.

Early Juveniles (to 10years) - Level 0_a: Areas of rock and coral along the inner, middle and outer continental shelf, bays and island passages and the entire water column of the GOA from Dixon Entrance to 170° W. longitude. Concentrations of young juveniles (2.5-10 cm) have been observed in areas of high relief (such as vertical walls, cloud sponges, fjord-like areas).

Late Juveniles (10-18 years) - Level 1: Areas of rock and coral along the inner, middle and outer continental shelf, nearshore bays and island passages of the GOA from Dixon Entrance to 170° W. longitude and the lower portion of the water column. High concentrations are found associated with high relief with refuge spaces such as overhangs, crevices and caves.

Adults (18+ years) - Level 1: Areas of rock, coral and cobble along the inner, middle and outer continental shelf, upper slope, nearshore bays and island passages of the GOA from Dixon Entrance to 170° W. longitude from and the lower portion of the water column. High concentrations are found associated with high relief containing refuge spaces such as overhangs, crevices and caves. Feeding areas contain fish, shrimp and crab.

4.2.2.14 Thornyhead Rockfish

Eggs - Level 0_a: Pelagic waters of the GOA from Dixon Entrance to 170° W. longitude during the late winter and early spring.

Larvae (duration <15 months) - Level 0_a: Pelagic waters extending to the seaward boundary of the EEZ of the GOA from Dixon Entrance to 170° W. longitude during the early spring through summer.

Juveniles (> 15 months) - Level 0_a: Areas of mud, sand, rock, sandy mud, cobble, muddy sand, and gravel and the lower portion of the water column along the middle and outer continental shelf and upper slope of the GOA from Dixon Entrance to 170° W. longitude.

Adults - Level 1: Areas of mud, sand, rock, sandy mud, cobble, muddy sand, and gravel and the lower portion of the water column along the middle and outer continental shelf and upper slope of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain shrimp, fish (cottids), and small crabs.

4.2.2.15 Atka Mackerel

Eggs (40-45 days) - Level 0_a: Areas of gravel, rock and kelp in shallow water, island passes, and the inner continental shelf of the GOA from Kodiak Island to 170° W. longitude.

Larvae (up to 6 months) - Level 0_a: Epipelagic waters of the middle and outer continental shelf, slope, and extending seaward to the edge of the EEZ of the GOA from Kodiak Island to 170° W. longitude.

Juveniles (up to 2 years) - Level 0_b: Unknown habitat association; assumed to settle near areas inhabited by adults, but have not been observed in fishery or surveys.

Adults - Level 1: Areas of gravel, rock and kelp on the inner, middle and outer continental shelf and the entire water column (to the surface) of the GOA from Kodiak Island to 170° W. longitude. Feeding areas contain copepods, euphausiids and meso-pelagic fish (myctophids). Spawning occurs in nearshore (inner

shelf and island passes) rocky areas and in kelp in shallow waters in summer. Move to offshore deeper areas nearby in winter. Perform diurnal/tidal movements between demersal and pelagic areas.

4.2.2.16 Skates

Eggs - Level 0_a: All bottom substrates of the slope and across the shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Larvae - no EFH definition determined: Not applicable (no larval stage)

Juveniles - Level 0_a: Broad range of substrate types (mud, sand, gravel, and rock) and the water column on the shelf and the upper slope of the GOA from Dixon Entrance to 170° W. longitude.

Adults - Level 1: Broad range of substrate types (mud, sand, gravel, and rock) and the lower portion of the water column on the shelf and the upper slope of the GOA from Dixon Entrance to 170° W. longitude.

4.2.2.17 "Other Species"

Red Squid

Eggs - Level 0_a: Areas of mud and sand on the upper and lower slope throughout the GOA from Dixon Entrance to 170° W. longitude.

Larvae - no EFH definition determined: Not applicable (no larval stage).

Juveniles and Adults - Level 0_a: Pelagic waters of the shelf, slope and basin to the seaward edge of the EEZ in the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain euphausiids, shrimp, forage fish, and other cephalopods.

Sculpins

Eggs - Level 0_a: All substrates on the inner, middle and outer continental shelf of the GOA from Dixon Entrance to 170° W. longitude. Some species deposit eggs in rocky shallow waters near shore.

Larvae - Level 0_a: Pelagic waters of the inner, middle and outer continental shelf and slope of the GOA from Dixon Entrance to 170° W. longitude, predominately over the inner and middle shelf.

Juveniles - Level 0_a: Broad range of demersal habitats from intertidal pools, all shelf substrates (mud, sand, gravel, etc.) and rocky areas of the upper slope of the GOA from Dixon Entrance to 170° W. longitude.

Adults - Level 1: Broad range of demersal habitats from intertidal pools, all shelf substrates (mud, sand, gravel, etc.) and rocky areas of the upper slope of the GOA from Dixon Entrance to 170° W. longitude.

Sharks

Eggs - no EFH definition determined: Not applicable (most are oviparous).

Larvae - no EFH definition determined: Not applicable (no larval stage).

Juveniles and Adults - Level 0_a: All waters and substrate types in the inner, middle and outer continental shelf and slope of the GOA from Dixon Entrance to 170° W. longitude.

Octopus

Eggs - Level 0_a: All bottom substrates of the shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Larvae - no EFH definition determined: Not applicable (no larval stage).

Juveniles and Adults - Level 0_a: Broad range of substrate types (mostly rock, gravel, and sand) and the lower portion of the water column on the shelf and the upper slope of the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain crustaceans and molluscs.

4.2.2.18 Forage Fish Complex

Eulachon

Eggs (duration 30-40 days) - Level 0_a: Bottom substrates of sand, gravel and cobble in rivers during April-June.

Larvae (duration 1-2 months) - Level 0_a: Pelagic waters of the inner continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Juveniles (to 3 years of age) - Level 0_a: Pelagic waters of the middle and outer continental shelf and upper slope throughout the GOA from Dixon Entrance to 170° W. longitude.

Adults (3+ years) - Level 0_a: Pelagic waters of the middle to outer continental shelf and upper slope throughout the GOA from Dixon Entrance to 170° W. longitude for non-spawning fishes (July-April). Feeding areas contain euphausiids and copepods. Rivers during spawning (April-June).

Capelin

Eggs (duration 2-3 weeks) - Level 0_a: Sand and cobble intertidal beaches down to 10 m depth along the shores of the GOA from Dixon Entrance to 170° W. longitude during May-August.

Larvae (duration 4-8 months) - Level 0_a: Epipelagic waters of the inner and middle continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Juveniles (1-2 yrs) - Level 0_a: Pelagic waters of the inner and middle continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude. May be associated with fronts in winter.

Adults (2+ yrs)- Level 0_a: Pelagic waters of the inner, middle and outer continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude during their non-spawning cycle (September-April). Populations associated with fronts in winter. Intertidal beaches of sand and cobble down to 10 m depth during spawning (May-August).

Myctophids and Bathylagids

Eggs - Level 0_c - no EFH definition determined: No information available at this time.

Larvae - Level 0_c - no EFH definition determined: No information available at this time.

Juveniles - Level 0_a: Pelagic waters ranging from near surface to lower portion of water column of the slope and basin regions throughout the GOA from Dixon Entrance to 170° W. longitude, and to the seaward extent of the EEZ.

Adults - Level 0_a: Pelagic waters ranging from near surface to lower portion of water column of the slope and basin regions throughout the GOA from Dixon Entrance to 170° W. longitude, and to the seaward extent of the EEZ.

Sand lance

Eggs (3-6 weeks) - Level 0_a: Bottom substrate of sand to sandy gravel along the inner continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Larvae (100-131 days) - Level 0_a: Pelagic and neustonic waters along the inner continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Juveniles - Level 0_a: Soft bottom substrates (sand, mud) and the entire water column of the inner and middle continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain zooplankton, calanoid copepods, mysid shrimps crustacean larvae, gammarid amphipods and chaetognaths.

Adults - Level 0_a: Soft bottom substrates (sand, mud) and the entire water column of the inner and middle continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude. Feeding areas contain zooplankton, calanoid copepods, mysid shrimps crustacean larvae, gammarid amphipods and chaetognaths.

Sand fish

Eggs - Level 0_a: Egg masses attached to rock in nearshore areas throughout the eastern Bering Sea and the Aleutians Islands.

Larvae - Level 0_c - no EFH definition determined: No information available at this time.

Juveniles - Level 0_a: Bottom substrates of mud and sand of the inner continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Adults - Level 0_a: Bottom substrates of mud and sand of the inner continental shelf throughout the GOA from Dixon Entrance to 170° W. longitude.

Pholids and Stichaeids

Eggs - Level 0_c - no EFH definition determined: No information available at this time.

Larvae - Level 0_c - no EFH definition determined: No information available at this time.

Juveniles - Level 0_a: Intertidal to demersal waters of the inner continental shelf with mud substrate throughout the GOA from Dixon Entrance to 170° W. longitude. Certain species are associated with vegetation such as eelgrass and kelp.

Adults - Level 0_a: Intertidal to demersal waters of the inner continental shelf with mud substrate throughout the GOA from Dixon Entrance to 170° W. longitude. Certain species are associated with vegetation such as eelgrass and kelp.

Gonostomatids

Eggs - Level 0_c - no EFH definition determined: No information is available at this time.

Larvae - Level 0_c - no EFH definition determined: No information is available at this time.

Juveniles - Level 0_c - no EFH definition determined: No information is available at this time.

Adults - Level 0_a: Bathypelagic waters throughout the GOA from Dixon Entrance to 170° W. longitude and to the seaward extent of the EEZ.

Euphausiids

Eggs - Level 0_a: Neustonic waters throughout the GOA from Dixon Entrance to 170° W. longitude and to the seaward extent of the EEZ in spring.

Larvae - Level 0_a: Epipelagic waters throughout the GOA from Dixon Entrance to 170° W. longitude and to the seaward extent of the EEZ in spring.

Juveniles - Level 0_a: Pelagic waters throughout the GOA from Dixon Entrance to 170° W. longitude and to the seaward extent of the EEZ. Dense populations are associated with upwelling or nutrient-rich areas, such as the edge of the continental shelf, heads of submarine canyons, edges of gullies on the continental shelf, in island passes in the Aleutian Islands and over submerged seamounts.

Adults - Level 0_a: Pelagic waters throughout the GOA from Dixon Entrance to 170° W. longitude and to the seaward extent of the EEZ. Dense populations are associated with upwelling or nutrient-rich areas, such as the edge of the continental shelf, heads of submarine canyons, edges of gullies on the continental shelf, in island passes in the Aleutian Islands, and over submerged seamounts.

4.2.3 Habitat Areas of Particular Concern

There are several habitat types in Alaska that meet have important ecological functions, are sensitive and vulnerable to human impacts, and are relatively rare. A summary of these habitat types is provided below.

4.2.3.1 Living Substrates in Shallow Waters

Habitat areas of particular concern include nearshore areas of intertidal and submerged vegetation, rock, and other substrates. These areas provide food and rearing habitat for juvenile groundfish and spawning areas of some species (e.g., Atka mackerel, yellowfin sole), and may have a high potential to be affected by shore-based activities.

Shallow inshore areas (less than 50 m depth) are very important to king crab reproduction. After molting through four larval (zoea) stages, king crab larvae develop into glaucothoe which are young crabs that settle in the benthic environment in nearshore shallow areas with significant cover, particularly those with living substrates (macroalgae, tube building polychaete worms, kelp, mussels, and erect bryozoans). The area north and adjacent to the Alaska peninsula (Unimak Island to Port Moller) and the eastern portion of Bristol Bay are locations known to be particularly important for rearing juvenile king crab.

All nearshore marine and estuarine habitats used by Pacific salmon, such as eel grass beds, submerged aquatic vegetation, emergent vegetated wetlands, and certain intertidal zones, are sensitive to natural or human induced environmental degradation, especially in urban areas and in other areas adjacent to intensive human-induced developmental activities. Many of these areas are unique and rare. The coastal zone is under the most intense development pressure, and estuarine and intertidal areas are limited in comparison with the areal scope of other marine habitats for salmon.

Herring also require shallow water living substrates for reproduction. Spawning takes place near the shoreline between the high tide level and 11 m. Herring deposit their eggs on vegetation, primarily rockweed (*Fucus sp.*) and eelgrass (*Zostera sp.*). These “seaweeds” are found along much of the Alaska coastline, but they often occur in discrete patches.

4.2.3.2 Living Substrates in Deep Waters

Habitat areas of particular concern include offshore areas with substrates of high-micro habitat diversity, which serve as cover for groundfish and other organisms. These can be areas with rich epifaunal communities (e.g., coral, anemones, bryozoans, etc.), or with large particle size (e.g., boulders, cobble). Complex habitat structures are considered most readily impacted by fishing activities (see previous sections of this document).

Corals are generally considered to be very slow growing organisms, and are a habitat of particular concern. Although scientists are not quite sure of coral's importance to fish habitat, it would certainly provide vertical structure for fish to use for protection and cover. Some observations to this claim have been provided by submersible observations. Coral habitat is likely very sensitive to human-induced environmental degradation from both fishing and non-fishing threats. It is not known how much coral there is off the coast of Alaska, but it is likely to be rare relative to other habitat types.

There are several species of deepwater coral found off Alaska. Two common species are red tree coral (*Primnoa willeyi*) and sea raspberry (*Eunephtya sp.*). Although these corals are thought to be distributed throughout the GOA and Aleutian Islands, much of the data analysis has focused on the eastern GOA. NMFS trawl surveys have indicated high concentrations in the immediate vicinity of Dixon Entrance, Cape Ommaney, and Alsek Valley. In the GOA, NMFS surveys have taken red tree coral in very deep areas (125-210 fathoms), whereas sea raspberries have generally been taken in shallower areas (70-110 fathoms).

Information on coral distribution has been summarized in a 1981 report by R. Cimberg, T. Gerrodette, and K. Muzik titled, “Habitat Requirements and Expected Distribution of Alaska Coral.” Though this report was written in the context of potential impacts of oil and gas exploration and development, information on habitat and distribution is relevant for our purposes. Though the report discusses coral distributions throughout Alaska, the focus here is on the information contained relevant to southeast Alaska.

The study notes that this Region probably has the largest number of coral species due tot he variety of habitats in terms of depth, substrate, temperature, and currents. *Primnoa sp.*, or red tree corals, are more abundant in southeast Alaska than in any other region. Other species of fan corals have been observed as well

as bamboo corals, cup corals, soft corals, and hydrocorals. The greatest number of distributional records for red tree corals are from the GOA, in particular from the inside waters of southeast Alaska. In southeast Alaska, red tree corals have frequently been reported in Chatham Strait, Frederick Sound, and Behm Canal. The frequency of occurrences increases toward the ocean entrances and further away from the fjords. This trend is likely due to swifter currents near the entrances and/or greater turbidity and lower salinities in the fjords. Areas of highest densities are found in regions where currents are 3/4 knots.

Distributional records were additionally analyzed relative to the depths at which they occurred. Red tree corals have been reported at depths from 10 to 800 m. The lower depth limit varied in different regions of Alaska, increasing along a geographic gradient from the Aleutians to southeast Alaska. The lower depth limit of these corals in each area corresponds with a mean spring temperature of 3.7 degrees C. The report indicates that in southeast Alaska there is a difference in the lower depth limit exhibited north of 57° latitude and that experienced south of that line (roughly running through Sitka). The data from the report indicate that, in the area of southeast Alaska north of 57°, red tree corals are predominately found between 50 and 150 meters in depth. Significant occurrences continue to exist from 150 to 250 m, and taper off rapidly beyond 250 m south of the 57° line, they occur over a broader depth range with equal occurrences from 50 to 450 m. The report indicates that other species of sea fans may be found deeper than *Primnoa*, at depths up to 2,000 m.

Bamboo corals also occur in the waters of both the inside passages of southeast Alaska and in the southeast GOA. These corals have a lower temperature tolerance, about 3° C, and exist in depths from 300-3,500 m. These corals are also expected to exist in a rocky, stable substrate and have a low tolerance for sediments.

The depth distribution of soft corals is, like the red tree corals, expected to range from 10-800 m, though they may exist on a much wider range of substrates. Hydrocorals, also occurring in southeast Alaska, have a depth range of 700-950 m, though they may occur at shallower depths in southeast Alaska than in the more northern, colder waters.

The report notes (again in the context of potential disturbance by oil and gas exploration and development) that recolonization of tropical coral communities requires at least several decades to recover from major perturbations. Alaskan corals would likely take much longer to recolonize following similar disturbances. For example, given a predicted growth rate of 1 cm/year for *Primnoa sp.*, a colony 1 m high would require at least 100 years to return to the pre-impacted state. This, of course, is regardless of the origin of the impact.

4.2.3.3 Freshwater Areas Used by Anadromous Fish

Habitat Areas of Particular Concern also include all anadromous streams, lakes, and other freshwater areas used by Pacific salmon and other anadromous fish (such as smelt), especially in urban areas and in other areas adjacent to intensive human-induced developmental activities.

4.2.4 Essential Fish Habitat Recommendations

Appendix F contains a description of potential adverse effects on EFH from fishing and non-fishing activities. Based on this assessment, Sections 4.2.4.1 and 4.2.4.2 contain habitat conservation and enhancement recommendations for non-fishing and fishing threats to EFH.

4.2.4.1 Habitat Conservation and Enhancement Recommendations for Non-fishing Threats to Essential Fish Habitat

Habitat alteration may lower both the quantity and quality of species production through physical changes or chemical contamination of habitat. Species and individuals within species differ in their tolerance to effects of habitat alteration. It is possible for the timing of a major alteration event and the occurrence of a large concentration of living marine resources to coincide in a manner that may affect fishery stocks and their supporting habitats. The effects of such events may be masked by natural phenomena or may be delayed in becoming evident. However, the process of habitat degradation more characteristically begins with small-scale projects that result in only minor losses or temporary disruptions to organisms and habitat. As the number and rate of occurrence of these and other major projects increases, their cumulative and synergistic effects become apparent over larger areas. It is often difficult to separate the effects of habitat alteration from other factors such as fishing mortality, predation, and natural environmental fluctuations. Decreasing the probability of impact will lead to the highest protection of EFH. The probability of impact directly relates to the amount of human activity we introduce to an environment. Recommendations are offered to protect EFH in Tables 4-3, 4-4, and 4-5.

Table 4-3 Near Shore Habitat and Waters (0-3 nm)

Recommendation	Area	Species
Minimize construction of structures such as causeways or breaches that would affect local flushing, water temperatures, water quality, lateral drift, and/or migration.	Sensitive areas, special aquatic and vegetation areas	groundfish, salmon, scallop, crab
Minimize construction of structures such as docks that ground on tidal lands during low water events.	Sensitive areas, special aquatic and vegetation areas	groundfish, salmon, crab
Minimize deposition of fill in tidelands.	Sensitive areas, special aquatic and vegetation areas	groundfish, salmon, crab
Stage rapid response equipment and establish measures for accidental impacts such as oil and hazardous material spills.	ports, sensitive areas	groundfish, salmon, scallop, crab
Monitor point source pollution sites such as fish processing waste, sewage, and storm water run off outfalls.	ports, vessel processors, communities	groundfish, salmon, scallop, crab
Minimize disposal or dumping of dredge spoils, drilling muds, and municipal and industrial wastes.	known concentration of bottom species and their habitats	groundfish, salmon, scallop, crab
Test dredge spoils prior to marine disposal	port and upland sources	groundfish, salmon, scallop, crab
Establish monitoring that incorporates Federal and State regulatory agency determinations, i.e., tracking database and GIS system	area wide	groundfish, salmon, scallop, crab

Table 4-4 Pelagic Habitat and Waters (3-12 nm)

Recommendation	Area	Species
Assess cumulative oil and gas production activities.	BSAI, Chukchi Sea, OCS, Cook Inlet, GOA	groundfish, salmon, scallop, crab
Identify marine disposal sites.	area wide	groundfish, salmon, scallop, crab
Establish monitoring that incorporates Federal and State regulatory agency determinations, i.e., tracking database and GIS system	area wide	groundfish, salmon, scallop, crab
Establish no discharge zones for ballast waters to prevent introduction of non-indigenous species and chemical contaminants.	ports, known gyres areas	groundfish, salmon, scallop, crab
Minimize disposal or dumping of dredge spoils, drilling muds, and municipal and industrial wastes.	known concentration of bottom species and their habitats	groundfish, salmon, scallop, crab

Table 4-5 Offshore Habitat and Waters (>12 nm)

Recommendation	Area	Species
Establish monitoring that incorporates Federal and State regulatory agency determinations, i.e., tracking database and GIS system	area wide	groundfish, salmon, scallop, crab
Establish no discharge zones for ballast waters to prevent introduction of non-indigenous species and chemical contaminants.	known offshore gyre areas	groundfish, salmon, scallop, crab
Minimize disposal or dumping of dredge spoils, drilling muds, and municipal and industrial wastes.	known concentration of bottom species and their habitats	groundfish, salmon, scallop, crab

4.2.4.2 Habitat Conservation and Enhancement Recommendations for Fishing Threats to Essential Fish Habitat

Area closures to trawling and dredging in the GOA management area serve to protect EFH from potential adverse impacts caused by these gear types. Other management measures, such as Sitka Pinnacles Marine Reserve, are designed to reduce the impact of fishing on marine ecosystems. Catch quotas, bycatch limits and gear restrictions control removals of prey species. Studies that compare seafloor habitats in areas heavily trawled with areas that have had little trawl effort may reveal future habitat conservation and enhancement measures necessary to protect EFH. Additionally, the annual review of existing and new EFH information during the SAFE report development process is expected to identify adverse effects to EFH from fishing and proposals to amend the FMP to minimize those adverse effects. Proposals can be submitted during the Council's plan amendment cycle.

4.3 Fishing Activities Affecting the Stocks

The Gulf of Alaska management area is utilized primarily by commercial fisheries. The groundfish fisheries have been entirely domestic since 1991 (a history of exploitation is addressed in Section 4.3.1). The commercial fleet is described in Section 4.3.2. There is also subsistence fishing for groundfish species (Section 4.3.3) in the GOA, although most of this activity takes place within state waters (0-3 nm). Recreational catch of groundfish in the GOA is described in Section 4.3.4.

4.3.1 History of Exploitation

The oldest fisheries in the GOA are the native subsistence fisheries for Pacific halibut, cod, herring, and other species. Catches were traded or sold to the Russians and later to the Americans after the purchase of Alaska by the United States in 1867. Groundfish and herring are still important sources of food to many groups of Alaskan natives, although these subsistence harvests are now dwarfed by commercial operations.

The first commercial groundfish fishery in the GOA was a setline fishery for cod by U.S. nationals in 1867. Later U.S. fisheries developed on halibut, sablefish, and other groundfish. Canadians were involved in fisheries in the GOA from the beginning of this century and directed most of their effort on halibut.

The commercial fishery for halibut began in coastal waters off Washington and British Columbia and expanded from there into the GOA after World War I. Both U.S. and Canadian nationals were involved in the fisheries, and in 1923 the United States and Canada ratified a halibut conservation treaty to regulate the fishery and to conduct research. The convention established the International Fisheries Commission, which was changed to the International Pacific Halibut Commission (IPHC) in 1953. Because of a combination of overfishing and environmental factors, the abundance of halibut declined and a new convention was signed in 1930 to broaden the Commission's regulatory powers for the rebuilding of the halibut stocks. Under

scientific management, the halibut stocks were gradually rebuilt. In 1962 the landings from the GOA reached an all-time high of 31,400 mt. High annual catches continued until 1966 followed by a decline so that by 1977 only 9,200 mt were landed. Canadian fishing in the GOA ended in 1981 as a result of extended U.S. jurisdiction.

The sablefish fishery began about 1906, and was relatively unimportant until about 1935 when the catch began to increase with effort continuing through the war years. Since 1946 the harvest has fluctuated from low levels to as high as 36,000 mt taken by foreign fleets in 1972. Following a period of stock decline, the fishery has now expanded to all areas of the GOA.

The Asian trawl fisheries on GOA groundfish began in 1962 when a Soviet fleet of 70 trawlers and support ships targeted on Pacific ocean perch (POP), an abundant groundfish of the outer continental shelf and upper slope. The next year Japanese fishing vessels of lesser numbers entered the GOA and began directed fisheries on POP and sablefish. The Asian trawl fisheries expanded rapidly in the l960s. POP was the first major species targeted by foreign fisheries. The combined effort of the Asian fisheries on POP stocks accounted for approximately 152,000 mt in 1966. The GOA foreign catch of POP steadily decreased through the 1970s, and by 1979 decreased to nearly 7,300 mt. By 1983, the catch decreased further to approximately 5,400 mt and in 1985 only bycatch amounts were allocated by the Council. In addition to POP, foreign fisheries have targeted on pollock, sablefish, flounder, rockfish, Pacific cod, Atka mackerel, and squid. 1986 was the last year of directed foreign harvests, which were limited to pollock and Pacific cod. Japan, U.S.S.R., and Republic of Korea were the major foreign participants in the GOA fisheries, although Canada, Poland, and Mexico also harvested relatively insignificant levels of catch.

With the advent of the Magnuson Fishery Conservation and Management Act of 1976 (later amended to the Magnuson-Stevens Fishery Conservation and Management Act), the exploitation and management of the fisheries resources of the GOA began to change. Domestic commercial groundfish fisheries steadily increased after 1978. Between 1978 and 1990, joint venture partnerships between U.S. catcher vessels and foreign processing vessels helped to build up U.S. capacity. Since 1991, the entire GOA groundfish harvest and processing has been entirely domestic.

Catch History

Catch statistics since 1956 are shown for the GOA in Table 4-6. The initial target species was sablefish, followed in the early 1960s by POP. During the early period of these fisheries, total catches of groundfish reached a peak of 360,131 mt in 1965. Following a decline in abundance of POP, other species (pollock, Pacific cod, other flatfish) were targeted. Since 1978, catches have varied from 146,703 mt to 356,659 mt, and have averaged around 180,000 mt in the early 2000s.

Table 4-6a Groundfish and squid catches in the Gulf of Alaska, 1956-2003 (pollock, Pacific cod, sablefish, flatfish), in metric tons.

Year	Pollock	Pacific Cod	Sablefish	Flatfish[a]	Arrowtooth flounder
1956			1,391		
1957			2,759		
1958			797		
1959			1,101		
1960			2,142		
1961			897		
1962			731		
1963			2,809		
1964	1,126	196	2,457	1,028	
1965	2,749	599	3,458	4,727	
1966	8,932	1,376	5,178	4,937	
1967	6,276	2,225	6,143	4,552	
1968	6,164	1,046	15,049	3,393	
1969	17,553	1,335	19,376	2,630	
1970	9,343	1,805	25,145	3,772	
1971	9,458	523	25,630	2,370	
1972	34,081	3,513	37,502	8,954	
1973	36,836	5,963	28,693	20,013	
1974	61,880	5,182	28,335	9,766	
1975	59,512	6,745	26,095	5,532	
1976	86,527	6,764	27,733	6,089	
1977	112,089	2,267	17,140	16,722	
1978	90,822	12,190	8,866	15,198	
1979	98,508	14,904	10,350	13,928	
1980	110,100	35,345	8,543	15,846	
1981	139,168	36,131	9,917	14,864	
1982	168,693	29,465	8,556	9,278	
1983	215,567	36,540	9,002	12,662	
1984	307,400	23,896	10,230	6,914	
1985	284,823	14,428	12,479	3,078	
1986	93,567	25,012	21,614	2,551	
1987	69,536	32,939	26,325	9,925	
1988	65,625	33,802	29,903	10,275	
1989	78,220	43,293	29,842	11,111	
1990	90,490	72,517	25,701	15,411	
1991	107,500	76,997	19,580	20,068	
1992	93,904	80,100	20,451	28,009	
1993	108,591	55,994	22,671	37,853	
1994	110,891	47,985	21,338	29,958	
1995	73,248	69,053	18,631	32,273	
1996	50,206	67,966	15,826	19,838	22,183
1997	89,892	68,474	14,129	17,179	16,319
1998	123,751	62,101	12,758	11,263	12,974
1999	95,637	68,613	13,918	8,821	16,209
2000	71,876	54,492	13,779	13,052	24,252
2001	70,485	41,614	12,127	11,817	19,964
2002	50,712	42,335	12,484	12,895	21,231
2003	49,516	40,958	14,319	11,497	29,993

[a]Includes all flatfish species, including arrowtooth flounder between 1964-1995.

Table 4-6b Groundfish and squid catches in the Gulf of Alaska, 1956-2003 (rockfish, Atka mackerel, other species, total of all species), in metric tons.

Year	Slope rockfish[a]	Pelagic shelf rockfish[b]	Demersal shelf rockfish	Thornyhead rockfish	Atka mackerel[c]	Skates[d]	Other species[e]	Total (all species)
1956								1,391
1957								2,759
1958								797
1959								1,101
1960								2,142
1961	16,000							16,897
1962	65,000							65,731
1963	136,300							139,109
1964	243,385							248,192
1965	348,598							360,131
1966	200,749							221,172
1967	120,010							139,206
1968	100,170							125,822
1969	72,439							113,333
1970	44,918							84,983
1971	77,777							115,758
1972	74,718							158,768
1973	52,973							144,478
1974	47,980							153,143
1975	44,131							142,015
1976	46,968							174,081
1977	23,453				19,455		4,642	195,768
1978	8,176				19,588		5,990	160,830
1979	9,921				10,949		4,115	162,675
1980	12,471			1,351	13,166		5,604	202,426
1981	12,184			1,340	18,727		7,145	239,476
1982	7,991		120	788	6,760		2,350	234,001
1983	7,405		176	730	12,260		2,646	296,988
1984	4,452		563	207	1,153		1,844	356,659
1985	1,087		489	81	1,848		2,343	320,656
1986	2,981		491	862	4		401	147,483
1987	4,981		778	1,965	1		253	146,703
1988	13,779	1,086	508	2,786	-		647	158,411
1989	19,002	1,739	431	3,055	-		1,560	188,253
1990	21,114	1,647	360	1,646	1,416		6,289	236,591
1991	13,994	2,342	323	2,018	3,258		1,577	247,657
1992	16,910	3,440	511	2,020	13,834		2,515	261,694
1993	14,240	3,193	558	1,369	5,146		6,867	256,482
1994	11,266	2,990	540	1,320	3,538		2,752	232,578
1995	15,023	2,891	219	1,113	701		3,433	216,585
1996	14,288	2,302	401	1,100	1,580		4,302	199,992
1997	15,304	2,629	406	1,240	331		5,409	231,312
1998	14,402	3,111	552	1,136	317		3,748	243,113
1999	18,057	4,826	297	1,282	262		3,858	231,780
2000	15,683	3,730	406	1,307	170		5,649	204,396
2001	16,479	3,008	301	1,339	76		4,801	182,011
2002	17,168	3,322	244	1,138	85		4,040	164,664
2003	18,683	3,048	252	1,158	578	3,330	6,337	176,341

[a]Catch defined as follows: 1961-78, Pacific ocean perch (*Sebastes Alutus*) only; 1979-1987, the 5 species of the Pacific ocean perch complex, 1988-90 the 18 species of the slope rockfish assemblage; 1991-, the 20 species of the slope rockfish assemblage.

[b]Up to 1998, included dusky, yellowtail, widow, black, and blue rockfish; black and blue rockfish were then removed from the FMP.

[c]Atka mackerel was added to the other species category in 1988; catch was recorded separately for 1990-1992, thereafter Atka mackerel was assigned as a separate target species.

[d]In response to a directed fishery that developed in 2003, skates were moved from 'other species' to a separate target category in 2004.

[e]After numerous changes, the category was stabilized in 1981 to include sharks, skates, sculpins, eulachon, capelin (and other *Osmeridae* smelts), and octopus. Squid was added in 1989. Eulachon and capelin were moved to the forage fish category in 1999.

4.3.2 Commercial Fishery

This section contains a general discussion of the commercial groundfish fisheries in the GOA. The information in this section comes from the annually (or biennially for some species) updated *Stock Assessment and Fishery Evaluation* (SAFE) report (NPFMC 2003), in particular the *Economic Status of the Groundfish Fisheries off Alaska* appendix (Hiatt et al. 2003). This document is available on the Council website, or by request from the Council office. Additionally, catch data is also reported on the NMFS Alaska region website. Website addresses for the Council and NMFS are included in Chapter 6.

In 2002, 824 vessels participated in the groundfish fisheries in the GOA. Of these, 642 were hook-and-line vessels, 131 pot vessels, and 123 trawl vessels. Total groundfish catch was 165,000 mt, which represents approximately 8 percent of the total groundfish catch off Alaska. Pollock and Pacific cod represented the largest part of the harvest in terms of weight. Total ex-vessel value of the GOA groundfish catch in 2002 was $137.3 million, with sablefish and Pacific cod accounting for three quarters of the total ex-vessel value.

The domestic pollock fishery began in the GOA in 1976 when a fleet of three trawlers from Petersburg trawled for pollock during the winter months. Approximately 60 mt of pollock were landed to shoreside processors. Pelagic trawl gear is the principle gear type that is utilized in the pollock fishery. A large majority of the pollock fishery concentrates in the Central regulatory area, although in 2002 approximately 20 percent of the pollock catch was landed in the Western area. Since 1998, full retention of pollock is required under the Improved Retention/Improved Utilization (IR/IU) program.

Pacific cod have been landed domestically since the late 1950s and early 1960s, however the fishery did not really begin to develop until 1978. Unlike most species, which are harvested predominately by one type of gear accounting typically for 90 percent or more of the catch, Pacific cod is taken by trawl, hook-and-line, and pot gear types. In 2002, 35 percent of the catch was taken by vessels using hook-and-line gear, and 47 percent by trawl gear, with the remainder by pot vessels. As with pollock, since 1998, full retention of Pacific cod is required in the GOA under the IR/IU program.

The U.S. longline fishery for sablefish began expanding in 1982 in the GOA and in 1988, harvested all sablefish taken in Alaska, except minor joint venture catches. Following the domestication of the fishery, the previously year-round season in the GOA began to shorten in 1984. By the late 1980s, the average season length decreased to one to two months, and was even as short as 10 days in some areas. In 1995 an Individual Fishing Quota (IFQ) program was implemented for the hook-and-line sablefish fishery, along with a season running from March to November. The sablefish IFQ fishery runs concurrently with the halibut IFQ fishery. IFQ management has increased fishery catch rate and decreased the harvest of immature fish, as well as increasing efficiency resulting in a savings in operating costs averaging $3.1 million annually. The directed sablefish fishery is primarily a hook-and-line fishery, although sablefish are also caught incidentally during directed trawl fisheries for species groups such as rockfish and deepwater flatfish. In 2002, the 12,400 mt of sablefish landed in the GOA had an ex-vessel value of $57.6 million.

The flatfish fishery also became entirely domestic in 1988. Since that time, the majority of the flatfish harvest has occurred on the continental shelf and slope east of Kodiak Island, in the Central regulatory area. The flatfish assemblage is managed in 5 target categories: deep water flatfish complex, rex sole, shallow water flatfish complex, flathead sole, and arrowtooth flounder. Arrowtooth flounder in the GOA is a species of high abundance but low commercial value. The ex-vessel value of all flatfish in the GOA in 2002 was $3.5 million, for 34,100 mt (of which 21,200 mt was arrowtooth flounder). The flatfish resources were lightly to moderately harvested in 2002, compared to their acceptable biological catch levels. The flatfish fisheries have been and are likely to continue to be limited by the potential for high bycatch of Pacific halibut, which

can result in target fishery closure due to reaching the halibut PSC limit prior to achieving the target species TAC. Since 2003, full retention of shallow-water flatfish is required under the IR/IU program.

The domestic fishery for rockfish became important in 1985, and expanded each year until full domestication in 1991. Pacific ocean perch was initially the primary target, however in the early 1990s, overall catch of slope rockfish diminished due to more restrictive management policies intended to promote rebuilding of POP stocks. During this time, catches of lower valued shelf rockfish, such as dusky rockfish, increased. Since 1996, increasing POP biomass has once again raised slope rockfish TACs. In 2002, slope rockfish accounted for 78 percent of GOA rockfish catch. Since the late 1990s, shore-based trawlers delivering to Kodiak processors have begun taking around 50 percent of the POP catch in the Central regulatory area, although catcher/processors continue to dominate catch in the Western and Eastern areas. Historically, bottom trawls have accounted for nearly all the commercial harvest of POP, however in recent years, a sizable portion of the catch has been taken by pelagic trawls. The 1998 trawl closure off Southeast Alaska east of 140° W. longitude significantly affected all rockfish catch in that area. The demersal shelf rockfish fishery is managed by the State of Alaska with Council oversight. It occurs exclusively in the Southeast Outside district. Price per pound has increased significantly over time. Since 2004, full retention of demersal shelf rockfish is required.

The directed skate fishery developed in 2003 in the Western and Central regulatory areas, around Kodiak Island, while skates were still managed under a group TAC as part of the ‘other species’ category. In response to conservation and management concerns, skates were moved to the target species category beginning in 2004. Skate catch in 2003 totalled 3,300 mt. Vessels using both hook-and-line and trawl gear retained skate catch in 2003.

The discards of groundfish in the groundfish fishery have received increased attention in recent years by NMFS, the Council, Congress, and the public at large. The discard rate is the percent of total catch that is discarded. For the GOA groundfish fisheries as a whole, the annual discard rate for groundfish decreased from 18.6 percent in 1994 (total discards, 43,500 mt) to 13.9 percent in 2002 (total discards, 23,100 mt).

The bycatch of Pacific halibut, crab, Pacific salmon, and Pacific herring has been an important management issue in the commercial fishery for more than twenty years. The retention of these species was first prohibited in the foreign groundfish fisheries, to ensure that groundfish fishers had no incentive to target on these species. Estimates of bycatch of these prohibited species are assessed annually in the *Stock Assessment and Fishery Evaluation* report. Additionally, management measures such as prohibited species catch limits and time and area closures regulate bycatch in the groundfish fisheries.

An extensive at-sea observer program was developed for the foreign fleets and then extended to the domestic fishery once it had all but replaced foreign participation. The North Pacific Groundfish Observer Program resulted in fundamental changes in the nature of the bycatch program. First, by providing good estimates of total groundfish catch and non-groundfish bycatch by species, it eliminated much of the concern that total fishing mortality was being underestimated due to fish that were discarded at sea. Second, it made it possible to establish, monitor, and enforce the groundfish quotas in terms of total catch as opposed to only retained catch. For groundfish fisheries, this means that both retained catch and discarded catch are counted against TACs. Third, it made it possible to implement and enforce bycatch quotas for the non-groundfish species that by regulation had to be discarded at sea. Finally, it provided extensive information that managers and the industry could use to assess methods to reduce bycatch and bycatch mortality. In summary, the observer program provided fishery managers with the information and tools necessary to prevent bycatch from adversely affecting the stocks of the bycatch species. Therefore, bycatch in the groundfish fisheries is principally not a conservation program, although it can be an allocation problem.

4.3.3 Subsistence Fishery

The coastal native peoples of Alaska have historically relied heavily upon marine resources for their subsistence. The Aleuts and Koniags utilized not only marine mammals and salmon extensively, but also other fish species such as halibut, cod, flounders, greenling, and smelt. Collins (1945) described the jig fishery for Atka mackerel in inshore waters, the drying of capelin and the taking of sculpins for human consumption. Halibut, turbot, and cod were fished in depths to 60 fathoms using line made of sinew or kelp, V-shaped wooden and bone hooks, floats of carved wood or inflated seal stomachs, and stone anchors (Hrdlicka, 1945). Clark (1974) and DeLaguna (1964) describe the use of similar techniques in the Kodiak and Yakutat areas, respectively. In addition to salmon, the Tlingit and Haida of the Yakutat and Southeastern areas of Alaska relied most heavily upon halibut, herring, and smelt. In the early protohistoric period, much of the fish was eaten raw or boiled or broiled, cod being one species which was always cooked before consumption.

Today, the use of fish for subsistence, with the exception of salmon and halibut, is considerably less than during the period prior to the establishment of local retail stores and easily accessible packaged foods. Of the groundfish species, cod and rockfish are the most extensively utilized, with flounders and greenling as lesser contributors. Southcentral Alaska has a much lower level of subsistence use than other areas of the GOA (NMFS 2004).

Subsistence resource use by residents of groundfish communities in the Alaska Peninsula and Aleutian Islands (Unalaska, Akutan, Sand Point, and King Cove) ranges from about 200 to over 450 pounds per capita. Groundfish ranges from about 4 to 9 percent of total subsistence resource consumption, primarily cod and rockfish. Residents of the City of Kodiak are reported to harvest and consume about 151 pounds of subsistence resource per capita, and groundfish average about 8 percent of the total per capita subsistence consumption (12 pounds per capita), with cod, rockfish, and greenling as primary species. In Southeast Alaska, specifically the communities of Petersburg, Sitka, and Yakutat, total subsistence resource consumption ranges between about 200 and 400 pounds per capita, with groundfish ranging between 1 and 5 percent of the total annual consumption, and the primary speecies flounder, cod, rockfish, and greenling (NMFS 2004).

4.3.4 Recreational Fishery

In most areas of the state, groundfish, except rockfish, are not highly regarded as sportfish. Relatively minor recreational fisheries for flounder, Pacific cod, and greenling exist near coastal population centers. However, these fisheries account for very few recreational fishing days when compared with the primary sport fisheries for salmon, steelhead trout, chars, and halibut.

Based upon Alaska Department of Fish and Game Sport Fish Division data, it appears that recreational use of rockfish and Pacific cod accounted for 4 percent of all sport fish harvest in Alaska in 2000 , the latest data currently available. Rockfish made up the majority of this catch with 131,628 fish harvested, and 4,605 of Pacific cod. In the same year, halibut sport landings, statewide, were estimated at 403,280 fish, approximately 12 percent of total harvest (the amount of halibut harvested by sport fishing was the third largest in 2000, after coho and sockeye salmon) (Walker et al. 2003).

Recreational use of groundfish has increased since 1990, when rockfish harvest represented only 2 percent of total Alaska sportfish harvest. Virtually all of the sport catch is taken in the Southeast and Southcentral regions of the state, and is associated with the larger population centers (Walker et al. 2003). However,

although groundfish as a sport fish resource may be growing in importance, the volume of total harvest of groundfish in the recreational fishery is small in comparison to the directed commercial catch.

4.4 Economic and Socioeconomic Characteristics of the Fishery

This section contains a general discussion of the economic and socioeconomic characteristics of the commercial groundfish fisheries in the GOA. The information cited in this section is from the annually updated *Economic Status of the Groundfish Fisheries off Alaska* appendix to the SAFE (Hiatt et al. 2003). This document is available on the Council website, or by request from the Council office. The website address for the Council is included in Chapter 6.

Estimates of ex-vessel value by area, gear, type of vessel, and species, are included in the annual Economic Status appendix to the SAFE report. The ex-vessel value of the landings in the GOA groundfish fisheries, excluding the value added by at-sea processing, increased from $103.5 million in 1998 to$145.8 million in 2000, then decreased to $116.5 million in 2001 and increased to $137.3 million in 2002. The distribution of ex-vessel value by type of vessels differed by area, gear, and species. In 2002, catcher vessels accounted for 86 percent of the ex-vessel value of the groundfish landings compared to 72 percent of the total catch because catcher vessels take larger percentages of higher priced species such as sablefish, which was $2.15 per pound in 2002. Similarly, trawl gear accounted for only 32 percent of the total ex-vessel value compared to 78 percent of the catch because much of the trawl catch is of low-priced species such as pollock, which was about $0.11 per pound in 2002.

Residents of Alaska and of other states, particularly Washington and Oregon, are active participants in the GOA groundfish fisheries. For the GOA groundfish fisheries as a whole, 59 percent of the 2002 catch was made by vessels with owners who indicated that they were not residents of Alaska. Alaska vessels accounted for the majority of the Pacific cod catch. Vessels with owners who indicated that they were not residents of Alaska accounted for 48 percent of the 2002 ex-vessel value. Vessels owned by residents of Alaska accounted for a much larger share of the ex-vessel value than of catch (52 percent compared to 41 percent) because these vessels accounted for relatively large shares of the higher priced species such as sablefish.

Employment data for at-sea processors (but not including inshore processors) indicate that in 2002, the crew weeks totaled 5,287. The maximum monthly employment occurred in July.

There are a variety of at least partially external factors that affect the economic performance of the GOA groundfish fisheries. They include landing market prices in Japan, wholesale prices in Japan, U.S. imports of groundfish products, U.S. per capita consumption of seafood, U.S. consumer and producer price indexes, foreign exchange rates, and U.S. cold storage holdings of groundfish. Exchange rates and world supplies of fishery products play a major role in international trade. Exchange rates change rapidly and can significantly affect the economic status of the groundfish fisheries.

4.5 Fishing Communities

This section contains a general discussion of the fishing communities that depend on the commercial groundfish fisheries in the GOA. The information cited in this section is drawn from the *Final Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries* (NMFS 2004). This document is available on the NMFS Alaska Region website, or by request from the NMFS Alaska Region

office. Other sources of information on GOA fishing communities are *Faces of the Fisheries*, a publication of community profiles by the Council (NPFMC 1994), and *Gulf of Alaska Coastal Communities: An Overview*, a report prepared by the Institute for Social and Economic Research (ISER) for the Gulf of Alaska Coastal Communities Coalition (ISER 1999).

Fishing communities in the Gulf of Alaska are shown in Figure 4-2. Kodiak is the dominant GOA fishing community for groundfish, and as a result, it is discussed independently in Section 4.5.1. Sections 4.5.2, 4.5.3, and 4.5.4 address major groundfish communities in the Eastern, Central, and Western regulatory areas. The FMP was amended in 2003 to allow certain small and isolated communities to purchase sablefish IFQ; these communities are discussed in Section 4.5.5.

Figure 4-2 Gulf of Alaska fishing communities.

[PLACEHOLDER]

4.5.1 Kodiak

Kodiak is the dominant GOA fishing community for groundfish, and is important for salmon, halibut, and other species. In 2001, the region accounted for about 10 percent of the volume and about 13 percent of the value of the total groundfish processed in Alaska. The region accounted for almost 16 percent of the volume of groundfish processed inshore in all regions of the state (1992-2000). This volume included 11 percent of the pollock, 28 percent of the Pacific cod, 54 percent of the flatfish, and 30 percent of the combined Atka mackerel, rockfish, sablefish, and other groundfish category of groundfish processed. The City of Kodiak is the location of virtually all of the direct links with the commercial groundfish fishery within the region.

Kodiak groundfish processing began with the domestication of the groundfish fisheries. Prior to 1988, groundfish was processed aboard foreign vessels. The first surimi production in Alaska took place in Kodiak in 1985. According to the City of Kodiak, Kodiak is currently home port to 770 commercial fishing vessels, making it the state's "largest fishing port". The development or evolution of the Kodiak harvesting fleet has essentially paralleled that of the processors to which they deliver (along with the development of a fleet component that in part or in whole participates in BSAI fisheries).

The City of Kodiak has become the hub community of the region, at present comprising just less than 50 percent of the total Kodiak Island Borough population. Furthermore, a significant part of the region's population lives very near Kodiak in unincorporated areas, so that at present, approximately 85 percent of the Kodiak Island Borough population lives in and around the City of Kodiak. In terms of ethnicity, the city is about 13 percent Native, while organized communities outside the city are predominantly Native (68 to 94 percent). The predominant minority in the city and its surroundings is Asian and Pacific Islanders, followed by Natives and Blacks. The economy of the City of Kodiak is dependent on fishing, and groundfish are an important component of this dependence. The fishing sector provides an important base for the retail and government sectors, which follow it in relative size. The military sector is also significant, and is actually second in income and earnings, primarily because of a local Coast Guard base, the largest in the country.

In recent years, groundfish has made up over 70 percent by weight of the fish processed in the Kodiak Island region. In 2001, pollock comprised about 43 percent of the groundfish by volume, followed by Pacific cod at about 29 percent. Although Kodiak residents own both onshore and offshore processing facilities, onshore plants that process pollock and Pacific cod are owned predominantly by entities outside the region (1995 to present). Kodiak residents are active in the ownership of offshore processing vessels for groundfish other than pollock. Residents historically have owned three to six offshore processing facilities, with the lower

numbers in earlier years. In 2001, catcher-processors owned by regional residents had a wholesale product value of $23.6 million, and shoreplants had an analogous figure of $2.8 million.

The Kodiak-owned catcher vessel fleet is very diverse. Some vessel classes, especially the larger trawl vessels, have displayed remarkable stability over time. Smaller trawlers have become fewer. Fixed gear vessels have increased in number. Most of the fleet's fishing activity is in the central GOA, and product is delivered to Kodiak shoreplants. Regional vessel ownership is heavily concentrated in the City of Kodiak. Since 1991, catcher vessels owned by Kodiak residents have harvested a significant amount of fish in the Bering Sea as well. In 2001, the central GOA accounted for 57 percent of ex-vessel value, and the Bering Sea accounted for 27 percent. Pacific cod accounted for 25 percent by volume and 45 percent by value of retained groundfish harvest, while pollock accounted for 60 percent of volume and 29 percent by value in 2001.

Residents of the City of Kodiak are reported to harvest and consume about 151 pounds of subsistence resource per capita, of which 72 percent is fish. However, groundfish comprise only about 8 percent of the total (12 pounds per capita).

4.5.2 Eastern Regulatory Area Communities - Petersburg, Sitka, and Yakutat

The top three Southeast Alaska region ports account for almost all of the region's reported processing. In alphabetical order, they are Petersburg, Sitka, and Yakutat. All three communities support diverse fisheries, pursued by fishers participating in multiple fisheries. Of most importance are salmon and halibut. The main groundfish fisheries are rockfish and sablefish.

The economy of Petersburg historically has been based on commercial fishing and timber harvests. Alaska's first shrimp processor, Alaska Glacier Seafoods, was founded in 1916. The cannery has operated continuously since its founding, and is now known as Petersburg Fisheries, a subsidiary of Icicle Seafoods, Inc. Petersburg has developed into one of Alaska's major fishing communities with the largest home-based halibut fleet in Alaska, but landings of shrimp, crab, salmon, herring and other fish are also locally important. Several processors operate cold storage, canneries and custom packing services, employing over 1,100 people during the peak season.

Sitka is one of the oldest communities in Alaska. In 1878 one of the first canneries in Alaska was built in Sitka. The city is home to a sizable fishing fleet, a U.S. Coast Guard Air Station, which handles marine search-and-rescue missions, a campus of University of Alaska Southeast and the private Sheldon Jackson College. The economy is diversified with fishing, fish processing, tourism, government, transportation, retail, and health care services. Sitka is a port of call for many cruise ships each summer and fish processing provides seasonal employment.

The city of Yakutat was formed in 1948, but in 1992, the city was dissolved and a borough was organized. Fishing and subsistence activities are prevalent, and Yakutat's economy depends on fishing, fish processing and government employment. A cold-storage plant is the major private employer, although lodges and fishing charters in the Situk River drainage provide some jobs. Subsistence hunting and fishing activities focus on salmon, trout, shellfish, deer, moose, seals, bears and goats.

Among the important processing communities, Petersburg, Yakutat, and Sitka all display different patterns. In Sitka and Petersburg, Caucasians are the great majority of the population (74 and 87 percent, respectively), with Alaska Natives at 21 and 10 percent, respectively. Yakutat is 55 percent Native and 43 percent Caucasian. This overall population composition reflects the general identity or 'character' of each

community, as the contemporary demographics of Petersburg highlights its Norwegian fishing history, Sitka its diverse Native/Russian-American history, and Yakutat its Native heritage. Fisheries in general, and groundfish fisheries in particular, are relatively small contributors to Southeast Alaska region employment, especially compared to the government, services, and retail sectors, although fishing and fish processing are more important for the three communities than the region as a whole. There are fewer overall economic opportunities in Yakutat compared to the other two communities.

Most Southeast Alaska regional groundfish processing occurs in Petersburg, Sitka, and Yakutat. These communities differ in the degree to which they participate in groundfish fisheries and in the mix of species that they exploit. Of greatest significance regionally among groundfish is the combined category that lumps Atka mackerel, rockfish, sablefish, and "other" (non-pollock, non-cod, and non-flatfish) groundfish. Most of the active processors in this region use groundfish only as a supplementary product acquired as bycatch. Rockfish are targeted only sometimes as a primary product, and total volume is still low. The groundfish fishery is important for components of the local fleet, but serves a secondary role for most processors. For the most part, Southeast regional processors tend to concentrate on higher-value, low-volume species such as sablefish and rockfish that are typically sold whole or as headed and gutted product. In 2001, the combined category accounted for 94 percent of the volume and over 99 percent of the value of all groundfish processed in the region.

Ownership patterns for catcher vessels are much the same as for processors, in that they indicate a fishery more dependent on limited quantities of Pacific cod, rockfish, and sablefish pursued with longline gear rather than higher volumes of fish pursued with trawl gear. Most locally owned vessels are relatively small and use longline gear for groundfish (and probably participate in other fisheries). Sitka, Petersburg, and Juneau are the most important communities in terms of regional vessel ownership. Over the 1992-2000 period, Sitka vessels accounted for 30 percent of the value of the groundfish landed by the regionally owned fleet, and for 29 percent of the vessels in that fleet. Petersburg residents accounted for 17 percent of the value and 16 percent of the regionally owned fleet, while Juneau residents owned 13 percent of both value and vessels during this period. In 2001, 74 percent of the harvest value came from the eastern GOA, and 20 percent from the central GOA. The local fleet is a multi-species, multi-gear fleet concentrated in Sitka and Petersburg. For groundfish, the fleet targets sablefish and rockfish. Thus, most of the Pacific cod and pollock processed by the region's shoreplants is harvested and delivered by non-local vessels.

Subsistence utilization in the regionally important groundfish communities of Petersburg, Sitka, and Yakutat ranges between about 200 and 400 pounds per capita. Groundfish represents 1 to 5 percent of the total subsistence resources consumed.

4.5.3 Central Regulatory Area Communities - Cordova, Homer, Nikiski, and Seward

Participation in the groundfish fishery in Southcentral Alaska varies considerably from other Alaska regions. In addition to spanning the most heavily populated area of the state, the region also differs from the others by virtue of its connection of communities and ports by a road system. This, in turn, influences the nature of engagement with the groundfish fishery. Homer and Seward serve as the primary ports for groundfish trucked on the Alaska road system. Cordova, Nikiski, and Seward accounted for the majority of processing through 2001, however the recent situation is somewhat fluid, as Steller sea lion protection measures may have already had significant effects on the groundfish (and especially pollock) fisheries that exist in the region.

Cordova, arguably Southcentral's most fishery- dependent community, has its origins in transportation as well as fishing. In Homer, sport fishing for halibut and salmon contributes significantly to the economy along

with the commercial fisheries. A total of 541 area residents hold commercial fishing permits. In 2000, the estimated gross fishing earnings of residents neared $27 million. The fish dock is equipped with cold storage facilities, ice manufacturing and a vacuum fish-loading system. Nikiski, now important as a landing/processing/shipping location for the groundfish fishery does not have the type of historical ties to commercial fisheries seen in a number of the other communities. As an ice-free harbor, Seward has become an important supply center for Interior Alaska. At the southern terminus of the Alaska Railroad, Seward has been a transportation hub for decades. The economy also includes tourism, commercial fishing, ship services and repairs, oil and gas development, a coal export facility, a state prison and the University of Alaska's Institute of Marine Services.

The groundfish processed in the region in 1999 accounted for less than two percent of the groundfish processed inshore in all Alaska regions. The combined Atka mackerel, rockfish, sablefish, and other groundfish category accounted for 43 percent of the volume reported over the period 1991-1998, and Pacific cod and pollock accounted for 35 and 17 percent of the total, respectively. The economies of the Southcentral Alaska region groundfish communities tend to be more diversified than those of the Alaska Peninsula/Aleutian Islands or Kodiak Island regions, and groundfish are of lesser importance for employment and income to the region in absolute and relative terms. In 2001, 18,000 tons with a wholesale value of $25 million were reported for regionally owned processors. Of the total value, $20 million came from shoreplants and $5 million from catcher-processors.

Fixed gear catcher vessels predominate, and since 1995, five or fewer trawl vessels have been locally owned. In the fixed gear vessel class, smaller vessel classes predominate by a large margin. This pattern is due, in part, to the relatively small scale of fisheries (and processing capacity) in the Southcentral Alaska region, the diversified nature of the fisheries pursued, and the presence of relatively sheltered waters. Ownership of vessels is spread through numerous communities in the region, but (in order of importance) Homer, Anchorage, Cordova, and Seward combined accounted for 63 percent of the total number of regionally owned vessels between 1992 and 2000, and these vessels, in turn, accounted for 73 percent of the ex-vessel value accrued by regionally owned vessels over this same period. In 2001, 67 percent of value came from the central GOA, 14 percent came from the western GOA and 10 percent come from the Bering Sea. In 2001, for retained harvest, 49 percent of volume and 44 percent of value came from Pacific cod, while the combined Atka mackerel, rockfish, sablefish, and other groundfish category accounted for 11 percent of volume and 47 percent of value.

Until May 2000, Homer, Kenai, and Seward were not classified as subsistence communities. For Cordova, groundfish are reported as approximately 4 percent (7 pounds per capita) of the total subsistence consumption (179 pounds per person per year).

4.5.4 Western Regulatory Area Communities - Dutch Harbor/Unalaska, Akutan, King Cove, Sand Point

The Alaska Peninsula/Aleutian Islands region is in several ways the center of the Alaska groundfish fishery in general, and the Bering Sea pollock fishery in particular. In 2001, the region accounted for about 88 percent by volume and 79 percent by value of all groundfish processed in Alaska. Unlike the rest of the GOA communities, most of the region's communities are primarily involved in the Bering Sea and Aleutian Islands fisheries, although there is participation in the GOA fisheries.

Unalaska/Dutch Harbor has been the number one fishing port in the United States in terms of volume of catch landed since 1992, and held the number one rank in value of catch landed from 1988 through 1999, slipping to number two in 2000 and 2001. Groundfish (especially pollock) is a central part of the community's

fishery-based economy. Unalaska has extensive historical links to the groundfish fisheries, and over time, the level of activity associated with commercial fishing and fish processing has both increased and diversified, and is now the basis of the local economy. Large multi-species groundfish shore processing plants in the community include Alyeska, Unisea, and Westward. Royal Aleutian is a large crab processor, and Icicle brings significant processing capacity to the community in the form of mobile processing facilities.

Akutan has a large processing plant west of the village proper processes significant quantities of groundfish as well as crab. The processing plant supplies the community with substantial economic benefit, but large-scale commercial fishing activity is largely not integrated with the daily life of the community. The Trident plant is the principal facility in the Akutan port and, historically, a number of smaller, mobile processing vessels have operated seasonally out of the port of Akutan.

King Cove is historically a commercial fishing community. King Cove has had processing facilities as part of the community for decades and resident commercial fishing fleets that deliver to local seafood processors with longstanding relationships. Local fishermen traditionally have fished for all major species, including groundfish, herring, crab and salmon, with crab and salmon predominant. Groundfish has gained importance in recent years, with Peter Pan Seafoods Inc. plant qualifying as an AFA facility.

Sand Point, like King Cove, has had processing facilities as part of the community for decades and resident commercial fishing fleets that deliver to local seafood processors with longstanding relationships. It is home to the largest fishing fleet in the Aleutian Chain. Trident operates the current processing plant, processing cod, black cod, halibut, pollock, salmon and other assorted bottomfish. Peter Pan Seafoods Inc. operates a support station in Sand Point for their processing plant in King Cove.

Unalaska (population 4,283 in 2000) is the largest community in the region. Of the other four communities with more than 200 residents in 2000, three (Akutan [population 713], King Cove [population 792], and Sand Point [population 842, the second largest community in the region]) are substantially involved with the groundfish fishery and are the sites of large processing facilities. Communities have a wide range of employment opportunities that are closely related to the commercial fishery in general, and the groundfish fishery in particular. Processing workers tend to be in the community because of the employment opportunity, tend to leave when employment terminates, and comprise a significant portion of the population.

In the Alaska Peninsula/Aleutian Islands region in 2001, pollock comprised more than 93 percent of the groundfish volume processed, and Pacific cod 5 percent. Pollock accounted for 88 percent of processed product value, and Pacific cod 10 percent. Of the large groundfish processors in the region, six focus on Bering Sea groundfish; the others include the plants in Sand Point and King Cove, among others. The Bering Sea plants dominate processing in the region (and, indeed, the state) in terms of volume of groundfish processed. In 2000, eight non-Bering Sea pollock sector plants reported processing groundfish in Adak (1), Chignik (1), Unalaska/Dutch Harbor (3), King Cove (1), Sand Point (1), and St. Paul (1).

Catcher vessel ownership within the region is strongly clustered in Sand Point and King Cove, with a secondary cluster in Unalaska. King Cove residents owned 24 percent of the vessels that, in turn, accounted for 23 percent of the regionally owned vessel landings value over this same period. In 2001, 90 percent of the retained harvest value from these vessels came from the western GOA FMP area. About 34 percent retained harvest volume was Pacific cod, and 64 percent was pollock. For that same year, Pacific cod accounted for 66 percent of total groundfish value, and pollock 33 percent.

Akutan, King Cove, Sand Point, and Unalaska have a subsistence resource consumption ranging from about 200 pounds per capita to more than 450 pounds per capita. Of this total, groundfish specifically ranges from 4 to 9 percent of the total.

4.5.5 Communities Eligible for the Sablefish IFQ Community Quota Purchase Program

Table 4-7 lists the 42 GOA coastal communities that are eligible to purchase sablefish quota share under the community quota purchase program. The criteria require the communities to have populations of no greater than 1,500, no road access to larger communities, direct access to saltwater, and documented historic participation in the halibut or sablefish fisheries. The criteria for this program is intended to target a subset of GOA communities that need expanded economic opportunities and assistance in continuing long-term participation in the commercial halibut and sablefish fisheries. The criteria effectively limit eligibility to communities that received very little quota share in the initial allocation and are struggling to remain economically viable. These communities were evaluated as part of Amendment 66 to the GOA FMP (NPFMC 2002), and are all considered fishery-dependent to varying degrees. A National Resource Council (NRC) report notes on the issue of fishing-dependent communities, that for small, isolated communities such as many of those in Alaska: "the notion of dependency may include geographic isolation; lack of employment alternatives; social, economic, and cultural systems that have developed in these locations; and their dependence on fishing as a source of nutrition, livelihood, and life-style" (NRC 1999, p. 19). The NRC report notes that fishing may be used as part of a diverse set of lifestyles, so the fact that these communities differ means only that they are dependent on fishing in different ways related to their social, cultural, and economic systems.

Most of these communities rely on subsistence fishing and hunting, as documented by the State of Alaska, either as a primary food source or to supplement other sources. The dominant subsistence species harvested are halibut, salmon, shrimp, crab, and clams. For some communities, including Kasaan, Akhiok, Larsen Bay, Old Harbor, Port Lions, Ivanof Bay, Yakutat, and the Chignik area, the majority of the residents continue to participate in subsistence fishing (and hunting) activities. Subsistence fishing does not appear to be of high importance for a few communities that have alternative income sources, including Hollis (which relies mostly on logging) and Halibut Cove (primarily an artist community), Pelican, Port Graham, and Seldovia. The level of reliance on the fishing industry varies by community, but because of the limited economic opportunities in these smaller, remote communities, fishing, whether commercial or subsistence, represents a significant factor in the overall economy.

The broad conclusion gathered from collective sources is that fishing plays a role in the identity of all of the proposed communities – nearly all of the communities are reliant on subsistence harvests, and commercial fishing, whether for sablefish, halibut, or otherwise, is the dominant source of jobs and income in most of these communities.

The analysis in NPFMC (2002) shows that most of these communities have a significant portion of their population living at or below the poverty level and relatively high unemployment levels, compared to the State of Alaska as a whole. The State-wide unemployment rate reported by the Alaska Department of Labor in August 2000 was 6.3 percent. The Kenai Borough, in which most of the Central area communities are located, reported an average unemployment rate of 10.2 percent for the year 2000. Of the 14 eligible communities in the Central area, all but 3 reported higher unemployment rates than the State average, and 8 were higher than the average of the Kenai Peninsula Borough. Likewise, although none of the eligible Eastern area communities are located within an organized borough, the nearby Skagway-Hoonah-Angoon census area reported an unemployment rate of 9.4 percent in 2000. Seventeen of the 21 eligible communities in Area 2C reported higher unemployment rates than the State average and 14 reported higher than the

Skagway-Hoonah-Angoon area average. In the Western area, only 2 of the 7 target communities fall below the State unemployment average. Five of these communities are in the Lake and Peninsula Borough, which had an average unemployment rate of 10.1 percent in 2000. Of the 5 eligible communities located in that borough, two reported higher 2000 unemployment rates than the borough's 2000 average. The remaining 2 Western area communities are in the Aleutians East Borough, which had an average unemployment rate of 4.6 percent in 2000. Both communities reported higher rates than the borough overall.

Table 4-7 Communities eligible for the sablefish IFQ community quota share purchase program

Eastern regulatory area		Central regulatory area		Western regulatory area
Angoon	Klawock	Akhiok	Ouzinkie	Chignik
Coffman Cove	Metlakatla	Chenega Bay	Port Graham	Chignik Lagoon
Craig	Meyers Chuck	Halibut Cove	Port Lions	Chignik Lake
Edna Bay	Pelican	Karluk	Seldovia	Ivanof Bay
Elfin Cove	Point Baker	Larsen Bay	Tatitlek	King Cove
Gustavus	Port Alexander	Nanwalek	Tyonek	Perryville
Hollis	Port Protection	Old Harbor	Yakutat	Sand Point
Hoonah	Tenakee Springs			
Hydaburg	Thorne Bay			
Kake	Whale Pass			
Kassan				

4.6 Ecosystem Characteristics

Ecosystem characteristics of the Gulf of Alaska are assessed annually in the *Ecosystem Considerations* appendix to the *Bering Sea and Aleutian Islands and Gulf of Alaska Stock Assessment and Fishery Evaluation*. Since 1995, this document has been prepared in order to provide information about the effects of fishing from an ecosystem perspective, and the effects of environmental change on fish stocks. Since 1999, the section has included information on indicators of ecosystem status and trends, and more ecosystem-based management performance measures.

Since 2003, an annual Ecosystem Assessment has also been included in the appendix to the SAFE. The primary intent of the assessment is to summarize historical climate and fishing effects of the shelf and slope regions of the eastern Bering Sea and Aleutian Islands, and Gulf of Alaska, from an ecosystem perspective and to provide an assessment of the possible future effects of climate and fishing on ecosystem structure and function. The *Ecosystem Considerations* sections from 2000 to the present are available online at www.afsc.noaa.gov/refm/reem/Assess/Default.htm or by request from the Council office.

4.6.1 Ecosystem Trends in the Gulf of Alaska Management Area

This section is drawn from the *Final Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries* (NMFS 2004), available on the NMFS Alaska Region website (www.fakr.noaa.gov), or by request from the NMFS Alaska Region office.

Mueter (1999) examined GOA groundfish communities using groundfish and shrimp trawl data collected over several years from the eastern and western GOA. To identify spatial and temporal patterns in community structure, the data were analyzed for species richness, diversity, total abundance, and indices of species composition in relation to depth, temperature, salinity, sediment composition, geographic location, and time of sampling. The data were then compared to local and larger scale atmospheric and oceanographic changes. In general, species richness and diversity peaked at water depths of about 200–300 m in the GOA. Higher abundance, lower species richness and diversity, and a different species composition of demersal

fishes were found in the western GOA as compared to the eastern GOA. Mueter concluded that these large-scale spatial patterns were related to upwelling differences between the two regions.

With respect to long-term trends, the lowest species richness (number of species per haul) was observed in 1984, whereas the lowest species diversity (as measured by the Shannon-Wiener diversity index) was seen in 1996. It is difficult to tell whether these trends are real because of changes in trawl survey techniques and gear usage during the 12-year sample period. General increases in total groundfish biomass were seen from 1984 to 1996 (Figure 4-3), coupled with statistically significant changes in species composition (Figure 4-4). Community structure in nearshore areas around Kodiak Island changed during this same period, with decreasing populations of shrimp and small forage fish and increasing populations of large, fish-eating species such as Pacific cod and flatfish.

Mueter found that the total biomass of commercially-fished species in shelf and slope areas had increased since 1984, despite a considerable, concurrent increase in harvest effort. At the same time, the abundances of unexploited (or underexploited) species including skate, some shark species, forage species, arrowtooth flounder, and other flatfish had increased (Figure 4-5). Populations of an overexploited species, the Pacific ocean perch, had also rebounded from low population levels. The controlling factor for these increases appeared to be environmental, with changes in community species composition in nearshore areas linked to an increase in advection in the Alaska Coastal Current. Mueter concluded that increased flow around the GOA may have enhanced the supply of nutrients and plankton on the shelf and upper slope areas, resulting in higher productivity.

In addition to Mueter's work, studies by Piatt and Anderson (1996), Anderson and Piatt (1999), Orensanz *et al.* (1998), Robards *et al.* (1999) and others, discussed in Section 3.10.1.5, provide evidence that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA. An important conclusion to be drawn from these studies is that any effects of human activities on the marine environment should be considered in the context of the powerful physical forces that appear to be driving the BSAI and GOA ecosystems.

Figure 4-3 Estimated trend in the combined catch per unit of effort of 72 groundfish taxa from 1984-1996, averaged over Gulf of Alaska shelf and upper slope to 500 meters.

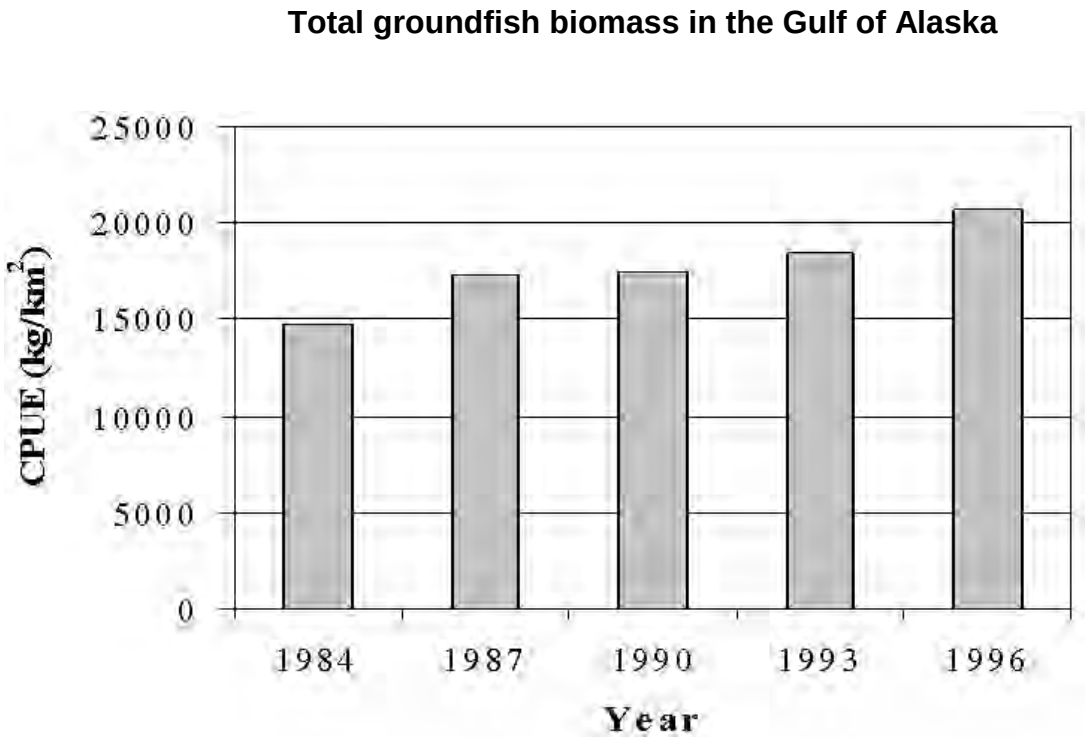


Figure 4-4 Trend index of species composition based on ordination of species abundance data from five triennial surveys on Gulf of Alaska shelf and slope with approximate 95 percent confidence interval. Source: NMFS.

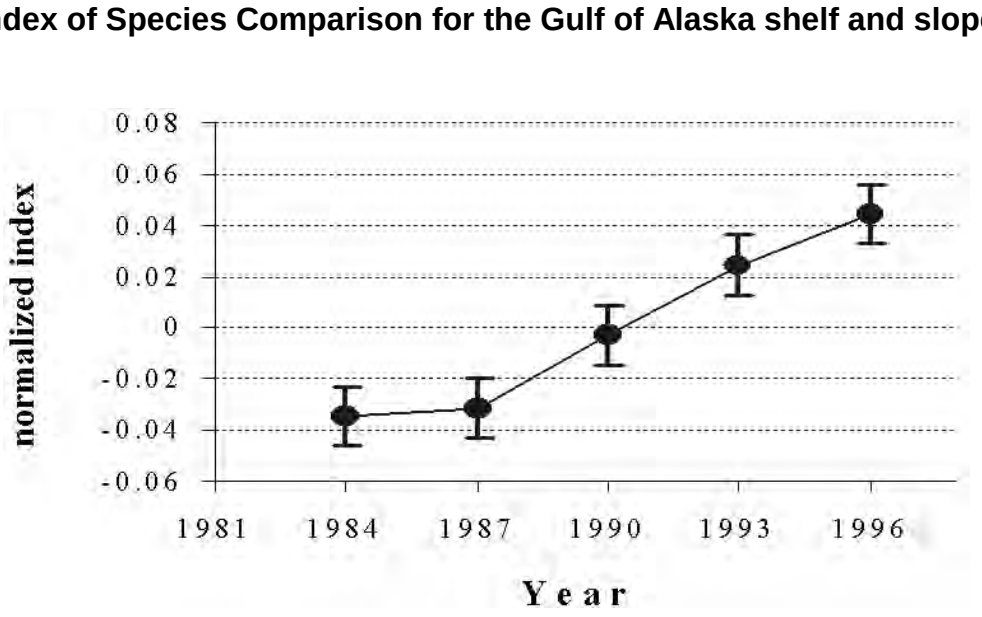
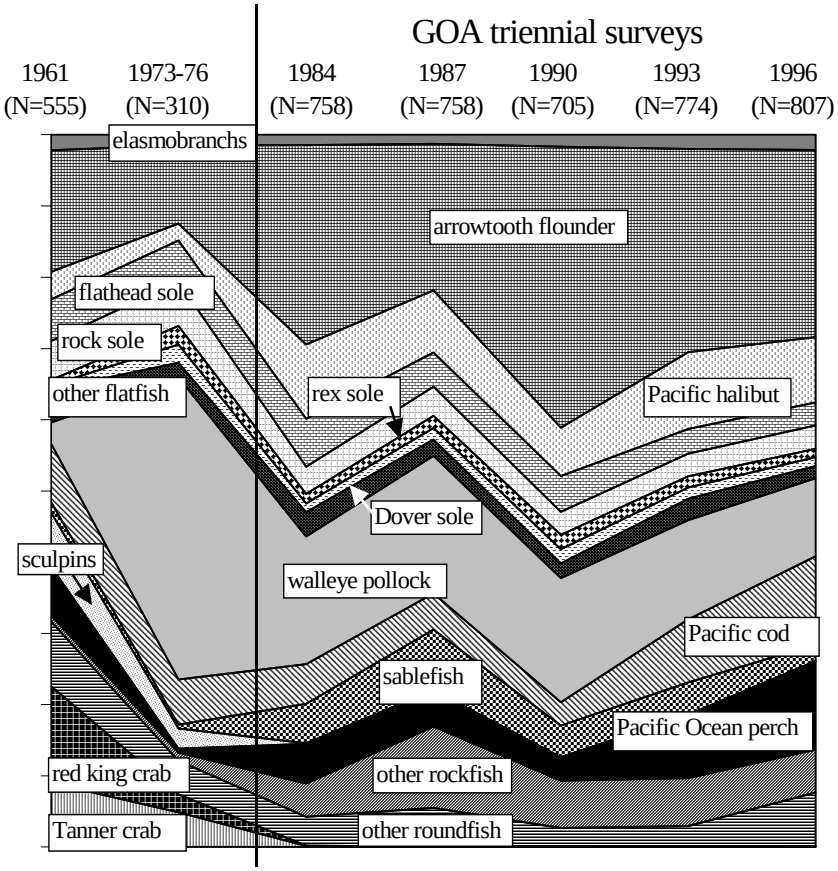


Figure 4-5 Relative species composition for major groundfish taxa in the Gulf of Alaska from 1961 through 1996. Source: NMFS.



4.6.2 Climate-Implicated Change

This section is drawn from the *Final Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries* (NMFS 2004), available on the NMFS Alaska Region website (www.fakr.noaa.gov), or by request from the NMFS Alaska Region office.

Evidence from observations during the past two decades and the results of modeling studies using historical and recent data from the North Pacific Ocean suggest that physical oceanographic processes, particularly climatic regime shifts, might be driving ecosystem-level changes that have been observed in the BSAI and GOA. Commercial fishing has not been largely implicated in BSAI and GOA ecosystem changes, but studies of other ecosystems with much larger fishing pressures indicate that fishing, in combination with climate change, can alter ecosystem species composition and productivity (Jennings and Kaiser 1998, Livingston and Tjelmeland 2000).

During 1997 and 1998, a period of warmer-than-usual ambient air temperatures (Hare and Mantua 2000), a number of unusual species occurrences were observed in the BSAI and GOA, including the following examples:

- In 1998, several warm-water fish species, including Pacific barracuda (*Sphyraena argentea*), were observed and/or caught in the GOA. Ocean sunfish (*Mola mola*) and chub mackerel (*Scomber*

japonicus), occasionally recorded in southeast Alaskan waters, were documented there in unusually large numbers. Similarly, Pacific sleeper sharks (*Somniosus pacificus*) were caught (and released) in higher than normal levels in Cook Inlet, and salmon sharks (*Lamna ditropis*) were taken in fairly large numbers off Afognak Island (Kevin Brennan, ADF&G, personal communication).

- Spiny dogfish (*Squalus acanthias*) substantially increased in the Kodiak area and in Prince William Sound (Bill Bechtol and Dave Jackson, ADF&G, personal communication). In 1998, this species' inclusion in collection tows increased by more than 40 percent. A corresponding increase in spiny dogfish has been observed in the International Pacific Halibut Commission's GOA halibut longline bycatch surveys (Lee Hulbert, NMFS, personal communication).

- Individuals of several marine mammal species were seen at unusual times and/or places during 1998, including a Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) near Haines and a northern right whale (*Eubalaena glacialis*) off Kodiak Island.

- Unusual bird sightings in the GOA included a gray-tailed tattler (*Heteroscelus brevipes*) south of the Kenai Peninsula and a mallard (*Anas platyrhynchos*) several miles offshore in the open ocean. Common murre (*Uria aalge*) die-offs were reported in Cook Inlet, Kodiak, the eastern Aleutians, Resurrection Bay, and the EBS.

- Three northern elephant seals (*Mirounga angustirostris)* were spotted in nearshore waters around Unalaska during late June and early July, whereas they are usually found farther offshore and at a different time of year.

- There were poor returns of chinook (*Oncorhynchus tshawytscha*) and sockeye (*Oncorhynchus nerka*) salmon to Bristol Bay during both years.

Research on climate shifts as a forcing agent on species and community structure of the North Pacific Ocean can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). The approach used in these studies assesses correlations between past climatic patterns and changes in biomass or recruitment rate for particular marine species. Because cause-and-effect relationships between temporal and spatial patterns of climate change and corresponding patterns of change in biological populations have not been proven for the BSAI and GOA, the correlations must be considered circumstantial. But there are reasons to expect that causal links do exist. For example, stronger recruitment would be expected under more favorable climatic conditions, because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected in the strength or weakness of the affected age groups within future fisheries.

Francis and Hare (1994) analyzed historical data supporting a climate shift that caused a precipitous decline in the sardine (*Sardinops sagax*) population off Monterey, California in the 1950s. Although it had been widely concluded that this decline resulted solely from overfishing, the data indicate instead that a change in sea surface temperature was closely correlated with the sardines' disappearance, and this related closely to patterns of sardine numbers in marine sediments off Southern California. Consequently, both climate and fishing are now recognized to be implicated in the sardine population decline.

Francis and Hare (1994) related the intensity of the Aleutian low pressure system (Aleutian low), a weather pattern, with production of salmon and zooplankton. Winter ambient air temperatures at Kodiak and the North Pacific Index, an index tracking the intensity of the Aleutian low during the winter, were used as

indicators of climatic severity. Strong correlations were found between long-term climatic trends and Alaskan salmon production. Annual weather patterns were found to be closely correlated with changes in zooplankton populations.

For the northeastern North Pacific Ocean, McGowan *et al.* (1998) showed that interannual climatic variations linked to the ENSO and decadal-scale climate shifts can be detected in physical oceanographic data. For instance, the depth of the mixed layer in the California Current and GOA became shallower over time, whereas the mixed-layer depth in the Central Pacific deepened during the same period. This was not, however, reflected in the mass flow of the California Current. Greater depth of the mixed layer during elevated sea surface temperature events was correlated with decreased nutrient availability, plankton abundance, and shifts in community structure. These researchers concluded that climatic events such as ENSO are correlated with changes in biological populations associated with the California Current. Biological processes in the GOA appear to be more strongly influenced by variations in the Aleutian low.

According to McGowan *et al.* (1998), climate-related changes in the biological communities of the California Current system ranged from declines in kelp forests to shifts in the total abundance and dominance of various zooplankton species. Some fish and invertebrate populations declined, and the distributional ranges of species shifted northward. In addition, seabird and marine mammal reproduction were apparently affected by ENSO conditions. Interdecadal changes in community structure also occurred, with intertidal communities becoming dominated by northward-moving southern species and changes in species proportions occurring in most other sectors of the ecosystem.

Interdecadal shifts observed in the northeastern North Pacific Ocean ecosystem have been of the opposite sign from those in the California Current system, with increases in zooplankton biomass and salmon landings observed in the GOA (McGowan *et al.* 1998, Francis and Hare 1994). These shifts have corresponded to the intensity and location of the winter mean Aleutian low, which changes on an interdecadal time scale.

Klyashtorin (1998) linked catch dynamics of Japanese sardines, California sardines, Peruvian sardines, Pacific salmon, Alaska pollock, and Chilean jack mackerel in the Pacific with an atmospheric circulation index that shows trends similar to the North Pacific Index used by other researchers. Other species, such as Pacific herring and Peruvian anchovy, are negatively associated with this index.

Hollowed *et al.* (1998) analyzed oceanographic and climatic data from the eastern North Pacific Ocean and compared those data with information on recruitment for 23 species of groundfish and five non-salmonid species and with catch data for salmon. The fish recruitment data were compared to environmental factors over various time scales and with varying time lags. Hollowed *et al.* (1998) found that, for species such as pollock, cod, and hake, recruitment was generally stronger during ENSO events. Whereas salmon and large-mouthed flatfish such as arrowtooth flounder, Greenland turbot, and Pacific halibut responded more strongly to longer-term events such as decadal-scale climatic regime shifts. Because both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support climate change as an important controlling factor in ecosystem dynamics.

There is considerable evidence that decadal and basin-scale climatic variability (Section 3.3.4) can affect fish production and ecosystem dynamics. Sudden basin-wide shifts in climatic regime have been observed in the North Pacific Ocean (Mantua *et al.* 1997), apparently due to changes in atmospheric forcing. Eastward- and northward-propagating storm systems dominate the wind stress on surface waters for short periods (less than one month), mixing the upper layers and altering sea surface temperatures (Bond *et al.* 1994). Because fish are very sensitive to ambient water temperature, even changes in surface temperature, if sufficiently frequent

or prolonged, can alter fish distribution and reproductive success as well as recruitment (the number of juveniles that survive to enter the adult, reproducing portion of the population).

In a long-term trends analysis by computer, Ingraham and Ebbesmeyer (Ingraham *et al.* 1998) used the OSCURS model to simulate wind-driven surface drift trajectories initiated during winter months (December through February) for the period 1946 to present. The model-generated endpoints of the 3-month drift trajectories shifted in a bimodal pattern to the north and south around the mean. The winter flow during each year was persistent enough to result in a large displacement of surface mixed-layer water. The displacement also varied in a decadal pattern. Using the rule that the present mode is maintained until three concurrent years of the opposite mode occur, four alternating large-scale movements in surface waters were suggested: a southward mode from 1946 to 1956, a northward mode from 1957 to 1963, a southward mode from 1964 to 1974, and a northward mode from 1975 to 1994. As more northern surface water shifts southward, colder conditions prevail farther south, and as southward water moves northward, warmer conditions prevail farther north, both potentially affecting fish distribution and population dynamics.

Real-world evidence that atmospheric forcing alters sea surface temperatures comes from two principal sources: shorter-term ENSO events and longer-term Pacific Decadal Oscillations (Mantua *et al.* 1997). Temperature anomalies in the BSAI and GOA indicate a relatively warm period in the late 1950s, followed by cooling especially in the early 1970s, followed by a rapid temperature increase in the latter part of that decade. Since 1983, the BSAI and GOA have undergone different temperature changes. Sea surface temperatures in the BSAI have been below normal, whereas those in the GOA have been generally above normal. Consequently, the temperature difference between the two bodies of water has jumped from about 1.1°C to about 1.9°C (U.S. GLOBEC 1996).

Subsurface temperatures, potentially an even more important influence on biological processes, have been documented to change in response to climatic drivers. There was a warming trend in subsurface temperatures in the coastal GOA from the early 1970s into the 1980s similar to that observed in GOA sea surface waters (U.S. GLOBEC 1996).

In addition, seawater temperature changes in response to ENSO events occurred, especially at depth, in 1977, 1982, 1983, 1987, and in the 1990s. The 1997-1998 ENSO event, one of the strongest recorded in the twentieth century, substantially changed the distribution of fish stocks off California, Oregon, Washington, and Alaska. The longer-term impacts of the 1997-1998 ENSO event remain to be seen. Francis *et al.* (1998) reviewed the documented ecological effects of this most recent regime shift through lower, secondary, and top trophic levels of the North Pacific Ocean marine ecosystem. Some of the following impacts on higher trophic levels are based on this review:

- Parker *et al*. (1995) demonstrated marked similarities between time series of the lunar nodal tidal cycle and recruitment patterns of Pacific halibut.

- Hollowed and Wooster (1995) examined time series of marine fish recruitment and observed that some marine fish stocks exhibited an apparent preference (measured by the probability of strong year and average production of recruits during the period) for a given climate regime.

- Hare and Francis (1995) found a striking similarity between large-scale atmospheric conditions and salmon production in Alaska.

- Quinn and Niebauer (1995) studied the Bering Sea pollock population and found that high recruitment coincided with years of warm ocean conditions (above normal air and bottom

temperatures and reduced ice cover). This fit was improved by accounting for density-dependent processes.

Additional evidence of marine ecosystem impacts linked to climatic forcing comes from Piatt and Anderson (1996), who provided evidence of possible changes in prey abundance due to decadal-scale climate shifts. These authors examined relationships between significant declines in marine birds in the northern GOA during the past 20 years and found that statistically significant declines in common murre populations occurred from the mid- to late 1970s into the early 1990s. They also found a substantial alteration in the diet composition of five seabird species collected in the GOA from 1975 to 1978 and from 1988 to 1991, changing from a capelin-dominated diet in the late 1970s to a diet in which capelin was virtually absent in the later period.

The effects of ten-year regime shifts on the inshore GOA were analyzed using data from 1953 to 1997 (Anderson and Piatt 1999). Three taxonomic groups dominated (approximately 90 percent) the biomass of commercial catches during this period: shrimp, cod and pollock, and flatfish. When the Aleutian low was weak, resulting in colder water, shrimp dominated the catches. When the Aleutian low was strong, water temperatures were higher, and biomass the catches were dominated by cod, pollock, and flatfish. Similar results were reported in very nearshore areas of lower Cook Inlet (Robards *et al.* 1999).

Few patterns were seen in the less-common species over the course of the study. Generally, the transitions in dominance lagged behind the shift in water temperature, strengthening the argument that the forcing agent was environmental. However, different species responded to the temperature shift with differing time lags. This was most evident for species at higher trophic levels, which are typically longer-lived and take longer to exhibit the effects of changes. The evidence suggests that the inshore community was reorganized following the 1977 climate regime shift. Although large fisheries for pandalid shrimp may have hastened the decline for some stocks (Orensanz *et al.* 1998), unfished or lightly fished shrimp stocks showed declines. Both Orensanz *et al.* (1998) and Anderson and Piatt (1999) concluded that the large geographic scale of the changes across so many taxa is a strong argument that climate change is responsible.

Other studies have linked production, recruitment, or biomass changes in the BSAI with climatic factors. For example, a climate regime shift that might have occurred around 1990 has been implicated in a large increase in gelatinous zooplankton in the BSAI (Brodeur *et al.* 1999). Recruitment in both crabs and groundfish in the BSAI has been linked to climatic factors (Zheng and Kruse 1998, Rosenkranz *et al.* 1998, Hollowed *et al.* 1998, Hare and Mantua 2000).

There are indications from several studies that the BSAI ecosystem responds to decadal oscillations and atmospheric forcing, and that the 1976-1977 regime shift had pronounced effects. A peak in chlorophyll concentrations in the late 1970s was closely correlated with an increase in summer mixed-layer stability documented at that time (Sugimoto and Tadokoro 1997). Also, on a decadal time scale, chlorophyll concentrations in the summer were positively correlated with winter wind speeds, indicating a positive response of BSAI phytoplankton to stronger Aleutian lows (Sugimoto and Tadokoro 1997).

Evidence of biological responses to decadal-scale climate changes are also found in the coincidence of global fishery expansions or collapses of similar species complexes. Sudden climate shifts in 1923, 1947, and 1976 in the North Pacific Ocean substantially altered marine ecosystems off Japan, Hawaii, Alaska, California, and Peru. Sardine stocks off Japan, California, and Peru exhibited shifts in abundance that appear to be synchronized with shifts in climate (Kawasaki 1991). These historical 60-year cycles are seen in paleo-oceanographic records of scales of anchovies, sardines, and hake as well. Other examples are salmon stocks

in the GOA and the California Current whose cycles are out of phase. When salmon stocks do well in the GOA, they do poorly in the California Current and vice-versa (Hare and Francis 1995, Mantua *et al.* 1997).

In addition to decadal-scale shifts, interannual events such as the ENSO can have significant impacts on fish distribution and survival, and can affect reproduction, recruitment, and other processes in ways that are not yet understood. This is particularly true for higher-latitude regions such as the northern California Current and GOA. As noted above, the 1997-1998 ENSO event significantly changed the distribution of fish stocks off California, Oregon, Washington, and Alaska. A change that has persisted to the present. Predicting the implications of this trend for future fishery management is problematic, in part because ENSO signals propagate from the tropics to high latitudes through the ocean as well as through the atmosphere, and it is difficult to separate these two modes of influence. Information on the dynamics of North Pacific Ocean climate and how this is linked to equatorial ENSO events is not adequate to adjust fisheries predictions for such abrupt, far-reaching, and persistent changes. Warm ocean conditions observed in the California Current during the present regime may be due, in large part, to the increased frequency of ENSO-like conditions.

In conclusion, evidence from past and present observations and modeling studies at the community and ecosystem levels for the BSAI and GOA suggest that climate-driven processes are responsible for a large proportion of the multi-species and ecosystem-level changes that have been documented. Modeling studies have been a valuable tool for elucidating the possible long-term implications of various fishing strategies. As with all computer-based models, these have been sensitive to unproven assumptions about recruitment and its relationship to climate. As the preceding discussion suggests, the models could be improved by incorporating components that include climatic effects on species, particularly with respect to recruitment. However, this approach has not been widely applied yet to species in the BSAI and GOA ecosystems.

4.6.3 Interactions Among Climate, Commercial Fishing, and Ecosystem Characteristics

This section is drawn from the *Final Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries* (NMFS 2004), available on the NMFS Alaska Region website (www.fakr.noaa.gov), or by request from the NMFS Alaska Region office.

Groundfish fishery management in the BSAI and GOA is implemented in a dynamic environment where both commercial fishing and climate-driven physical oceanographic processes interact in complex ways to affect the marine ecosystem. To characterize these interactions, it is necessary to distinguish, where feasible, the separate effects of fishing and climate on biological populations. The following discussion reviews current knowledge regarding these effects and their relationship to ecosystem characteristics.

Three processes underlie the population structure of species in marine ecosystems: competition, predation, and environmental factors. Natural variations in the recruitment, survival, and growth of fish stocks are consequences of these processes. The first process, competition, is a basic concept underlying many ecological theories (e.g., Hairston *et al.* 1960, Welden and Slauson 1986, Yodzis 1978, 1994). It requires an assumption that species in an ecosystem are limited in their access to critical resources such as food, space, reproductive mates, and time for important activities. Predation is important, because it changes prey density, thereby directly or indirectly affecting populations throughout the ecosystem. Finally, environmental factors, particularly climatic processes, are thought to be major agents of change in North Pacific Ocean ecosystems. Climate has the potential to influence the important biological processes of reproduction, growth, consumption and predation, movement, and, ultimately, the survival of marine organisms.

Against this complex and dynamic natural background, human activities such as commercial fishing can influence the structure and function of marine ecosystems. Like competition, predation, and climate change,

the effects of commercial fishing can extend over a range of temporal, spatial, and population scales. Large-scale commercial fishing has the potential to influence ecosystems in several ways. It may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways though the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. In addition, the selective removal of species has the potential to change predator-prey relationships and community structures. Fishing gear may alter bottom habitat and damage benthic organisms and communities.

Both climate and commercial fishing activity currently influence the structure and function of the North Pacific Ocean ecosystem (Francis *et al.* 1999). Since climate change and commercial fishing can co-vary, it may be difficult to distinguish the impacts of the two (e.g., Trites *et al.* 1999). The primary way in which complex scientific knowledge is integrated to further the understanding of the influence of natural and human-related processes on marine ecosystems is through the use of models. Models can be as simple as conceptual diagrams that show a picture of how we think a certain ecosystem process operates, or they can be very complicated, with quantitative descriptions of the relationships between various factors and species growth, recruitment, movement, or survival. Reviews of the status of models that have been developed to understand the effects of climate and fishing on ecosystems have been produced by Livingston (1997) and Hollowed *et al.* (2000a). These reviews outline the types of models presently being used and the state of our ability to understand and predict the effects of the two important factors of climate and fishing in marine ecosystems by using models.

Most models that consider more than one species link the species together through knowledge about their feeding (trophic) interactions. Once the trophic linkages among species are understood, questions about impacts of predators and prey on one another (Yodzis 1994), or how natural or human-induced habitat changes affect the food-web structure (Yodzis 1996), can be addressed with a variety of multi-species or ecosystem models. Another model type, called a technical interaction model, may consider the simultaneous capture of groups of species by a particular fishery or type of fishing gear.

With the exception of information on forage fish, which—unlike many marine species—are preyed on as adults and not just mainly as juveniles, most scientific advice from multi-species models is not presently being used in making short-term management decisions. These models are mainly useful for trying to understand the possible medium- (6 to 10 years) and longer-term implications of various management strategies on the ecosystem.

However, long-term predictions from single-species, multi-species, and ecosystem-level models remain uncertain, because the predictions rely heavily on assumptions about recruitment, particularly for predators (Gislason 1991 and 1993), which may be strongly influenced by environmental variation. Limitations still exist regarding the ability to predict both future changes in climate and recruitment rates resulting from a particular climate state.

Therefore, as noted by Parkes (2000) and Hall (1999a), predator-prey models are not considered reliable enough to provide directly applicable management advice at the present time. Hall (1999b) notes that ecosystem-based management advice should move toward setting single-species biological reference points for non-target species, developing single-species reference points for localized regions (i.e., spatially explicit management), and using measures of system-level properties (e.g., species diversity, trophic level of the catch, biomass-size distributions) to derive ecosystem-level reference points.

Food web models of the BSAI, specifically, the EBS shelf, ecosystem have been developed for the 1950s and 1980s (Trites *et al.* 1999). These models use the Ecopath strategy for evaluating mass-balance in marine

ecosystems. Ecopath uses estimates of biomass, consumption, diet, and turnover rates of populations or groups of populations to evaluate energy flow and mass-balance in a particular ecosystem (Christensen 1990).

Ecopath creates static biomass flow models of ecosystems and represents a snapshot of the ecosystem for a given time period. Species in these models are linked, so that the biomass transfer resulting from processes such as fecundity, mortality, production, respiration, and predation are in equilibrium (balanced). These types of models provide a way to identify large-scale views of ecosystems and to highlight data gaps (Christensen 1990, 1992, 1994; Pauly and Christensen 1995).

An examination of energy flow within the ecosystem is instructive, although one must be careful in interpreting the inevitable differences among the flow estimates. For instance, although the magnitude of biomass flow from prey to tertiary consumers (e.g., juvenile pollock to seabird predators) is modest relative to that between primary producers and primary consumers (e.g., phytoplankton to crustaceans), it may nonetheless play a significant role in the dynamics of the food web (P. Yodzis, University of Guelph, Ontario, Canada, personal communication). Further, if a food web is composed of few, highly connected species in a trophic sense, removal of a predator may yield a larger ecosystem perturbation than a similar removal from an ecosystem with weaker trophic links among many predators and prey (e.g., Pimm 1982).

The Ecopath models for the Bering Sea were initially developed to see if impacts of intensive whale harvesting that occurred in the 1950s and 1960s were sufficient to explain the ecosystem structural changes that were observed in the 1980s, discussed in Section 3.10.1.3. The primary removal of energy in both decades was by harvesting whales and pelagic fishes in the 1950s, and pollock in the 1980s. The production estimate for the 1950s simulation showed baleen whales as the dominant ecosystem component. These whales were classed as a midlevel consumer with a trophic level slightly higher than pollock, due to their consumption of squid. The dominant component in the 1980s simulation was pollock, the dominant fishery. There was a slight drop in trophic level of the catch between the two periods, but this was acknowledged to be an artifact of the volume of squid assumed in the diet of the baleen whales. Without this assumption, there was little change in trophic level of harvest. Trophic level of the catch actually incr eased from the 1950s to the 1980s, if only fish harvests are considered. This would suggest that harvesting in the Bering Sea at present is at a level that has been sustained over long periods. A further result of this simulation was that whale harvests required an estimated 47 percent of net primary production in the Bering Sea in the 1950s. Fisheries of the 1980s, dominated by pollock, required only 6.1 percent of primary production.

Measures of ecosystem maturity show some differences between the two Bering Sea models. The ratio of primary production to respiration, net system production, and the ratio of biomass to throughput indicate a more mature ecosystem state in the 1950s compared with the 1980s. This is due to the assumption that benthic infauna biomass was lower in the 1980s. However, benthic infaunal surveys used to estimate biomass for the two models used different methods and may not be comparable.

Trophic pyramids are similar for the two time periods, and both indicate that biomass and energy flow were distributed fairly well throughout the system. The steep-sided shape of the pyramids indicates that there is a lot of energy flow at lower trophic levels. One system maturity index, the ratio of primary production to total biomass, actually indicates a more mature system in the 1980s relative to the 1950s. However, this was due to assumptions about the change in primary production between the two time periods, for which there is conflicting evidence. Conclusions about system maturity will be premature until trends in primary production and benthic infauna biomass are better understood.

The Bering Sea appears to be more mature than other modeled ecosystems, particularly with regard to total system throughput, which measures the sum of all energy flows in the system. It has ecosystem measures that indicate it has significant strength in reserve, which makes it more resilient or resistant to perturbations compared with other ecosystems.

Ecosim, a forward-looking simulation coupled to Ecopath, was used to project the results of various scenarios. The model was run in either an equilibrium or dynamic mode. The equilibrium mode assumed that the total biomass of the ecosystem remained stable, and as the biomass of one component declined, others were required to increase to balance it. Dynamic models do not have this requirement.

The equilibrium mode of Ecosim was used to examine the results of changes in a species' abundance on interacting groups. The results of the equilibrium model suggest that changes in baleen whale numbers could significantly affect pollock populations, and that increases in sperm whale numbers could yield decreases in the numbers of Steller sea lions through competition. Reducing pelagic fish numbers reduces the numbers of seabirds that feed on them, as well as numbers of Steller sea lions and large flatfish. Increasing fishing pressure on pollock would have little effect on their biomass, and increasing fishing pressure on large flatfish would result in increased Steller sea lion populations through the removal of a competitor.

In a different approach, the dynamic mode of Ecosim was used to look at possible mechanisms involved in the historical marine biomass changes seen between the 1950s and the 1980s. Scenarios used for the dynamic model were a regime shift that resulted in changes in primary production; a commercial fishery simulation to see if fishing whale could account for the observed changes; three pollock fishing scenarios that project into the future; and scenarios which varied the fishery mortalities on pollock and pelagic fishes.

These simulations suggested that commercial harvesting of fish and whales had little likelihood of producing the changes seen in actual pollock populations since the 1950s. The effect of increasing primary production provided a much more realistic change in the pollock population. While most groupings showed increases, Steller sea lions did not.

There are substantial uncertainties about the abundance of small pelagic fish in both time periods and the abundance of pollock in the 1950s model. Low abundance of pollock and higher abundance of small pelagic fish in the 1950s was assumed. However, although non-standardized surveys by the Soviets during the 1950s showed apparently lower pollock abundance, their research on diet composition of groundfish indicated that pollock was a primary prey item of many species. It is possible that pollock may have been more abundant in the 1950s than has been assumed. Further model testing with this change in assumptions should be done.

Another dynamic simulation showed that, contrary to what might be expected, stopping the commercial pollock harvest had a slight negative effect on Steller sea lions. This is because two of the Steller sea lion prey items, small pelagic fish and juvenile pollock, declined when adult pollock increased. Adult pollock are cannibalistic and compete with small pelagic fish for large zooplankton prey in this model. More recent versions of the model, which changed the assumptions regarding recruitment now show that juvenile pollock actually increase under this scenario, but that Steller sea lions still show a slight negative effect. This is presumably because of the assumption of the dominance of small pelagic fish as a prey item of Steller sea lions. Small pelagic fish still decline under the assumption of increasing pollock, because adult pollock compete with them for large zooplankton prey.

In conclusion, these model simulations indicate uncertainty about the biomass of lower trophic level species in the two time periods. It appears that climate-related shifts in lower trophic level production could partly explain the ecosystem changes that occurred between the 1950s and the 1980s. However, the model only

captures predation-related recruitment variability and cannot show climate-related variability in recruitment, which is probably much larger. More detailed scenarios that examine the spatial availability of prey will have to be performed to improve our understanding of the complex interaction between fishery removals and predator-prey interactions.

Chapter 5 Relationship to Applicable Law and Other Fisheries

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) is the primary domestic legislation governing management of the U.S. marine fisheries. The relationship of the Fishery Management Plan (FMP) for Groundfish of the Gulf of Alaska (GOA) Management Area with the Magnuson-Stevens Act and other applicable Federal law is discussed in Section 5.1. The relationship of the FMP to international conventions is addressed in Section 5.2. The relationship of the FMP to other Federal fisheries is addressed in Section 5.3, and to State of Alaska fisheries in Section 5.4.

5.1 Magnuson-Stevens Act and Other Applicable Federal Law

The FMP is consistent with the Magnuson-Stevens Act (16 USC 1851), including the ten National Standards, and other applicable law.

5.2 International Conventions

The U.S. is party to many international conventions. Those that directly or indirectly address conservation and management needs of groundfish in the Gulf of Alaska management area include:

- Convention for the Preservation of the Halibut Fishery of the North Pacific Ocean and the Bering Sea (basic instrument for the International Pacific Halibut Commission – IPHC)

This plan has a most significant relationship to the management of the Pacific halibut fishery that continues to be vested in the International Pacific Halibut Commission. Many of the management measures contained herein are for the expressed purpose of mitigating a severe crisis in the domestic halibut fishery by recognizing a situation in which the trawl fishery (and possibly the sablefish setline fishery) could be a major contributor to declining halibut abundance.

<u>International Pacific Halibut Commission</u>

The IPHC was created to conserve, manage, and rebuild the halibut stocks in the Convention Area to those levels which would achieve and maintain the maximum sustainable yield from the fishery. The halibut resource and fishery have been managed by the IPHC since 1923. The IPHC was established by a Convention between the United States and Canada, which has been revised several times to extend the Commission's authority and meet new conditions in the fishery. "Convention waters" are defined as the waters off the west coasts of Canada and the United States, including the southern as well as the western coasts of Alaska, within the respective maritime areas in which either Party exercises exclusive fisheries jurisdiction. Under the Protocol to the Convention, the Commission retains a research staff and recommends, for the approval of the Parties, regulations regarding: (1) the setting of quotas in the Convention Area, and (2) joint regulation of

the halibut fishery in the entire Convention Area under Commission regulations. Neither U.S. nor Canadian halibut fishing vessels are presently allowed to fish in the waters of the other country.

The fishery for Pacific halibut in the GOA is conducted under an Individual Fishing Quota (IFQ) program, in conjunction with the FMP-managed sablefish resource. A realized benefit of the IFQ program is the reduction in halibut bycatch mortality. Much of the longline bycatch of halibut occurred in sablefish fisheries. To the extent that sablefish fishers have halibut IFQ, this halibut is now retained and counted against target quotas.

5.3 Other Federal Fisheries

The North Pacific Fishery Management Council (Council) has implemented four other FMPs in the Alaska exclusive economic zone (EEZ). These FMPs govern groundfish fishing in the Gulf of Alaska (GOA), king and tanner crab fishing in the BSAI, and scallop and salmon fishing in the Alaska EEZ. The relationship of the BSAI groundfish FMP with these other management plans is discussed below.

Bering Sea and Aleutian Islands Groundfish FMP

The GOA and BSAI groundfish fisheries are managed in close connetion with one another. While many of the same groundfish species occur in both the GOA and BSAI management areas, they are considered to be separate stocks. There is some overlap between participants in the GOA and BSAI groundfish fisheries. Many of the management measures and stock assessment science is similar for the two areas. Management measures proposed for the GOA groundfish fisheries are analyzed for potential impacts on BSAI fisheries.

BSAI King and Tanner Crab FMP

The fishery management units for the BSAI crab FMP and the GOA groundfish FMP do not overlap. Some participants in the BSAI crab fishery also target groundfish in the GOA, and processors may process catch originating from fisheries authorized under both FMPs.

Scallop FMP

There is very little interaction between the scallop FMP and the BSAI groundfish FMP. Virtually none of the vessels participating in the scallop fishery target groundfish. The scallop FMP contains sideboard measures constraining AFA pollock fishery participants from participating in the scallop fishery.

Salmon FMP

Pacific salmon are a prohibited species in the GOA groundfish FMP. There is no fishing of salmon allowed in the EEZ, therefore there is no overlap of participants or grounds conflicts. The GOA groundfish FMP does include management measures to reduce the bycatch of salmon in federal waters, including catch limits and area closures.

5.4 State of Alaska Fisheries

The Constitution of the State of Alaska states the following in Article XIII:

Section 2 General Authority. The legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State, including land and waters, for the maximum benefit of the people.

Section 4 Sustained Yield. Fish, forest, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses.

Section 15 No Exclusive Right of Fishery, has been amended to provide the State the power "to limit entry into any fishery for purposes of resource conservation" and "to prevent economic distress among fishermen and those dependent upon them for a livelihood".

These are the basic tenets by which the natural resources of Alaska are managed.

The management of demersal shelf rockfish is delegated to the State of Alaska under Council oversight, as described in Section 3.8.1. The relationship of the FMP with State of Alaska fisheries is discussed below.

State parallel groundfish fishery

In the Western and Central regulatory areas, a parallel groundfish fishery occurs where the State allows the federal species TAC (total allowable catch) to be harvested in State waters. Parallel fisheries occur for pollock, Pacific cod, rockfish, and flatfish species, for some or all gear types. Opening state waters allows the effective harvesting of fishery resources because many fish stocks straddle State and Federal jurisdiction and in some cases a significant portion of the overall federal TAC is harvested within State waters. Although the State cannot require vessels fishing inside state waters during the Federal fishery to hold a Federal permit, it can adopt regulations similar to those in place for the Federal fishery if those regulations are approved by the Board of Fisheries and meet State statute. An example of a Federal fishery regulation that was concurrently adopted by the Board of Fisheries is the Steller sea lion protection measures implemented in 2001.

State groundfish fishery

State groundfish fisheries also occur exclusively in GOA state waters for Pacific cod, lingcod, sablefish, and rockfish, and are managed by the State of Alaska Board of Fisheries. For some species, the State conducts an independent stock assessment to determine the annual harvest level, however, for Pacific cod, the annual harvest level is determined based on the federal assessment. The Council and the State of Alaska Board of Fisheries work closely together through a joint protocol committee on issues of mutual importance, and usually meet once a year. The Commissioner of the Alaska Department of Fish and Game, or his designee, sits on the Council.

State shellfish fishery

There is no federal fishery for king and tanner crab in the GOA. These species are prohibited in the GOA groundfish fisheries, and must be immediately returned to the sea with a minimum of injury. Area closures have been put in place around Kodiak Island and in Cook Inlet to protect crab habitat from groundfish bottom trawls.

State salmon fishery

Pacific salmonids are prohibited species in the GOA groundfish FMP, and must be immediately returned to the sea with a minimum of injury. Some controversy exists regarding the degree to which salmon bycatch in the groundfish fisheries affects the stability of State salmon runs.

State herring fishery

There is virtually no interaction between the state herring fishery and the GOA groundfish FMP fisheries. Pacific herring are considered a prohibited species in the groundfish fishery, and must be immediately returned to the sea with a minimum of injury.

Subsistence fisheries

Subsistence fisheries in Alaska are managed by the State, and take place primarily in State waters. Groundfish fishery participants and fishing communities engage in subsistence activities, however groundfish are a minor target of subsistence fishing (see Section 4.3.3 for a description of the subsistence groundfish fishery). Where appropriate, subsistence groundfish harvests are accounted for in annual groundfish stock assessment.

Chapter 6 References

This chapter contains references that may assist the reader in evaluating the FMP. Section 6.1 describes the sources of available data regarding the Gulf of Alaska (GOA) groundfish fisheries, including annually updated reference material. Section 6.2 provides management and enforcement considerations for the GOA groundfish fisheries. A list of the literature cited in the FMP is included in Section 6.3.

6.1 Sources of Available Data

Although every effort is made to keep the FMP updated with recent descriptions of the stocks and fisheries, the availability of new data far exceeds the ability of the Council and NMFS to amend the FMP. As a result, in some cases, it may be more expeditious to access the regularly updated reference material directly in order to gain a current picture of the status of the groundfish fisheries. The North Pacific Fishery Management Council (Council) (Section 6.1.1), the National Marine Fisheries Service (NMFS) Alaska Fisheries Science Center (AFSC) (Section 6.1.2), and NMFS Alaska Region office (Section 6.1.3), each produce an abundance of reference material that is useful for understanding the groundfish fisheries. The sections below provide an overview of the types of reports and data available through the various organizations and their websites.

6.1.1 North Pacific Fishery Management Council

6.1.1.1 Stock Assessment and Fishery Evaluation Report

The *Stock Assessment and Fishery Evaluation* (SAFE) report is compiled annually by the GOA Groundfish Plan team, which is appointed by the Council. The sections are authored by AFSC and State of Alaska scientists. As part of the SAFE report, a volume assessing the *Economic Status of the Groundfish Fisheries off Alaska* is also prepared annually, as well as a volume on *Ecosystem Considerations*.

The SAFE report provides information on the historical catch trend; estimates of the maximum sustainable yield of the groundfish complex, as well as its component species groups; assessments on the stock condition of individual species groups; assessments of the impacts on the ecosystem of harvesting the groundfish complex at the current levels given the assessed condition of stocks, including consideration of rebuilding depressed stocks; and alternative harvest strategies and related effects on the component species groups.

The SAFE report annually (or biennially for some species) updates the biological information base necessary for multispecies management. It also provides readers and reviewers with knowledge of the factual basis for TAC decisions, and illustrates the manner in which new data and analyses are used to obtain individual species groups' estimates of acceptable biological catch and maximum sustainable yield.

Copies of the most recent SAFE reports are available online (see below), and by request from the North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska, 99501.

6.1.1.2 Website

Much of the information produced by the Council can be accessed through its website, to be found at:

http://www.fakr.noaa.gov/npfmc

The information available through the website includes the following.

- FMPs: summaries of the FMPs as well as the FMPs themselves are available on the website
- Meeting agendas and reports: annual quota specifications, amendments to the FMPs or implementing regulations, and other current issues are all discussed at the five annual meetings of the Council. Meeting agendas, including briefing materials where possible, and newsletter summaries of the meeting are available on the website, as well as minutes from the meetings.
- Current issues: the website includes pages for issues that are under consideration by the Council, including amendment analyses where appropriate

6.1.2 NMFS Alaska Fisheries Science Center

Much of the information produced by the AFSC can be accessed through its website, to be found at:

http://www.afsc.noaa.gov/

The information available through the website includes the following.

- Species summaries: a summary of each groundfish species is available online, including AFSC research efforts addressing that species where applicable
- Issue summaries: a summary of major fishery issues is also available, such as bycatch or fishery gear effects on habitat
- Research efforts: a summary of the research efforts for each of the major AFSC divisions is provided on the website
- Observer Program: the homepage describes the history of the program and the sampling manuals that describe, among other things, the list of species identified by observers
- Survey reports: the groundfish stock assessments are based in part on the independent research surveys that are conducted annually, biennially, and triennially in the management areas. Reports of the surveys are made available as NMFS-AFSC NOAA Technical Memorandum , and are available on the website; the data maps and data sets are also accessible.
- Publications: the AFSC Publications Database contains more than 4,000 citations for publications authored by AFSC scientists. Search results provide complete citation details and links to available on-line publications.
- Image library: the website contains an exhaustive library of fish species

6.1.3 NMFS Alaska Region

6.1.3.1 Programmatic SEIS for the Alaska Groundfish Fisheries

Published in 2004, the *Final Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries* (PSEIS) (NMFS 2004) is a programmatic evaluation of the BSAI and GOA groundfish fisheries. The document includes several alternative management policies for the fisheries, and provides the supporting analysis for Amendment 74 to the GOA FMP, which changed the FMP management policy.

The PSEIS contains a detailed evaluation of the impact of the FMP on groundfish resources, other fish and marine invertebrates, habitat, seabirds, marine mammals, economic and socioeconomic considerations, and the ecosystem as a whole. The impacts are evaluated in comparison to a baseline condition (for most resources this is the condition in 2002) that is comprehensively summarized and includes the consideration of lingering past effects. Additionally, sections of the document describe the fishery management process in place for the Alaska federal fisheries, and the changes in management since the implementation of the FMP in 1978.

6.1.3.2 Website

Much of the information produced by NMFS Alaska region can be accessed through its website, to be found at:

http://www.fakr.noaa.gov/

The information available through the website includes the following.

- Regulations: the FMP's implementing regulations can be found on the Alaska region website, as well as links to the Magnuson-Stevens Act, the American Fisheries Act, the International Pacific Halibut Commission, and other laws or treaties governing Alaska's fisheries
- Catch statistics: inseason and end of year catch statistics for the groundfish fisheries can be found dating back to 1993, or earlier for some fisheries; annual harvest specifications and season opening and closing dates; and reports on share-based fishery programs (such as the individual fishing quota program for fixed-gear sablefish)
- Status of analytical projects: the website includes pages for the many analytical projects that are ongoing in the region
- Habitat protection: maps of essential fish habitat, including a queriable database; status of marine protected areas and habitat protections in Alaska
- Permit information: applications for and information on permits for Alaska fisheries; data on permit holders
- Enforcement: reports, requirements, and guidelines
- News releases: recent information of importance to fishers, fishery managers, and the interested public.

The NMFS Alaska region website also links to the national NMFS website, which covers national issues. For example, NMFS-wide policies, for example on bycatch or improving stock assessments, may be found

on the national website. Also, NMFS produces an annual report to Congress on the status of U.S. fisheries, which can be accessed from this website.

6.2 Management and Enforcement Considerations

This section provides information about management and enforcement of the groundfish fisheries off Alaska. Management and enforcement responsibilities include the following:

- Data collection, research, and analysis to prepare annual stock assessments;
- The annual groundfish specifications process through which TAC limits and prohibited species catch (PSC) limits are established;
- The ongoing process of amending the FMPs and regulations to implement fishery management measures recommended by the Council or NMFS;
- Monitoring of commercial fishing activities to estimate the total catch of each species and to ensure compliance with fishery laws and regulations;
- Actions to close commercial fisheries once catch limits have been reached; and
- Actions taken by NMFS Enforcement, the U.S. Coast Guard (USCG), and NOAA General Counsel to identify, educate, and, in some cases, penalize people who violate the laws and regulations governing the groundfish fisheries.

Management of the groundfish fisheries in the GOA and enforcement of management measures governing those fisheries comprise a complex system for overseeing fisheries that range geographically over an extensive area of the Gulf of Alaska and North Pacific Ocean.

NMFS manages the fisheries off Alaska based on TAC amounts for target species and PSC amounts for species that may not be retained. The TAC and PSC amounts are further subdivided by gear type, area, and season. As the complexity of the management regime has grown, the number of TAC and PSC subdivisions has grown as well. For example, in 1995 for the BSAI there were 40 TAC allocations, 38 PSC allocations and two CDQ allocations. In 2003 for the BSAI, there were 152 TAC allocations, 78 PSC allocations, and 34 CDQ allocations. Each allocation represents a possible need for NMFS to take management actions, such as closing fisheries, reallocating incidental catch amounts, or investigating overages. When a directed fishery in one area is closed, the boats that participated in the fishery often move to another area or change to another target. This, in turn, often leads to the need for additional management actions.

Though the number of allocations has increased, the quantity of fish available for these allocations has not, and NMFS is required to manage increasingly small blocks of fish. To do this adequately requires the use of increasingly sophisticated catch-monitoring tools, such as observer coverage, electronic reporting, vessel monitoring systems (VMS), and the use of at-sea scales. Though these tools increase the quantity, quality, and timeliness of the data available to NMFS management, they also increase the demands on staff to effectively make use of a larger and more complex data system.

Current fishery management recognizes that a meaningful enforcement program must accompany management measures for them to be effective. As management becomes more complex, the difficulty of adequately enforcing the regulations grows. As the size and complexity of the regulatory environment increases, the burden on enforcement personnel to fully understand the nuances and implications of

regulations increases as well. NMFS/Alaska Region enforcement maintains approximately 36 agents and officers stationed in nine Alaskan ports for monitoring groundfish landings: Juneau, Anchorage, Dutch Harbor, Homer, Ketchikan, Kodiak, Petersburg, Seward, and Sitka. In addition, enforcement personnel regularly travel to other Alaskan ports to monitor landings and conduct investigations. Enforcement personnel associated with NMFS Northwest Region assist in the monitoring of Alaska Region groundfish harvest, primarily individual fishing quota (IFQ) sablefish, landed at ports in the Northwest Region. Also, USCG personnel conduct enforcement activities, monitor vessel activity, conduct at-sea boardings and aircraft overflights, and assist NMFS enforcement personnel in monitoring dockside landings.

A key component of management and enforcement is education and outreach. Complex management programs are accompanied by a regulatory structure that can be difficult for the fishing industry to understand and comply with. This is exacerbated when regulations change rapidly. When fishermen believe that regulations are unduly burdensome or unnecessary, they are less likely to comply voluntarily. Thus, successful implementation of the regulations is dependent on outreach programs that explain the goal of regulations and why they are necessary. NMFS Management, NMFS Enforcement, and the USCG all conduct extensive outreach and education programs that seek not only to explain the regulations, but to help the fishing industry understand the rationale for those regulations.

6.2.1 Expected Costs of Groundfish Management

Estimates of the costs of BSAI and GOA groundfish management are summarized in Table 6-1 below. For reasons discussed in the table, it has not been possible to make accurate estimates of exact expenditures on groundfish management, nor, in some cases, to distinguish between the two groundfish fisheries. An examination of the Table 6-1 suggests that the GOA and BSAI groundfish fisheries appear to cost the U.S. in excess of $60 million, annually, in management and related research efforts. A larger share of this appears to be spent in the BSAI than the GOA.

A comparison of the costs reported in this section with estimates of revenues generated by the groundfish fisheries does not constitute a cost-benefit analysis of this management effort. There are a number of reasons for this:

- The gross revenues from fishing are not a measure of the value of the commercial groundfish fisheries. On one hand, they ignore the private costs (the opportunity costs of labor and capital) used to catch and process the fish resources. On the other hand, they ignore the appropriate measure of benefits to consumers - the “consumers’ surplus” or the value that consumers would be willing to pay for consuming the fish, over and above what they actually have to pay.
- Management costs are only imperfectly identified. Many costs are incurred for multiple purposes, and it is difficult to determine what costs were incurred for which function. Research into ecosystem dynamics may support groundfish management, as well as many other goals. Agency staff often had difficulty determining what portion of an agency budget was spent on groundfish management; staff were often unable to make the even more detailed cost assignment to GOA or BSAI management. This is a problem inherent in the nature of the joint or fixed costs that are often involved. There often simply is no logical way to make these allocations. Even when cost estimates are provided, they are generally very rough approximations.
- The comparison would imply that the management activity was related to the revenues in a specific way. However, specific causal relationships have not been analyzed here. Moreover, even if a causal relationship were implied, it would only be an evaluation of whether or not management at the given level had higher benefits than costs. It would not involve an evaluation

of alternative approaches or levels of management. It would thus be of very limited use for policy decisions.

- The BSAI and GOA groundfish fisheries produce a range of social and ecological services beyond the commercial production and consumption of groundfish products. Groundfish support sport and subsistence fisheries and are an integral part of the North Pacific ecosystem. For example, groundfish provide forage for other fish species, seabirds, and marine mammals. The commercial values above only represent one "use" of the groundfish resources.

Table 6-1 presents the estimated cost of groundfish fishery management in a "typical" year in the period 2002-2006. Often the cost estimates are based on operations in the 2003 Federal year, the most recently completed fiscal year at the time the estimates were completed (May 2004). In some instances they incorporate projections; for example, the estimates for the NMFS Alaska Region's Restricted Access Management Program are estimates of anticipated costs following implementation of the new Crab Rationalization Program. Almost all of the agencies listed here have multiple functions. Often an activity - such as a Coast Guard patrol - will carry out a wide range of tasks in addition to supporting groundfish management. It has therefore often been impossible for agency staff to separate groundfish management costs from overall expenditures, or to separate out GOA and BSAI groundfish management expenditures from groundfish expenditures. Where agency staff did not feel they had a basis on which to make an estimate, no estimate has been provided. In general, estimates are provided to the hundred thousand dollar level. This convention may reasonably approximate costs in some instances where budgets are relatively small and well defined criteria exist for making estimates. In other instances, the reader should be aware that they may provide an undue sense of precision. In general, these estimates are very rough.

The general procedure has been to get budget information from the various departments and to allocate that to groundfish, GOA groundfish, and BSAI groundfish drawing on agency expertise. There are a number of problems inherent with this process. Many activities produce multiple outcomes and it is difficult or impossible to assign their costs to one of those outcomes. Often there is no clear bright line between fishery management activities and other activities. In many cases, the appropriate criteria for allocating costs to one activity or another were not well defined. Much of this analysis depends on the judgement of agency analysts, and the use of different analysts for each agency means that differing judgements might have been used by different agencies. For all of these reasons, the reader should be aware that these estimates can only be treated as rough approximations.

Table 6-1 Estimated cost of fishery management by government agencies. Estimates are expressed in millions of dollars. Note: These estimates are rough approximations.

Agency		Function	Overall Alaska region expenditures	Groundfish fisheries	GOA	BSAI
North Pacific Fishery Management Council (Council)		The Council is one of eight regional councils established by the Magnuson Fishery Conservation and Management Act in 1976 (which has been renamed the Magnuson-Stevens Fishery Conservation and Management Act) to oversee management of the nation's fisheries. With jurisdiction over the 900,000 square mile Exclusive Economic Zone (EEZ) off Alaska, the Council has primary responsibility for groundfish management in the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI), including cod, pollock, flatfish, mackerel, sablefish, and rockfish species harvested mainly by trawlers, hook and line longliners and pot fishermen. The Council also makes allocative and limited entry decisions for halibut, though the U.S. - Canada International Pacific Halibut Commission (IPHC) is responsible for conservation of halibut. Other large Alaska fisheries such as salmon, crab and herring are managed primarily by the State of Alaska. The Council budget is about $3 million, annually. Staff reports that groundfish takes about 80% of their effort, with a 1 to 2 ratio of GOA to BSAI concerns.	$3.0	$2.4	$0.8	$1.6
National Marine Fisheries Service (Alaska Region)			Estimates below by division			
	Sustainable Fisheries Division (SFD)	The SFD implements the intent of the Council and NOAA Fisheries approved management programs consistent with the Magnuson-Stevens Act and other applicable law. SFD coordinates with the State of Alaska on the development of management programs, including halibut subsistence, and the International Pacific Halibut Commission on the development of regulations governing the Pacific halibut fishery off Alaska. SFD collects and manages catch data from North Pacific groundfish fisheries, develops and maintains information systems for integrating catch and observer data for estimating species specific total catch and uses those data to manage fisheries in an orderly and safe manner while maintaining harvest amounts within specified total allowable catch and prohibited species catch limits. SFD staff provides current and historic fishery statistics to other government agencies and the public, maintaining the confidentiality of protected statistics; and providing guidance to the Council and other management agencies on implementation and monitoring considerations of proposed management measures. The SFD administers and manages the Western Alaska Community Development Program so that allocations of groundfish, crab, and halibut quotas to the CDQ groups are accomplished consistent with applicable law and are harvested within established administrative and fishery management regulations to provide the maximum economic benefits to western Alaska communities.	$3.6	$2.9	$0.9	$2.0
	Protected Resources Division (PRD)	The PRD is responsible under the Endangered Species Act (ESA) for consultations on Federal actions that may affect listed marine mammal species for which NMFS has trust responsibility. NMFS is also responsible for recovering listed protected species to the point that they are no longer in danger of extinction and may be removed from listing under the ESA.	$2.2	$0.8	No estimate provided	

Agency		Function	Overall Alaska region expenditures	Groundfish fisheries	GOA	BSAI
	Habitat Conservation Division (HCD)	The HCD carries out NOAA Fisheries' statutory responsibilities for habitat conservation in Alaska under the Magnuson-Stevens Fishery Conservation and Management Act, Fish and Wildlife Coordination Act, National Environmental Policy Act, Federal Power Act, and other laws. HCD has two principal programs: identification and conservation of Essential Fish Habitat (EFH) through fishery management, and environmental review of non-fishing activities that may adversely affect EFH or other habitats for living marine resources. HCD also supports habitat restoration projects in conjunction with the NOAA Fisheries Restoration Center. HCD has staff located in the Alaska Regional Office in Juneau and a field office in Anchorage.	$1.6	$0.4	$0.2	$0.2
	Restricted Access Management (RAM)	RAM implements the Alaska Region's licensing and permitting programs. Specific duties within that broad mandate include calculation and issuance of Individual Fishing Quota (IFQ) permits in the halibut and sablefish IFQ program, together with annual issuance of related permits and licenses, cost recovery activities mandated by the Magnuson-Stevens Act, and determinations on applications for transfers, hired skippers, and other program elements. Additionally, RAM oversees implementation of several other licensing programs, including the North Pacific groundfish and crab License Limitation program (LLP), the Federal Fisheries and Processing Permit program, and vessel, processor, and cooperative permitting under the American Fisheries Act . During FY03, RAM assumed responsibilities for implementation of the subsistence halibut program.	$1.9	$0.4	$0.3	$0.1
	Other NMFS-AKR organizational units: Regional Directorate, Operations, Management & Information	Fulfills a variety of Regional leadership & coordination roles. Includes: workload competence, quality, and management. IT support, grants administration, administrative appeals. Finance & logistical support. NEPA coordination & compliance, preparation of NEPA, E.O. 12866, and Reg Flex analyses for other divisions.	$6.2	$3.5	$1.0	$2.5
	Grants administered by the Alaska Region	The Alaska Region dispenses millions of dollars in grants for fishery management administration and research. Grants to the State of Alaska to assist with groundfish related activity are discussed below, under the line for the State of Alaska. In general, there are few other funds distributed for groundfish related projects. Considerable funding is used for marine mammal related projects, and in recent years large sums have been dispensed for Steller sea lion (SSL) research. In FY 2003, total marine mammal related grants were about $13 million, of which about $11 million were for SSL research. While much of this marine mammal work will have implications for groundfish management, it serves many other purposes as well, and cannot be considered primarily a groundfish management cost item. It is therefore not listed in the summary columns.	Grants to the state are described below. No additional significant grants specifically for groundfish.			
Alaska Fisheries Science Center (AFSC)			Estimates below by division			
	Resource Assessment and Conservation Engineering Division (RACE)	The RACE Division conducts fishery surveys to measure the distribution and abundance of approximately 40 commercially important fish and crab stocks in the eastern Bering Sea, Gulf of Alaska, and marine waters off California, Oregon, and Washington. Data derived from these surveys are analyzed by Center scientists and supplied to fishery management agencies and to the commercial fishing industry.	$17.7	$13.6	$5.8	$7.8

Agency		Function	Overall Alaska region expenditures	Groundfish fisheries	GOA	BSAI
	Resource Ecology and Fisheries Management (REFM)	The REFM Division conducts research and data collection to support management of Northeast Pacific and eastern Bering Sea fish and crab resources. Groundfish and crab stock assessments are developed annually and used by the Pacific and North Pacific Fishery Management Councils to set catch quotas (based on assessments). Division scientists also evaluate how fish stocks and user groups might be affected by fishery management actions.	$11.2	$10.7	$3.2	$7.5
	Auke Bay Lab (ABL)	ABL has housed federal fisheries research in Alaska since 1960. The laboratory is located 12 miles north of Juneau and consists of six research programs.	$12.0	$3.9	$2.9	$1.0
NOAA Office of General Counsel - Alaska Region		The NOAA General Counsel serves as the chief legal officer for the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. The position of the NOAA General Counsel was established in section 2(e)(1) of Reorganization Plan No. 4 of 1970 that created NOAA. The General Counsel is appointed by the Secretary of Commerce, with the approval of the President. The Office of the General Counsel provides legal service and guidance for all matters that may arise in the conduct of NOAA's missions. The Office of the Alaska Regional Counsel (GCAK)s co-located with the Alaska Region of the NOAA National Marine Fisheries Service (NMFS) in Juneau, Alaska. GCAK provides legal advice and assistance on issues related to the administration of NOAA programs in Alaska.	$2.0	No estimates provided		
NOAA Office of Law Enforcement - Alaska Region		NOAA Fisheries Office for Law Enforcement is dedicated to the enforcement of laws that protect and conserve our nation's living marine resources and their natural habitat. NOAA Fisheries special agents and enforcement officers have specified authority to enforce over 100 legislative acts under 32 statutes, as well as numerous treaties related to the conservation and protection of marine resources and other matters of concern to NOAA. These are projected FY2004 costs. They do not include costs of sablefish IFQ enforcement. IFQ halibut and IFQ sablefish enfrorcement were so interlinked, staff was unable to break out the costs. Total IFQ enforcement expenditures were projected to be $1.73 million.	$5.0	$2.4	$1.8	$0.6
United States Coast Guard - 17th District (USCG)		The Coast Guard supports the groundfish fisheries by providing at-sea enforcement of all domestic fishery regulations. The numbers provided cannot capture the accurate cost of domestic fishery enforcement. Because all Coast Guard ships and aircraft are multi-mission platforms, counting all fishery resources hours expended will overestimate the cost. The Coast Guard does not conduct patrols that strictly examine fishery regulations nor does any boarding conducted by the Coast Guard look only for compliance with fishery regulations. All federal laws and regulations are enforced on every boarding. Because of that, the true cost of at-sea enforcement is something less than the number provided but a more accurate number is intangible. Many of the resource hours used to build these numbers would have been conducted in the absence of FMP requirements for enforcement. Such patrols would enforce safety regulations and/or drug laws, and interdict alien migration. Currently all of these are being enforced concurrently with fishery regulations. The numbers provided include resources from the Coast Guard budget in Alaska and the Pacific Area headquarters budget. This is necessary because some Coast Guard ships patrolling in Alaska come from the lower 48 or Hawaii, and are not funded from the Alaskan Coast Guard budget. The numbers are therefore not conducive to comparing amount spent on enforcement in Alaska to overall the Coast Guard budget in Alaska.		< $40.2	< $13.9	< $26.3

Agency	Function	Overall Alaska region expenditures	Groundfish fisheries	GOA	BSAI
Alaska Department of Fish and Game (ADF&G)	The groundfish fisheries in the EEZ are a source of jobs and income for many residents of Alaska; groundfish stocks and fishing operations move across the line dividing state from federal jurisdiction; a large proportion of groundfish harvests from the EEZ are delivered to state ports and are recorded on state fish landings records. For all these reasons, the State of Alaska has a significant role in the management of groundfish stocks and fisheries in the EEZ. The state spends money to support the Council process. State managers are particularly important in the management of the demersal shelf rockfish fishery in the eastern GOA. The state spends money on port sampling of groundfish landings, collecting landings records, and data processing and analysis of landings records. The Alaska Board of Fisheries interacts with the Council and considers management proposals to better coordinate federal and state regulations. State ADF&G offices provide local sources of information on EEZ management rules for the public. A significant part of the state's contribution is supported with federal funding. The figure for groundfish represents the value of federal grants awarded to the state. This understatesADF&G expenditures.		>$2.5	No estimates provided	
Other agencies of the State of Alaska	The Alaska Commercial Fisheries Entry Commission processes landings records and Commercial Operators' Annual Reports reports and is an important source for price information for shoreside landings; the Alaska Department of Commerce monitors CDQ group activity and is involved in the process of allocating CDQ among the groups; the Alaska Division of Measurement Standards checks scales for shoreside plants.	No estimate provided			
Fish and Wildlife Service (USFWS)	A representative of the USFWS serves on the Council and on the Ecosystem and Steller Sea Lion Mitigation committees. The USFWS is also represented on the Groundfish Planning Team. USFWS seabird and marine mammal expertise help provide a broader ecological perspective on fisheries management. In addition to long-term seabird and marine mammal population monitoring programs in the GOA and BSAI, USFWS staff are actively engaged with industry and NMFS to develop strategies and technologies to reduce the incidental take of seabirds in groundfish fisheries.	No estimate provided			
Alaska Fisheries Information Network (AKFIN)	AKFIN is a cooperative data program of the Pacific States Marine Fishery Commission, Alaska Department of Fish and Game, Commercial Fisheries Entry Commission, North Pacific Fisheries Management Council, and NOAA. AKFIN transfers, analyzes, and processes agency fishery data for reporting. AKFIN integrates and aggregates all state and federal harvest and value to produce data sets for FMP analyses and reports such as *Fisheries of the US.*	$0.8	$0.7	$0.4	$0.3

Agency	Function	Overall Alaska region expenditures	Groundfish fisheries	GOA	BSAI
North Pacific Research Board (NPRB)	The NPRB's mission is to develop a comprehensive science program of the highest caliber to enhance understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems and fisheries. It conducts its work through science planning, prioritization of pressing fishery management and ecosystem information needs, coordination and cooperation among research programs, competitive selection of research projects, increased information availability, and public involvement. The NPRB will seek to avoid duplicating other research. The NPRB expects to support $5 to $6 million in new research each year. Its annual administrative budget is about $0.85 million budget. The groundfish estimate includes NPRB 2003 expenditures for groundfish projects already funded, matching funds provided by grantees, and a third of the agency's annual budget. Costs associated with the NPRB may also be reflected in budgets for other agencies. For example, the ABL has used funds from the NPRB for Aleutian Islands coral investigations. The NPRB reports the $0.8 was expended on this project in 2003, and that there were $0.3 in matching funds.		$5.5	Not estimated	
Costs incurred by the private sector	The private sector incurs costs that could fairly be described as management costs. These include the costs of the paperwork associated with the management system, the private costs associated with the observer program, the costs of operating various cooperative or CDQ catch management programs, and the costs of participating in the Council and regulatory processes[1].	for paperwork: for observers:	$3.7 >$10.8	> $1.1	> $9.7

[1] The line between the costs of management and the costs associated with advocacy in the Council process, or with the normal management of an independent business, can be hard to draw. Some of the more important components of this cost item include:

- Costs incurred by private citizens, fisheries organizations, environmental organizations, and other private parties for participation in the Council process.
- Costs of meeting observer requirements (about $10.8 million per year - using 2002 observer days and a cost of $365/day). These provide a low estimate of the total cost of the observer program to fishing operations because fishing operations incur economic and operational impacts that are not directly reflected in the money they must spend on observer coverage. Fishing vessel operators may have to alter their travel plans and schedules to pick up or drop off observers; the observers take up limited space on vessels. Provisions must be made to accommodate the necessary work of the observer on deck (e.g., observing gear setting and retrieval, recording and sampling of catch and bycatch). The observer also occupies "living space" aboard, which otherwise could have housed additional crew members. These operational impacts may be reflected in both increased operating expenses and reduced harvests and revenues. It is not possible, with available information, to quantify these effects, but they may represent a substantial additional cost of operation.
- CDQ groups have significant responsibilities for managing target and non-target quotas. This quota management function may involve personnel and data processing contracts. AFA cooperatives similarly are involved in quota management.
- CDQ groups and AFA cooperatives, and other fishermen, contract with private firms to provide fishing companies with rapidly updated information about the location of PSC bycatch hotspots. Fishing companies are then able to alter their fishing behavior so as to avoid areas with high PSC bycatch. By reducing PSC bycatch, companies are able to extend fishing seasons and avoid other constraints on fishing activity.
- NMFS collects fees from fishermen to offset the costs of managing sablefish IFQ programs. In 2003, NMFS collected an estimated $1.0 million in sablefish cost recovery fees. These costs are already reflected in NMFS spending described above, and should not be counted a second time. However, they do represent a management cost incurred by industry, and are reported here to capture this distributive effect.

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Fishery Management Plan for Gulf of Alaska Groundfish

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Appendix A History of the Fishery Management Plan

The Fishery Management Plan (FMP) for Groundfish of the Gulf of Alaska (GOA) was implemented on December 1, 1978. Since that time it has been amended over sixty times, and its focus has changed from the regulation of mainly foreign fisheries to the management of fully domestic fisheries. The FMP was substantially reorganized in Amendment 75. Outdated catch data or other scientific information, and obsolete references, were also removed or updated.

Section A.1 contains a list of amendments to the FMP since its implementation in 1978. A detailed account of each of the FMP amendments, including its purpose and need, a summary of the analysis and implementing regulations, and results of the amendment, is contained in Appendix D to the *Final Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries*, published by National Marine Fisheries Service (NMFS) in 2004.

A.1 Amendments to the FMP

Amendment 1 on December 1, 1978:

1. Extended OYs, DAH, TALFF to October 31, 1979.
2. Changed fishing year to November 1 - October 31.

Amendment 2 on January 1, 1979:

Allowed directed foreign longline fishery for Pacific cod west of 157° W outside of 12 miles year-round.

Amendment 3 on December 1, 1978:

1. Established special joint venture reserve wherein TALFF = 0.8 OY - DAH - JVP.
2. Specified that allocations will be reevaluated on January 1, 1979 and reapportioned if necessary.

Amendment 4 on August 16, 1979:

1. Allowed foreign fishing beyond 3 miles between 169° and 170° W.
2. Removed prohibition on taking more than 25% TALFF during December 1 to May 31.
3. Allowed foreign longlining for sablefish seaward of 400 m from May 1 to September 30 and seaward of 500 m from October 1 to April 30 between 140°and 170° W.
4. Allowed directed Pacific cod longline fishery between 140° and 157° W beyond 12 miles except as prohibited within 400 m isobath during halibut season.
5. Exempted foreign longliners from nationwide closures upon attaining OY if the OY is not for species targeted by longliners.
6. Increased squid OY to 5,000 mt from 2,000 mt.
7. Increased Atka Mackerel OY to 26,800 mt from 24,800 mt.

8. Reduced number of management areas to three from five.
9. Removed domestic one-hour tow restriction on offbottom trawls from December to May.
10. Provided for the annual review of domestic permits and the reporting of catch within 7 days of landing.

Amendment 5 on June 1, 1979:

Established a separate OY for Rattails of 13,200 mt.

Amendment 6 on September 22, 1979:

Released unused DAH to TALFF and reapportioned DAH by regulatory areas.

Amendment 7 on November 1, 1979:

1. Extended plan year through October 31, 1980.
2. Implemented the processor preference amendment wherein
   DAH = DAP + DNP + JVP; Reserve = 20% OY;
   OY = DAH + Reserve + TALFF
3. Provided for review and reapportionment of Reserve to DAH or TALFF on January 2, March 2, May 2, and July 2.
4. Increased Pacific cod OY to 60,000 mt from 34,800 mt.
5. Increased Atka mackerel OY to 28,700 mt from 26,800 mt.
6. Created separate OY for *Sebastolobus* spp. of 3,750 mt.
7. Provided for new domestic reporting requirements to increase accuracy of forecasting U.S. fishing activity.

Amendment 8 on November 1, 1980:

1. Changd plan year to calendar year and eliminated expiration date.
2. Distributed OYs for squid, 'Other species', *Sebastolobus* spp., and 'Other rockfish' Gulfwide.
3. Established four species categories: Unallocated, Target, Other species and Non-specified.
4. Divided Eastern Regulatory Area into Yakutat, Southeast Inside and Outside for sablefish only.
5. Set a reserve release schedule of 40% in April, 40% in June, and 20% in August.
6. Required biodegradable panels in sablefish pots.

Amendment 9 on October 2, 1981:

Established Lechner Line around Kodiak which is closed from two days before king crab season to February 15.

Amendment 10 on June 1, 1982:

1. Closed area east of 140° W to all foreign fishing.
2. Deleted U.S. sanctuaries east of 140° W as not necessary.
3. Permitted foreign mid-water trawling only, year-round between 140° and 147° W.
4. For POP in the Eastern Regulatory Area: reduced ABC to 875 mt from 29,000 mt, let OY = ABC, DAH = 500 mt, TALFF = 200 mt, and Reserve = 175 mt.

Amendment 11 on October 16, 1983:

1. Increased pollock OY in Central Gulf to 143,000 mt from 95,200 mt.
2. Established a new management objective for sablefish: sablefish in the Gulf of Alaska will be managed Gulfwide to benefit the domestic fishery.
3. Divided the Yakutat district into two sablefish management districts: Western Yakutat and Eastern Yakutat.
4. Set sablefish OY equal to ABC. ABC set at 75% of EY to promote stock rebuilding. Gulfwide OY is 8,230-9,478 mt, of which 500 mt is in State internal waters of Southeast.
5. Specified that DAH will be determined annually based on previous year's domestic catch, plus amounts necessary to accommodate projected needs of the domestic fishery reserves and unneeded DAH can be apportioned as needed.
6. Granted field order authority for Regional Director to adjust time and/or area restrictions on foreign fisheries for conservation reasons.
7. Placed radio/telephone catch reporting requirements on domestic vessels leaving State waters to land fish outside Alaska.

Amendment 12 (withdrawn)

Amendment 13 on August 13, 1984:

Combined Western and Central areas for pollock management and set a combined OY of 400,000 mt (follow up to emergency regulations passed in December 1983 and May 1984).

Amendment 14 on November 18, 1985:

1. Established gear/area restrictions and Optimum Yield (OY) apportionments to specific gear types for sablefish.
2. Established a Central Southeast Outside District with a 600 mt OY for demersal shelf rockfish.
3. Reduced pollock OY in the combined Western/Central Regulatory Area from 400,000 mt to 305,000 mt.
4. Reduced Pacific Ocean perch OY in the Western and Central Regulatory Areas from 2,700 mt and 7,900 mt to 1,302 mt and 3,906 mt, respectively.
5. Reduced Gulfwide ‘Other Rockfish’ OY from 7,600 mt to 5,000 mt.
6. Reduced Atka mackerel OY in the Central and Eastern Regulatory Areas from 20,836 mt and 3,186 mt to bycatch levels only of 500 mt and 100 mt, respectively.
7. Reduced Gulfwide ‘Other species’ OY to the framework amount of 22,460 mt.
8. Established catcher/processor reporting requirements.
9. Implemented a framework procedure for setting and adjusting halibut PSC limits.
10. Implemented NMFS Habitat Policy.
11. Set season for hook and longline and pot sablefish fishery.

Amendment 15 on April 8, 1987:

1. Revised and expanded management goals and objectives.
2. Established a single OY range and an administrative framework procedure for setting annual harvest levels for each species category.
3. Established framework procedures for setting PSCs for fully utilized groundfish species applicable to joint ventures and foreign fisheries.

4. Revised reporting requirements for domestic at-sea processors.
5. Established time/area restrictions on non-pelagic trawling around Kodiak to protect king crab for three years, until December 31, 1989.
6. Established authority for Regional Director to make inseason adjustments in the fisheries.

Amendment 16 on April 7, 1988:

1. Revised definition of "prohibited species" (to include with Council approval of an identical definition in the Bering Sea/Aleutian Islands FMP).
2. Updated the plan's descriptive sections, reorganized chapters, and incorporated current Council policy.
3. Revised reporting requirements to include maintenance of at-sea transfer logs by catcher/processing vessels.

Amendment 17 on May 26, 1989:

Required all processing vessels receiving fish caught in the EEZ to report to NMFS when fishing for or receiving groundfish will begin or cease, and to submit to NMFS weekly catch/receipt and product transfer reports.

Amendment 18 on November 1, 1989:

1. Established a procedure for annually setting fishing seasons using a regulatory amendment for implementation.
2. Established a Shelikof District in the Central Regulatory Area.
3. Continued the Type I and II trawl closure zones and added a Type III trawl closure zone around Kodiak Island to protect king and Tanner crab. This measure sunsets December 31, 1992.
4. Suspended the halibut PSC framework for 1990 only, substituting 2,000 mt trawl and 750 mt fixed gear halibut PSC caps; halibut PSC framework, including halibut PSC apportionments by gear type, to be reinstituted January 1, 1991 by regulatory amendment.
5. Implemented an observer program.
6. Implemented a revised recordkeeping and data reporting system.
7. Clarified the Secretary's authority to split or combine species groups within the target species management category by a framework procedure.

Amendment 19 on November 15, 1990:

1. Prohibited the practice of pollock roe-stripping (defined as the taking of roe from female pollock and the subsequent discard of the female carcass and all male pollock).
2. Divided the pollock total allowable catch (TAC) into equal quarterly allowances in the Western and Central Gulf regulatory areas.

Amendment 20 approved by the Secretary on January 1, 1991:

I.1.1 Established an IFQ program for directed fixed gear sablefish fisheries in the GOA.

Amendment 21 on January 18, 1991:

1. Amended the definition of overfishing.

2. Established interim harvest levels until superseded by publication of final groundfish specifications in the Federal Register.
3. Provided limited authority to the State of Alaska to manage the demersal shelf rockfish fishery with Council oversight.
4. Provided for legal fishing gear to be defined by regulatory amendment.
5. Clarified and expanded the existing framework for managing halibut bycatch, including the adoption of an incentive program to impose sanctions on vessels with excessively high halibut bycatch rates. The vessel incentive program originally adopted by the Council was disapproved by the Secretary. The Council adopted a revised incentive program which was submitted on November 30, 1990 to the Secretary for review and approval.

Amendment 22 on April 24, 1992:

1. Authorize the NMFS Regional Director to approve experimental fishing permits after consultation with the Council.
2. Rescind Gulf of Alaska reporting area 68 (East Yakutat Area) and combine it with Area 65 (Southeast Outside).
3. Require groundfish pots to be identified by some form of tag (regulatory amendment).

Amendment 23 on June 1, 1992:

1. For the GOA, 90 percent of the Pacific cod TAC and 100 percent of the pollock TAC for each fishing year, is proposed to be allocated to the inshore component of the groundfish fishery. Ten percent of the Pacific cod TAC, and an appropriate percentage of the pollock TAC for bycatch purposes, is proposed to be allocated to the offshore component.

Amendment 24 on September 23, 1992:

1. Establish hot spot authority in the GOA that parallels a revised hotspot in the BS/AI. Establish time/area closures to reduce bycatch rates of prohibited species.
2. Expand the Vessel Incentive Program (VIP) to include all trawl fisheries in the GOA. The new incentive program will include chinook salmon as well as halibut (regulatory amendment).
3. Delay opening of all trawl fisheries in the GOA until January 20. The opening date for non-trawl fisheries, including hook and line, pot and jigging, will continue to be January 1. Delay the GOA rockfish opening date by six months until the beginning of the third quarter (regulatory amendment).
4. The fishery definitions for both the Vessel Incentive Program and the PSC allowance limits would be the same. The definitions of fisheries for these programs would be: Mid-water pollock if pollock is $\geq$ to 95% of the total catch, and other target fisheries would be determined by the dominate species in terms of retained catch (regulatory amendment).

Amendment 25 on January 19, 1992:

1. Establish new districts in the combined Western and Central Regularatory Area for purposes of managing pollock. Three new management districts in the combined W/C Regulatory Area are established and the existing Shelikof Strait management district would be removed. The W/C Areas are combined into three districts by dividing it at 154° and 159° W. longitudes.
2. Limit the maximum amount of any quarterly pollock TAC allowance that may be carried over to subsequent quarters to 150 percent of the initial quarterly allowance.

3. Prohibit trawling year round in the Gulf of Alaska within 10 nautical miles of 14 Steller sea lion rookeries.

Amendment 26 on December 17, 1992:

Reinstate King Crab Protective Zones around Kodiak Island on a permanent basis.

Amendment 27 on January 22, 1993:

Establish legal zones for trawl testing when fishing is otherwise prohibited.

Amendment 28, implemented on August 10, 1995 and effective on September 11, 1995:

Created a moratorium on harvesting vessels entering the BSAI groundfish fisheries other than fixed gear sablefish after January 1, 1996. The vessel moratorium will last until the Council replaces or rescinds the action, but in any case will end on December 31, 1998. The Council extended the moratorium to January 1, 1999 under Amendment 59. The Council may however extend the moratorium up to 2 additional years, if a permanent limited access program is imminent.

Amendment 29 implemented on July 24, 1996:

Established a Salmon Donation Program that authorizes the voluntary retention and distribution of salmon taken as bycatch in the groundfish trawl fisheries off Alaska to economically disadvantaged individuals.

Amendment 30 implemented on October 6, 1994, superceded Amendments 13 and 18, repealed and replaced by Amendment 47:

Implemented language changes to the Fishery Management Plans to indicate that observer requirements under the FMPs are contained in the North Pacific Fisheries Research Plan.

Amendment 31 implemented October 18, 1993:

Created a separate target category for Atka mackerel in the FMP.

Amendment 32 implemented March 31, 1994:

Established a procedure for deriving the annual GOA TACs for POP. POP stocks are considered to be rebuilt when the total biomass of mature females is equal to, or greater than, B_{MSY}.

Amendment 33 was withdrawn.

Amendment 34 implemented September 23, 1994.

Corrected the inadvertant inclusion of the Community Development Quota program in the FMP by removing and reserving section 4.4.1.1.8 on “Community Development Quotas”.

Amendment 35 implemented on November 7, 1994, revised Amendment 20:

Implemented the Modified Block plan to prevent excessive consolidation of the halibut and sablefish fisheries, and clarifies the transfer process for the IFQ program.

Amendment 36 implemented on February 23, 1996, revised Amendment 20:
Established a one-time transfer of halibut and sablefish IFQ for CDQ.

Amendment 37 implemented on July 26, 1996, revised Amendment 20:
Allowed freezing of non-IFQ species when fishing sablefish IFQ.

Amendment 38 implemented on September 25, 1996, revised Amendment 32:

Revised the rebuilding plan formula for setting TAC for Pacific ocean perch to allow the Council to recommend a POP TAC at or below the amount dictated by the formula.

Amendment 39 implemented on April 16, 1998:
Defined a forage fish species category and authorized that the management of this species category be specified in regulations in a manner that prevents the development of a commercial directed fishery for forage fish which are a critical food source for many marine mammal, seabird and fish species.

Amendment 40 implemented on January 1, 1996, superceded Amendment 23:
Extended provision of Amendment 23, inshore/offshore allocation.

Amendment 41, implemented on January 1, 1999, except for some parts on January 1, 2000:

1. Created a license program for vessels targeting groundfish in the GOA, other than fixed gear sablefish that is pending regulatory implementation. The license program will replace the vessel moratorium and will last until the Council replaces or rescinds the action.

Amendment 42 implemented on August 16, 1996, revised Amendment 20
Increased sweep-up levels for small quota share blocks for sablefish managed under the sablefish and halibut IFQ program.

Amendment 43 implemented on December 20, 1996, revised Amendment 20:
Established sweep-up provisions to consolidate very small quota share blocks for halibut and sablefish.

Amendment 44 implemented on January 9, 1997, revised Amendment 21:
Established a more conservative definition of overfishing.

Amendment 45 implemented May 30, 1996:

Authorized the combining of the third and fourth quarter seasonal allowances of pollock TAC for the combined Western/Central Regulatory areas.

Amendment 46 implemented April 6, 1998:

Removed black and blue rockfishes from the FMP.

Amendment 47 was withdrawn

Amendment 48 was approved by the Council in October, 2003:
Revised the Total Allowable Catch specifications process, and changed the title of the FMP.

Amendment 49 implemented on January 3, 1998:

Implemented an Increased Retention/Increased Utilization Program for pollock and Pacific cod beginning January 1, 1998 and shallow water flatfish beginning January 1, 2003.

Amendment 50 implemented on July 13, 1998, revised Amendment 29:

Established a Prohibited Species Donation Program that expands the Salmon Donation Program to include halibut taken as bycatch in the groundfish trawl fisheries off Alaska to economically disadvantaged individuals.

Amendment 51 was partially implemented on January 20, 1999, superceded Amendment 40:

Extended the Inshore/Offshore allocation established with Amendment 23.

Amendment 52 was withdrawn

Amendment 53 was withdrawn

Amendment 54 implemented on April 29, 2002, revised Amendment 20:

Revised use and ownership provisions of the sablefish IFQ program.

Amendment 55 implemented on April 26, 1999:

Implemented the Essential Fish Habitat (EFH) provisions contained in the Magnuson-Stevens Fishery Conservation and Management Act and 50 CFR 600.815. Amendment 55 describes and identifies EFH fish habitat for GOA groundfish and describes and identifies fishing and non-fishing threats to GOA groundfish EFH, research needs, habitat areas of particular concern, and EFH conservation and enhancement recommendations.

Amendment 56 implemented on March 8, 1999, revised Amendment 44:

Revised the overfishing definition.

Amendment 57 implemented on January 19, 1999, superceded Amendment 28:

Extended the vessel moratorium through December 31, 1999.

Amendment 58 implemented on October 24, 2001 and January 1, 2002; superceded Amendment 57:

1. Required that the vessel would be a specific characteristic of the license and could not be severed from it.
2. Authorized license designations for the type of gear to harvest LLP groundfish as either "trawl" or "non-trawl" gear (or both).
3. Rescinded the requirement that CDQ vessels hold a crab or groundfish license.
4. Added a crab recency requirement which requires one landing during 1/1/96-2/7/98 in addition to the general license and area endorsement qualifications.
5. Allowed limited processing (1 mt) for vessels <60' LOA with catcher vessel designations.

Amendment 60 implemented on December 27, 2002.

Prohibited bottom trawling in Cook Inlet.

Amendment 61 implemented on January 21, 2000:

Conformed the FMP with the American Fisheries Act (AFA) of 1998 that established sideboard measures to protect non-AFA (non-pollock) fisheries from adverse impacts resulting from AFA.

Extended the inshore/offshore allocations for the GOA.

Amendment 62 is pending

Amendment 63 is pending

Amendment 64 implemented in 2003:
Changed recordkeeping and reporting requirements for the IFQ program.

Amendment 65 was withdrawn

Amendment 66 implemented 2004:
Established a community quota share purchase program for the IFQ sablefish fishery.

Amendments 67-69 are not assigned

Amendment 70 was withdrawn

Amendment 71 is unassigned

Amendment 72 is pending

Amendment 73 is pending

Amendment 74, implemented in 2004:
Revised management policy.

Amendment 75, is pending
Housekeeping amendment to reorganize and update the FMP.

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Appendix B Geographical Coordinates of Areas Described in the Fishery Management Plan

This appendix describes the geographical coordinates for the areas described in the Fishery Management Plan (FMP). This appendix divides the descriptions into two types: Gulf of Alaska (GOA) management area, regulatory areas, and districts (Section B.1), and closed areas (Section B.2).

B.1 Management Area, Regulatory Areas and Districts

Management Area

The GOA management area encompasses the United States (U.S.) exclusive economic zone (EEZ) of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170° W. longitude and Dixon Entrance at 132°40' W. longitude.

Regulatory Areas

Three regulatory areas are described in Section 3.1 of the FMP and are defined as follows:

Eastern regulatory area:	That part of the GOA management area that is west of 147° W. longitude.
Central regulatory area:	That part of the GOA management area that is east of 147° W. longitude and west of 159° W. longitude.
Western regulatory area:	That part of the GOA management area that is east of 159° W. longitude and west of 170° W. longitude.

Districts

The Central regulatory area is divided into two districts, defined as follows:

Chirikof District:	That part of the Central regulatory area between 154° W. longitude and 159° W. longitude.
Kodiak District:	That part of the Central regulatory area between 147° W. longitude and 154° W. longitude.

The Eastern regulatory area is divided into two districts, defined as follows:

West Yakutat District: That part of the Eastern regulatory area between 140° W. longitude and 147° W. longitude.

Southeast Outside District: That part of the Eastern regulatory area between 132°40' W. longitude and 140° W. longitude, and north of 54°30' N. latitude.

B.2 Closed Areas

Specific areas of the GOA are closed to some or all fishing during certain times of the year and are described in Section 3.5.2 of the FMP.

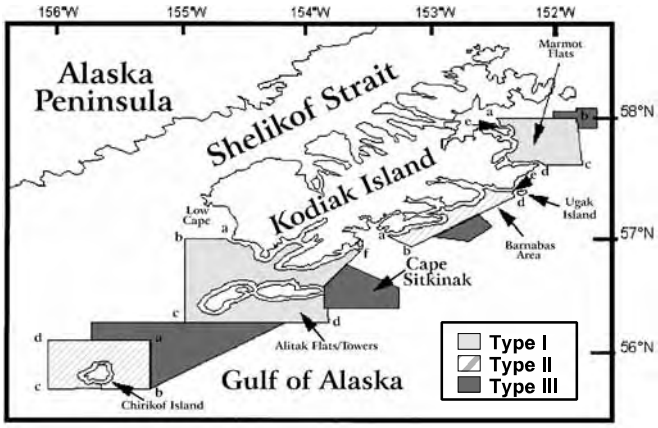
Sitka Pinnacles Marine Reserve

The Sitka Pinnacles Marine Reserve encompasses an area totalling 2.5 square nautical miles off Cape Edgecumbe. Vessels holding a Federal fisheries permit are prohibited at all times from fishing for groundfish or anchoring in the Sitka Pinnacles Marine Reserve. The area is defined by straight lines connecting the following pairs of coordinates in a counter-clockwise manner:

(56°55.5' N.,	135°54.0' W.)
(56°57.0' N.,	135°54.0' W.)
(56°57.0' N.,	135°57.0' W.)
(56°55.5' N.,	135°57.0' W.)

King Crab Closures around Kodiak Island

The reference points described in the Type I and II areas can be found on the Kodiak Island King Crab Closures figure below.



Type I Areas

Alitak Flats and Towers Areas: All waters of Alitak Flats and the Towers Areas enclosed by a line connecting the following 7 points in the order listed:

a	(56°59.4' N.,	154°31.1' W.)	Low Cape
b	(57°00.0' N.,	155°00.0' W.)	
c	(56°17.0' N.,	155°00.0' W.)	
d	(56°17.0' N.,	153°52.0' W.)	
e	(56°33.5' N.,	153°52.0' W.)	Cape Sitkinak
f	(56°54.5' N.,	153°32.5' W.)	East Point of Twoheaded Island
g	(56°56.0' N.,	153°35.5' W.)	Kodiak Island, then along coastline until
a	(56°59.4' N.,	154°31.1' W.)	Low Cape

Marmot Flats Area: All waters enclosed by a line connecting the following five points in the clockwise order listed:

a	(58°00.0' N.,	152°30.0' W.)	
b	(58°00.0' N.,	151°47.0' W.)	
c	(57°37.0' N.,	151°47.0' W.)	
d	(57°37.0' N.,	152°10.1' W.)	Cape Chiniak, then along the coastline of Kodiak Island
e	(57°54.5' N.,	152°30.0 W.)	North Cape
a	(58°00.0' N.,	152°30.0 W.)	

Type II Areas

Chirkof Island Area: All waters surrounding Chirkof Island enclosed by a line connecting the following four points in the counter-clock wise order listed:

a	(56°07' N.,	155°13' W.)
b	(56°07' N.,	156°00' W.)
c	(55°41' N.,	156°00' W.)
d	(55°41' N.,	155°13' W.)
a	(56°07' N.,	155°13' W.)

Barnabas Area: All waters enclosed by a line connecting the following six points in the counter clockwise order listed:

a	(57°00.0' N.	153°18.0' W.)	Black Point
b	(56°56.0' N.	153°09.0' W.)	
c	(57°22.0' N.	152°18.5' W.)	South Tip of Ugak Island
d	(57°23.5' N.	152°17.5' W.)	North Tip of Ugak Island
e	(57°25.3' N.	152°20.0' W.)	Narrow Cape, then along the coastline of Kodiak Island
f	(57°04.2' N.	153°30.0' W.)	Cape Kasick
a	(57°00.0' N.	153°18.0' W.)	Black Point, including inshore waters

Type III Areas

Outer Marmot Bay: All waters bounded by lines connecting the following coordinates in the order listed:

(58°00.0' N., 151°55.4' W.)
(58°02.3' N., 151°55.4' W.)
(58°02.3' N., 151°47.0' W.)
(58°4.53' N., 151°47.0' W.)
(58°4.53' N., 151°35.25' W.)
(57°57.4' N., 151°35.25' W.)
(57°57.4' N., 151°47.0' W.)
(58°00.0' N., 151°47.0' W.)
(58°00.0' N., 151°55.4' W.)

Barnabas: All waters bounded by lines connecting the following coordinates in the order listed:

(57°14.3' N., 152°37.5' W.)
(57°10.0' N., 152°25.3' W.)
(57°02.32' N., 152°35.02' W.), then following the 3 mile limit to
(57°04.25' N., 152°54.15' W.), then following the 3 mile limit to
(57°14.3' N., 152°37.5' W.)

Horse's Head: All waters bounded by lines connecting the following coordinates in the order listed:

(56°49.55' N., 153°36.3' W.)
(56°34.35' N., 153°05.37' W.)
(56°28.35' N., 153°05.37' W.)
(56°28.35' N., 153°52.05' W.), then following the 3 mile limit to
(56°49.55' N., 153°36.3' W.)

Chirikof: All waters bounded by lines connecting the following coordinates in the order listed:

(56°16.45' N., 155°39.0' W.)
(56°16.45' N., 154°11.45' W.)
(55°41.0' N., 155°13.0' W.)
(56°07.1' N., 155°13.0' W.)
(56°07.1' N., 155°39.0' W.)
(56°16.45' N., 155°39.0' W.)

Cook Inlet non-Pelagic Trawl Closure Area

The use of non-pelagic trawl gear in Cook Inlet north of a line extending between Cape Douglas (58°51.10' N. latitude) and Point Adam (59°15.27' N. latitude) is prohibited.

Southeast Outside Trawl Closure

The use of trawl gear in Southeast Outside district (defined under Section B.1 above) is prohibited.

Appendix C Section 211 of the American Fisheries Act

American Fisheries Act, Section 211

SEC. 211. PROTECTIONS FOR OTHER FISHERIES; CONSERVATION MEASURES.

(a) GENERAL. The North Pacific Council shall recommend for approval by the Secretary such conservation and management measures as it determines necessary to protect other fisheries under its jurisdiction and the participants in those fisheries, including processors, from adverse impacts caused by this Act or fishery cooperatives in the directed pollock fishery.

(b) CATCHER/PROCESSOR RESTRICTIONS.

(1) GENERAL. The restrictions in this subsection shall take effect on January 1, 1999 and shall remain in effect thereafter except that they may be superseded (with the exception of paragraph (4)) by conservation and management measures recommended after the date of the enactment of this Act by the North Pacific Council and approved by the Secretary in accordance with the Magnuson-Stevens Act.

(2) BERING SEA FISHING. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) are hereby prohibited from, in the aggregate –

(A) exceeding the percentage of the harvest available in the offshore component of any Bering Sea and Aleutian Islands groundfish fishery (other than the pollock fishery) that is equivalent to the total harvest by such catcher/processors and the catcher/processors listed in section 209 in the fishery in 1995, 1996, and 1997 relative to the total amount available to be harvested by the offshore component in the fishery in 1995, 1996, and 1997;

(B) exceeding the percentage of the prohibited species available in the offshore component of any Bering Sea and Aleutian Islands groundfish fishery (other than the pollock fishery) that is equivalent to the total of the prohibited species harvested by such catcher/processors and the catcher/processors listed in section 209 in the fishery in 1995, 1996, and 1997 relative to the total amount of prohibited species available to be harvested by the offshore component in the fishery in 1995, 1996, and 1997.

(C) fishing for Atka mackerel in the eastern area of the Bering Sea and Aleutian Islands and from exceeding the following percentages of the directed harvest available in the Bering Sea and Aleutian Islands Atka mackerel fishery –

(i) 11.5 percent in the central area; and

(ii) 20 percent in the western area.

(3) BERING SEA PROCESSING. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) are hereby prohibited from –

(A) processing any of the directed fishing allowances under paragraphs (1) or (3) of section 206(b); and

(B) processing any species of crab harvested in the Bering Sea and Aleutian Islands Management Area.

(4) GULF OF ALASKA. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) are hereby prohibited from –

(A) harvesting any fish in the Gulf of Alaska;

(B) processing any groundfish harvested from the portion of the exclusive economic zone off Alaska known as area 630 under the fishery management plan for Gulf of Alaska groundfish; or

(C) processing any pollock in the Gulf of Alaska (other than as by catch in non-pollock groundfish fisheries) or processing, in the aggregate, a total of more than 10 percent of the cod harvested from areas 610, 620, and 640 of the Gulf of Alaska under the fishery management plan for Gulf of Alaska groundfish.

(5) FISHERIES OTHER THAN NORTH PACIFIC. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) and motherships eligible under section 208(d) are hereby prohibited from harvesting fish in any fishery under the authority of any regional fishery management council established under section 302(a) of the Magnuson-Stevens Act (16 U.S.C. 1852(a)) other than the North Pacific Council, except for the Pacific whiting fishery, and from processing fish in any fishery under the authority of any such regional fishery management council other than the North Pacific Council, except in the Pacific whiting fishery, unless the catcher/processor or mothership is authorized to harvest or process fish under a fishery management plan recommended by the regional fishery management council of jurisdiction and approved by the Secretary.

(6) OBSERVERS AND SCALES. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) shall –

(A) have two observers onboard at all times while groundfish is being harvested, processed, or received from another vessel in any fishery under the authority of the North Pacific Council; and

(B) weight its catch on a scale onboard approved by the National Marine Fisheries Service while harvesting groundfish in fisheries under the authority of the North Pacific Council.

This paragraph shall take effect on January 1, 1999 for catcher/processors eligible under paragraphs (1) through (20) of section 208(e) that will harvest pollock allocated under section 206(a) in 1999, and shall take effect on January 1, 2000 for all other catcher/processors eligible under such paragraphs of section 208(e).

(c) CATCHER VESSEL AND SHORESIDE PROCESSOR RESTRICTIONS.

(1) REQUIRED COUNCIL RECOMMENDATIONS. By not later than July 1, 1999, the North Pacific Council shall recommend for approval by the Secretary conservation and management measures to –

(A) prevent the catcher vessels eligible under subsections (a), (b), and (c) of section 208 from exceeding in the aggregate the traditional harvest levels of such vessels in other fisheries under the authority of the North Pacific Council as a result of fishery cooperatives in the directed pollock fisheries; and

(B) protect processors not eligible to participate in the directed pollock fishery from adverse effects as a result of this Act or fishery cooperatives in the directed pollock fishery.

If the North Pacific Council does not recommend such conservation and management measures by such date, or if the Secretary determines that such conservation and management measures recommended by the North Pacific Council are not adequate to fulfill the purposes of this paragraph, the Secretary may

by regulation restrict or change the authority in section 210(b) to the extent the Secretary deems appropriate, including by preventing fishery cooperatives from being formed pursuant to such section and by providing greater flexibility with respect to the shoreside processor or shoreside processors to which catcher vessels in a fishery cooperative under section 210(b) may deliver pollock.

(2) BERING SEA CRAB AND GROUNDFISH.

(A) Effective January 1, 2000, the owners of the motherships eligible under section 208(d) and the shoreside processors eligible under section 208(f) that receive pollock from the directed pollock fishery under a fishery cooperative are hereby prohibited from processing, in the aggregate for each calendar year, more than the percentage of the total catch of each species of crab in directed fisheries under the jurisdiction of the North Pacific Council than facilities operated by such owners processed of each such species in the aggregate, on average, in 1995, 1996, and 1997. For the purposes of this subparagraph, the term facilities means any processing plant, catcher/processor, mothership, floating processor, or any other operation that processes fish. Any entity in which 10 percent or more of the interest is owned or controlled by another individual or entity shall be considered to be the same entity as the other individual or entity for the purposes of this subparagraph.

(B) Under the authority of section 301(a)(4) of the Magnuson-Stevens Act (16 U.S.C. 1851(a)(4)), the North Pacific Council is directed to recommend for approval by the Secretary conservation and management measures to prevent any particular individual or entity from harvesting or processing an excessive share of crab or of groundfish in fisheries in the Bering Sea and Aleutian Islands Management Area.

(C) The catcher vessels eligible under section 208(b) are hereby prohibited from participating in a directed fishery for any species of crab in the Bering Sea and Aleutian Islands Management Area unless the catcher vessel harvested crab in the directed fishery for that species of crab in such Area during 1997 and is eligible to harvest such crab in such directed fishery under the license limitation program recommended by the North Pacific Council and approved by the Secretary. The North Pacific Council is directed to recommend measures for approval by the Secretary to eliminate latent licenses under such program, and nothing in this subparagraph shall preclude the Council from recommending measures more restrictive than under this paragraph.

(3) FISHERIES OTHER THAN NORTH PACIFIC.

(A) By not later than July 1, 2000, the Pacific Fishery Management Council established under section 302(a)(1)(F) of the Magnuson-Stevens Act (16 U.S.C. 1852 (a)(1)(F)) shall recommended for approval by the Secretary conservation and management measures to protect fisheries under its jurisdiction and the participants in those fisheries from adverse impacts caused by this Act or by any fishery cooperatives in the directed pollock fishery.

(B) If the Pacific Council does not recommend such conservation and management measures by such date, or if the Secretary determines that such conservation and management measures recommended by the Pacific Council are not adequate to fulfill the purposes of this paragraph, the Secretary may by regulation implement adequate measures including, but not limited to, restrictions on vessels which harvest pollock under a fishery cooperative which will prevent such vessels from harvesting Pacific groundfish, and restrictions on the number of processors eligible to process Pacific groundfish.

(d) BYCATCH INFORMATION. Notwithstanding section 402 of the Magnuson-Stevens Act (16 U.S.C. 1881a), the North Pacific Council may recommend and the Secretary may approve, under such terms and conditions as the North Pacific Council and Secretary deem appropriate, the public disclosure of any information from

the groundfish fisheries under the authority of such Council that would be beneficial in the implementation of section 301(a)(9) or section 303(a)(11) of the Magnuson-Stevens Act (16 U.S.C. 1851(a)(9) and 1853(a)(11)).

(e) COMMUNITY DEVELOPMENT LOAN PROGRAM. Under the authority of title XI of the Merchant Marine Act, 1936 (46 U.S.C. App. 1271 et seq.), and subject to the availability of appropriations, the Secretary is authorized to provide direct loan obligations to communities eligible to participate in the western Alaska community development quota program established under section 304(i) of the Magnuson-Stevens Act (16 U.S.C. 1855(i)) for the purposes of purchasing all or part of an ownership interest in vessels and shoreside processors eligible under subsections (a), (b), (c), (d), (e), or (f) of section 208. Notwithstanding the eligibility criteria in section 208(a) and section 208(c), the LISA MARIE (United States official number 1038717) shall be eligible under such sections in the same manner as other vessels eligible under such sections.

Appendix D Life History Features and Habitat Requirements of FMP Species

This appendix describes habitat requirements and life histories of the groundfish species managed by this fishery management plan (FMP). Each species or species group is described individually, however, two summary tables that denote habitat associations (Table D-1), biological associations (Table D-2), and reproductive traits (Table D-3) are also provided.

In each individual section, a species-specific tables summarizes habitat. The following abbreviations are used in these habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.

Location

BCH	=	beach (intertidal)
ICS	=	inner continental shelf (1-50 m)
MCS	=	middle continental shelf (50-100 m)
OCS	=	outer continental shelf (100-200 m)
USP	=	upper slope (200-1000 m)
LSP	=	lower slope (1000-3000 m)
BSN	=	basin (>3000 m)
BAY	=	nearshore bays, with depth if appropriate (e.g., fjords)
IP	=	island passes (areas of high current), with depth if appropriate

Water column

D	=	demersal (found on bottom)
SD/SP	=	semi-demersal or semi-pelagic, if slightly greater or less than 50% on or off bottom
P	=	pelagic (found off bottom, not necessarily associated with a particular bottom type)
N	=	neustonic (found near surface)

General

U	=	unknown
NA	=	not applicable

Bottom Type

M	=	mud
S	=	sand
MS	=	muddy sand
R	=	rock
SM	=	sandy mud
CB	=	cobble
G	=	gravel
C	=	coral
K	=	kelp
SAV	=	subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features

UP	=	upwelling
G	=	gyres
F	=	fronts
CL	=	thermo- or pycnocline
E	=	edges

Table D.1a Summary of habitat associations for GOA groundfish (pollock, Pacific cod, sablefish, flatfish).

| | | Life Stage/Activity (A = Adult, J = Juvenile, LJ = Late Juvenile, EJ = Early Juvenile, L = Larvae, E = Eggs) | | |

Table D.1b Summary of habitat associations for GOA groundfish (rockfish, Atka mackerel, squid, 'other species').

		Life Stage/Activity (A = Adult, J = Juvenile, L = Larvae, E = Eggs)																																				
		Pacific ocean perch			Shortraker & rougheye rockfish			Northern rockfish			Dusky rockfish			Yelloweye rockfish			Thornyhead rockfish				Atka mackerel				Squid			Sculpins				Sharks			Skates			Octopus		
		A	J	L	A	J	L	A	J	L	A	J	L	A	L	E	A	J	L	E	A	J	L	E	A	L	E	A	J	L	E	A	J	L	A	J	L	A	J	E
Location	beach (intertidal)																											X	X		X									
	inner Shelf (1-50m)		X	X					X			X									X			X	X	X		X	X	X	X	X	X					X	X	X
	middle Shelf (50-100m)		X	X		X			X			X		X	X		X	X			X				X	X		X	X	X	X	X	X		X	X	X	X	X	X
	outer Shelf (100-200m)	X	X	X	X	X		X	X		X	X		X	X		X	X			X				X	X		X	X	X	X	X	X		X	X	X	X	X	X
	upper Slope (200-1000m)	X	X	X	X			X			X			X	X		X	X							X	X	X	X		X		X	X		X	X	X	X	X	X
	lower Slope (>1000m)			X													X								X	X	X													
	basin (>3000m)			X																					X	X														
	bay/estuarine													X	X																									
	island pass													X	X						X			X																
	not known						X			X			X			X			X	X		X	X											X						
Substrate	mud/clay/silt				X												X	X									X	X	X			X			X			X		
	sand/granule				X												X	X									X	X	X			X			X			X		
	gravel	X	X		X						X	X		X	X	X	X	X			X			X				X	X		X	X			X			X		X
	pebble	X	X		X									X	X		X	X			X			X				X			X	X								X
	cobble	X	X		X			X	X		X	X		X	X	X	X	X			X			X				X			X									X
	boulder		X		X			X	X		X	X		X	X		X	X										X												
	bedrock				X						X			X	X	X	X	X																						
	not applicable			X			X			X			X													X				X		X	X	X						
vegetation	kelp forest																				X			X																
	sea grasses																																							
pelagic domain	near surface																						X			X				X										
	pelagic		X	X						X			X						X	X						X				X		X	X							
	semi-demersal/ semi-pelagic	X	X		X			X	X		X										X				X														X	
	demersal	X												X	X	X	X	X						X			X	X	X		X	X	X		X	X	X	X		X
	not known					X	X					X										X																		
oceanography	upwelling areas	X	X	X																					X	X														
	gyres																																							
	thermo/ pycnocline																																							
	fronts																				X				X	X														
	edges (ice, bathymetric)																				X																			

Table D.1c Summary of habitat associations for GOA groundfish (forage fish species).

		Life Stage/Activity (A = Adult, J = Juvenile, LJ = Late Juvenile, EJ = Early Juvenile, L = Larvae, E = Eggs)																															
		Eulachon				Capelin				Sand lance				Myctophids & Bathylagids				Sand fish				Euphausiids				Pholids and Stichaeids				Gonostomatids			
		A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E
Location	beach (intertidal)					X			X												X					X	X						
	inner Shelf (1-50m)			X		X	X	X		X	X	X	X					X	X														
	middle Shelf (50-100m)	X	X			X	X	X		X	X																						
	outer Shelf (100-200m)	X	X			X																X	X										
	upper Slope (200-1000m)	X	X											X	X							X	X							X			
	lower Slope (>1000m)													X	X							X	X							X			
	basin (>3000m)													X	X							X	X							X			
	bay/estuarine																																
	island pass																																
	not known															X	X			X				X	X			X	X		X	X	X
Substrate	mud/clay/silt				X					X	X							X	X							X	X						
	sand/granule				X	X			X	X	X		X					X	X														
	gravel				X								X																				
	pebble																																
	cobble					X			X												X												
	boulder																				X												
	bedrock																																
	not applicable	X	X	X		X	X	X				X		X	X							X	X							X			
vegetation	kelp forest																									X	X						
	sea grasses																									X	X						
pelagic domain	near surface							X				X												X	X								
	pelagic	X	X	X		X	X					X										X	X	X						X			
	semi-demersal/ semi-pelagic									X	X			X	X																		
	demersal				X				X				X					X	X		X												
	not known															X	X			X								X	X		X	X	X
oceanography	upwelling areas																					X	X										
	gyres																																
	thermo/ pycnocline																																
	fronts					X	X																										
	edges (ice, bathymetric)					X	X															X	X										

Table D.2a Summary of biological associations for GOA groundfish (pollock, Pacific cod, sablefish, flatfish).

Life Stage/Activity
(A = Adult, J = Juvenile, LJ = Late Juvenile, EJ = Early Juvenile, L = Larvae, E = Eggs)

		Walleye pollock				Pacific cod					Sablefish					Yellowfin sole					Greenland turbot					Arrowtooth flounder					Rock sole					Flathead sole					Alaska plaice				Dover sole					Rex sole			
		A	J	L	E	A	LJ	EJ	L	E	A	LJ	EJ	L	E	A	LJ	EJ	L	E	A	LJ	EJ	L	E	A	LJ	EJ	L	E	A	LJ	EJ	L	E	A	LJ	EJ	L	E	A	J	L	E	A	LJ	EJ	L	E	A	J	L	E
feeding type	carnivore	X	X			X	X	X			x	x	x			x	x	x			x	x				x	x	x			x	x	x			x	x	x			x	x			x	x	x			x	x		
	herbivore																																																						
	omnivore																																																						
	planktivore			X					X					x					x					x					x					x					x					x					x				x	
	detritivore																																																						
	not known																						x																																
movements	drift with ocean conditions	X	X	X	X		X	X	X					x	x																								x											x					
	reside in nursery areas									X																																													
	alongshore migrations																																																						
	inshore/ offshore migrations												x			x					x					x					x					x																			
	not known					X					x	x					x	x	x	x		x	x	x	x		x	x	x	x		x	x	x	x		x	x		x	x	x	x	x					x	x	x	x	x
social behavior	solitary																																																						
	schooling	X	X			X																																																	
	shoaling																																																						
	not known			X			X	X	X		X	X	X	X	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x
longevity of life stage	1 day																																																						
	1-30 days				X					X					X			x																																					
	1-12 months			X				X						X			x							x					x					x										x					x						
	1-5 years		X				X					X	X				x						x			x	x	x					x														x	x			x	x		
	5-20 years	X				X										x					x	x									x	x									x	x			x									
	20-50 years										X																																												
	>50 years																																																						
	not known								X										x											x						x	x	x	x	x				x					x				x	x

Table D.2b Summary of biological associations for GOA groundfish (rockfish, Atka mackerel, squid, 'other species').

		Life Stage/Activity (A = Adult, J = Juvenile, L = Larvae, E = Eggs)																																				
		Pacific ocean perch			Shortraker & rougheye rockfish			Northern rockfish			Dusky rockfish			Yelloweye rockfish			Thornyhead rockfish				Atka mackerel				Squid			Sculpins				Sharks				Skates			Octopus		
		A	J	L	A	J	L	A	J	L	A	J	L	A	L	E	A	J	L	E	A	J	L	E	A	L	E	A	J	L	E	A	J	L	E	A	J	E	A	J	E
feeding type	carnivore	X	X		X	X		X			X			X	X		X	X			X	X	X		X			X	X			X	X			X	X		X		
	herbivore																																								
	omnivore																																								
	planktivore			X			X									X								X		X														X	
	detritivore																																								
	not known								X	X		X	X						X	X							X			X	X			X	X						
movements	drift with ocean conditions																																								
	reside in nursery areas																																								
	alongshore migrations																																								
	inshore/ offshore migrations	X																			X				X																
	not known		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
social behavior	solitary																																								
	schooling	X						X						X	X						X																				
	shoaling																																								
	not known		X	X	X	X	X		X	X	X	X	X			X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
longevity of life stage	1 day																																								
	1-30 days																							X																	
	1-12 months			X												X			X				X			X	X														
	1-5 years																				X	X			X														X		
	5-20 years		X						X						X																										
	20-50 years										X																														
	>50 years	X			X			X						X																		X									
	not known					X	X			X		X	X				X	X		X								X	X	X	X		X	X	X	X	X	X		X	X

Table D.2c Summary of biological associations for GOA groundfish (forage fish species).

		Life Stage/Activity (A = Adult, J = Juvenile, LJ = Late Juvenile, EJ = Early Juvenile, L = Larvae, E = Eggs)																															
		Eulachon				Capelin				Sand lance				Myctophids & Bathylagids				Sand fish				Euphausiids				Pholids and Stichaeids				Gonostomatids			
		A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E	A	J	L	E
feeding type	carnivore																	X															
	herbivore																																
	omnivore									X	X															X	X						
	planktivore	X	X	X		X	X	X						X								X	X	X									
	detritivore																																
	not known											X	X		X	X	X		X	X	X							X	X	X	X	X	X
movements	drift with ocean conditions			X				X														X	X	X									
	reside in nursery areas																																
	alongshore migrations																																
	inshore/ offshore migrations	X				X	X																										
	not known		X							X	X	X	X	X	X	X	X	X	X	X	X									X	X	X	X
social behavior	solitary																									X							
	schooling	X	X			X	X																										
	shoaling																					X	X										
	not known			X						X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X	X
longevity of life stage	1 day																																
	1-30 days				X				X																								
	1-12 months																																
	1-5 years	X				X				X																							
	5-20 years																					X				X							
	20-50 years																																
	>50 years																																
	not known		X	X			X	X			X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X

Table D.3 Summary of reproductive traits for GOA groundfish.

	Age at Maturity (years unless indicated)				Fertilization/Egg Development					Spawning behavior						Spawning Season								
	Female		Male																					
	50%	100%	50%	100%	external	internal	oviparous	ovoviviparous	viviparous	batch spawner	broadcast spawner	egg case deposition	nest builder	egg/young guarder	egg/young bearer	early spring	late spring	early summer	late summer	early fall	late fall	early winter	late winter	not known
Walleye pollock	4		4		X						X					X								
Pacific cod	5		5		X					X						X						X	X	
Sablefish	65cm		57cm		X						X					X	X							
Yellowfin sole	10.5				X						X						X	X	X					
Greenland turbot	5-10				X						X									X	X	X	X	
Arrowtooth flounder	5		4		X																			X
Rock sole	9				X					X						X							X	
Flathead sole	6-7				X											X								
Alaska plaice	24cm				X																			
Pacific ocean perch	10.5					X			X												X	X		
Northern rockfish	12.8					X			X								X	X						
Shortraker and rougheye rockfish	20		20			X			X								X	X						
Thornyhead rockfish	12									X						X							X	
Dusky rockfish						X			X								X	X						
Atka mackerel	3		3		X							X	X					X	X					
Squid						X											X	X						
Sculpins					X	X						X	X									X	X	
Sharks						X		X																
Skates						X	X				X													X
Octopus						X																		X
Eulachon	3	5	3	5	X		X			X						X	X							
Capelin	2	4	2	4	X		X			X						X	X	X	X	X				
Sand Lance	2																							X
Myctophids & Bathylagids																								X
Sand fish																								X
Euphausiids	1				X						X					X	X							X
Pholids and Stichaeids	2-4				X									X		X	X					X	X	
Gonostomatids																								X

D.1 Walleye pollock

Pollock occur throughout the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI) FMP management areas and straddle into the Canadian and Russian Exclusive Economic Zones (EEZs), the international waters of the central Bering Sea, and into the Chukchi Sea. The stock that occurs in the management area covered by this FMP is the GOA pollock stock.

D.1.1 Life History and General Distribution

Pollock is the second most abundant groundfish stock in the GOA (after arrowtooth flounder), comprising 25-50% of the catch and 20% of the biomass.

Four stocks of pollock are recognized for management purposes: GOA, eastern Bering Sea, Aleutian Islands, and Aleutian Basin. There appears to be stock separation between the GOA stock and stocks to the north. The most abundant stock of pollock is the eastern Bering Sea stock. The Aleutian Islands stock extends through the Aleutian Islands from 170° W. to the end of the Aleutian Islands (Attu Island), with the greatest abundance in the eastern Aleutians (170° W. to Seguam Pass). The third stock, Aleutian Basin, appears to be distributed throughout the Aleutian Basin which encompasses the U.S. EEZ, Russian EEZ, and international waters in the central Bering Sea.

The GOA stock extends from southeast Alaska to the Aleutian Islands (170° W. longitude), with the greatest abundance in the western and central regulatory areas (147° W. to 170° W. longitude). Most of the information on pollock distribution in the GOA comes from triennial bottom trawl surveys. These surveys indicate that pollock are distributed throughout the shelf regions of the GOA at depths less than 300 m. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls. The principal spawning location is in Shelikof Strait, but data from pollock fisheries and exploratory surveys indicate that there are other concentrations of spawning in the Shumagin Islands, the east side of Kodiak Island and near Prince William Sound.

In the GOA, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area appears to be 2-3 weeks earlier than in Shelikof Strait. Spawning occurs pelagically and eggs develop throughout the water column (150-200 m in Shelikof Strait). Development is dependent on water temperature. Development takes approximately 2 weeks at ambient temperature (5 degrees C). Larvae are distributed in the upper 40 m of the water column. The larvae eat progressively larger naupliar stages of copepods as they grow and then small euphausiids as they approach transformation to juveniles (~25 mm standard length). FOCI survey data indicate larval pollock may utilize the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which reside in the colder bottom water.

The upper size limit for juvenile pollock in the GOA is about 38-42 cm. This is the size of 50% maturity.

GOA Pollock

Age	Mean length (cm)	Mean weight (kg)	Maturity
2	27.7	0.186	3%
3	35.6	0.380	12%
4	41.2	0.579	33%
5	45.3	0.760	64%
6	48.3	0.911	87%
7	50.4	1.033	96%
8	52.0	1.129	99%
9	53.1	1.204	100%
10	54.0	1.261	100%
11	54.6	1.305	100%
12	55.1	1.338	100%
13	55.4	1.253	100%
14	55.7	1.286	100%
15	55.9	1.312	100%

Sources for additional distribution data

Eggs and Larvae:

Art Kendall, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA, 206-526-4108.

Richard Brodeur, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA, 206-526-4318.

Shallow water concentrations:

Bill Bechtol, Alaska Department of Fish and Game, 3298 Douglas Place, Homer, Alaska 99603-8027.

D.1.2 Fishery

Since 1990, the GOA pollock Total Allowable Catch (TAC) has been divided into four regions; the Shumagin International North Pacific Fishery Commission (INPFC) area, the Chirikof INPFC area, the Kodiak INPFC area and the eastern GOA (east of 147° W. longitude). From 1990 to 1995 the TAC was divided into four quarterly fishing seasons with openers in January, June, July and October. In 1996, the TAC was divided into three fishing seasons with openers in January, June and September. Since 2000, the TAC has again been divided into four fishing seasons. One hundred percent of the catch is allocated to shoreside processing plants with the majority of the catch being processed on Kodiak Island.

Nearly the entire harvest of pollock is taken with pelagic trawl gear. In 1996 pelagic trawls took 91% of the pollock harvest. The pollock fishery has a very low bycatch rate with discards 10% or less since 1992. Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery the catch is almost exclusively pollock, but in the bottom trawl pollock fishery the bycatch of other species is higher. Between 1991 and 1994 the bycatch of other species was 18% in the bottom trawl pollock fishery, and 3% in the pelagic trawl pollock fishery. Most of the bycatch was Pacific cod and flatfish species.

The GOA pollock fishery primarily targets mature pollock. Fishery selectivity increases to a maximum around age 5-7 and then declines. The selectivity pattern varies between years due to shifts in fishing strategy.

Gulf of Alaska pollock stock

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Selectivity	6%	19%	45%	77%	100	97%	67%	38%	21%	21%	21%	21%	21%	21%

D.1.3 Relevant Trophic Information

Juvenile pollock through newly maturing pollock primarily utilize copepods and euphausiids for food. At maturation and older ages pollock become increasingly piscivorous, with pollock (cannibalism) a major food item in the Bering Sea. Most of the pollock consumed by pollock are age 0 and 1 pollock, and recent research suggests that cannibalism can regulate year-class size. Weak year-classes appear to be those located within the range of adults, while strong year-classes are those that are transported to areas outside the range of adult abundance.

D.1.4 Habitat and Biological Associations

Egg-Spawning: Pelagic on continental shelf over 100-200 m depth in GOA.

Larvae: Pelagic throughout the continental shelf within the top 40 m in the GOA.

Juveniles: Age 0 appears to be pelagic, as is age 2 and 3. Age 1 pelagic and demersal with a widespread distribution and no known benthic habitat preference.

Adults: Adults occur both pelagically and demersally on the outer and mid-continental shelf of the GOA. In the eastern Bering Sea few adult pollock occur in waters shallower than 70 m. Adult pollock also occur pelagically in the Aleutian Basin. Adult pollock range throughout the Bering Sea in both the U.S. and Russian waters, however, the maps provided for this document detail distributions for pollock in the U.S. EEZ and the basin.

Habitat and Biological Associations: Walleye Pollock

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	17-20 days at 4°C	None	Feb-Apr	OCS, MCS	P	NA	G?	
Larvae	60 days	copepod naupli and small euphausiids	Mar-Jul	OCS	P	NA	G? F	pollock larvae with jellyfish
Juveniles	Age 0.4 to Age 4	Pelagic crustaceans, copepods and euphausiids	Aug+	OCS, MCS, ICS	P, SD	NA	CL, F	
Adults	Age 4 - 16	Pelagic crustaceans and fish, primarily juvenile pollock	spawning Feb-Apr	OCS, BSN	P, SD	U	F, UP	Increasingly demersal with age. Appears to prefer 2-3°C water for spawning.

D.1.5 Literature

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D.2 Pacific cod

D.2.1 Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about 34° N. latitude, with a northern limit of about 63° N. latitude. Adults are demersal and form aggregations during the peak spawning season, which extends approximately from January through May. Pacific cod eggs are demersal and adhesive. Eggs hatch in about 15-20 days. Little is known about the distribution of Pacific cod larvae, which undergo metaphorphosis at about 25-35 mm. Juvenile Pacific cod start appearing in trawl surveys at a fairly small size, as small as 10 cm in the eastern Bering Sea. Pacific cod can grow to be more than a meter in length, with weights in excess of 10 kg. Natural mortality is believed to be somewhere between 0.3 and 0.4. Approximately 50% of Pacific cod are mature by ages 5-6. The estimated size at 50% maturity is 67 cm. The maximum recorded age of a Pacific cod from the BSAI or GOA is 19 years.

Sources for additional distribution data

Larvae/juveniles:

NMFS, Alaska Fisheries Science Center, FOCI Program, Ann Matarese 206-526-4111

D.2.2 Fishery

The fishery is conducted with bottom trawl, longline, pot, and jig gear. The age at 50% recruitment varies between gear types and regions. In the GOA, the age at 50% recruitment is 4 years for trawl gear and 5 years for other longline and pot gear. More than 100 vessels participated in each of the three largest fisheries (trawl, longline, pot). The trawl fishery is typically concentrated during the first few months of the year, whereas fixed-gear fisheries may sometimes run essentially year-round. Bycatch of crab and halibut often causes the Pacific cod fisheries to close prior to reaching the total allowable catch. In the GOA, trawl fishing has centers of activity around the Shumagin Islands and south of Kodiak Island, while the longline fishery is primarily located in the vicinity of the Shumagins.

D.2.3 Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod are polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, fishery discards, and yellowfin sole. Small Pacific cod feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod include halibut, salmon shark, northern fur seals, sea lions, harbor porpoises, various whale species, and tufted puffin.

D.2.4 Habitat and Biological Associations

Egg/Spawning: Spawning takes place in the sublittoral-bathyal zone (40-290 m) near bottom. Eggs sink to the bottom after fertilization, and are somewhat adhesive. Optimal temperature for incubation is 3-6° C, optimal salinity is 13-23 ppt, and optimal oxygen concentration is from 2-3 ppm to saturation. Little is known about the optimal substrate type for egg incubation.

Larvae: Larvae are epipelagic, occurring primarily in the upper 45 m of the water column shortly after hatching, moving downward in the water column as they grow.

Juveniles: Juveniles occur mostly over the inner continental shelf at depths of 60-150 m.

Adults: Adults occur in depths from the shoreline to 500 m. Average depth of occurrence tends to vary directly with age for at least the first few years of life, with mature fish concentrated on the outer continental shelf. Preferred substrate is soft sediment, from mud and clay to sand.

Habitat and Biological Associations: Pacific cod

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15-20 days	NA	winter-spring	ICS, MCS, OCS	D	M, SM, MS, S	U	optimum 3-6°C optimum 13-23 ppt
Larvae	U	copepods (?)	winter-spring	U	P (?)	U	U	
Early Juveniles	to 2 years	small invertebrates (mysids, euphausiids, shrimp)	all year	ICS, MCS	D	M, SM, MS, S	U	
Late Juveniles	to 5 years	pollock, flatfish, crab, fishery discards	all year	ICS, MCS, OCS	D	M, SM, MS, S	U	
Adults	5+ years	pollock, flatfish, fishery discards, crab	spawning (Jan-May) non-spawning (Jun-Dec)	ICS, MCS, OCS ICS, MCS, OCS	D	M, SM, MS, S	U	

D.2.5 Literature

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D.3 Sablefish

D.3.1 Life History and General Distribution

Sablefish are distributed from Mexico through the GOA to the Aleutian Chain, Bering Sea; along the Asian coast from Sagami Bay, and along the Pacific sides of Honshu and Hokkaido Islands and the Kamchatkan Peninsula. Adult sablefish occur along the continental slope, shelf gulleys, and in deep fjords such as Prince William Sound and Southeastern Alaska, at depths generally greater than 200 m. Adults are assumed to be demersal. Spawning or very ripe sablefish are observed in late winter or early spring along the continental slope. Eggs are apparently released near the bottom where they incubate. After hatching and yolk adsorption the larvae rise to the surface where they have been collected with neuston nets. Larvae are oceanic through the spring and by late summer, small pelagic juveniles (10-15 cm) have been observed along the outer coasts of Southeast Alaska, where they apparently move into shallow waters to spend their first winter. During most years, there are only a few places where juveniles have been found during their first winter and second summer. It is not clear if the juvenile distribution is highly specific or appears so because sampling is highly inefficient and sparse. During the occasional times of large year-classes the juveniles are easily found in many inshore areas during their second summer. They are typically 20-30 cm in length during their second summer, after which they apparently leave the nearshore bays. One or two years later they begin appearing on the continental shelf and move to their adult distribution as they mature. Size at 50% maturity in the Bering Sea is 65 cm for males and 67 cm for females; in the Aleutian Islands, it is 61 cm for males and 65 cm for females. At the end of the second summer (~1.5 years old) they are 35-40 cm in length.

<u>Sources of additional distribution data</u>

Eggs and Larvae:

> NMFS, Alaska Fisheries Science Center, FOCI Program, Art Kendall 206-526-4108, NMFS Auke Bay Lab, Bruce Wing 907-789-????

Juveniles:

> ADFG groundfish surveys: Jim Blackburn, ADFG, Kodiak AK 907-486-186, Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
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D.3.2 Fishery

The major fishery for sablefish in Alaska uses fixed gear (hook-and-line and pot gear), however sablefish are valuable in the trawl fishery as well. Sablefish enter the fixed gear fishery at 4-5 years of age, perhaps slightly younger in the trawl fishery. The fixed gear fishery takes place primarily in the spring and summer (the regulatory season is concurrent with halibut individual fishing quota season). The take of the trawl share of sablefish occurs primarily in association with openings for other species, such as the July rockfish openings, where they are taken as allowed bycatch. Deeper dwelling rockfish, such as shortraker, rougheye, and thornyhead rockfish are the primary bycatch in the fixed gear sablefish fishery. Halibut and rattails (*Albatrossia pectoralis* and *Corphaenoides acrolepis*) also are taken. By regulation, there is no directed trawl fishery for sablefish, however, directed fishing standards have allowed some trawl hauls to target sablefish, where the bycatch is similar to the fixed gear fishery, in addition perhaps to some deep dwelling flatfish.

D.3.3 Relevant Trophic Information

Larval sablefish feed on a variety of small zooplankton ranging from copepod naupli to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e., euphausiids).

The older demersal juveniles and adults appear to be opportunistic feeders, with food ranging from variety of benthic invertebrates, benthic fishes, as well as squid, mesopelagic fishes, jellyfish and fishery discards. Gadid fish (mainly pollock) comprise a large part of the sablefish diet. Nearshore residence during their second year provide the opportunity to feed on salmon fry and smolts during the summer months.

Young of the year sablefish are commonly found in the stomachs of salmon taken in the southeast troll fishery during the late summer.

Habitat and Biological Associations: Sablefish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14-20 days	NA	late winter-early spring: Dec-Apr	USP, LSP, BSN	P, 200-3000 m	NA	U	
Larvae	up to 3 months	copepod nauplii, small copepodites, etc	spring-summer: Apr-July	MCS, OCS, LSP, BSN	N, neustonic near surface	NA	U	
Early Juveniles	to 3 years	small prey fish, sandlance, salmon, herring, etc		OCS, MCS, ICS, during 1st summer, then obs'd in BAY, IP, until end of 2nd summer; not obs'd until found on shelf	P when offshore during 1st summer; D or SD/SP when inshore	NA when pelagic; bays where obs'd were soft bottomed, but not enough obs'd to assume typical	U ? or NA	
Late Juveniles	3-5 years	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	all year	continental slope, and deep shelf gulleys and fjords.	presumably D (caught with bottom tending gear)	varies, generally soft bottoms	U on slope, ? in fjords	
Adults	5 years to 35+	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	apparently year around, spawning movements (if any) are undescribed	continental slope, and deep shelf gulleys and fjords.	presumably D (caught with bottom tending gear)	varies, generally soft bottoms	U on slope, ? in fjords	

D.3.5 Literature

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D.4 Shallow water flatfish

The shallow water flatfish management complex in the GOA is comprised of seven species: rock sole (*Lepidopsetta bileneatus*), yellowfin sole (*Limanda aspera*), starry flounder (*Platichthys stellatus*), butter sole (*Isopsetta isolepis*), English sole (*Parophrys vetulus*), Alaska plaice (*Pleuronectes vetulus*) and sand sole (*Psettichthys melanostictus*). The rock sole resource in the GOA is now known to consist of two separate species; a northern and a southern form which have distinct characteristics and overlapping distributions. The two species of rock sole and yellowfin sole are the most abundant and commercially important species of this management complex in the GOA, and the description of their habitat and life history best represent the shallow water complex species.

D.4.1 Life History and General Distribution

Yellowfin sole

Distributed in North American waters from off British Columbia, Canada, (approximately 49° N. latitude) to the Chukchi Sea (about 70° N. latitude) and south along the Asian coast to about 35° N. latitude off the South Korean coast in the Sea of Japan. Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the eastern Bering Sea shelf. From over-winter grounds near the shelf margins, adults begin a migration onto the inner shelf in April or early May each year for spawning and feeding. A protracted and variable spawning period may range from as early as late May through August occurring primarily in shallow water. Fecundity varies with size and was reported to range from 1.3 to 3.3 million eggs for fish 25-45 cm long. Eggs have been found to the limits of inshore ichthyoplankton sampling over a widespread area to at least as far north as Nunivak Island. Larvae have been measured at 2.2-5.5 mm in July and 2.5-12.3 mm in late August - early September. The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach approximately 15 cm. The estimated age of 50% maturity is 10.5 yrs (approximately 29 cm) for females based on samples collected in 1992 and 1993. The upper size limit of juvenile yellowfin sole is approximately 27 cm. Natural mortality rate is believed to range from 0.12-0.16.

Rock sole

Distributed from California waters north into the GOA and Bering Sea to as far north as the Gulf of Anadyr. The distribution continues along the Aleutian Islands westward to the Kamchatka Peninsula and then southward through the Okhotsk Sea to the Kurile Islands, Sea of Japan, and off Korea. Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central GOA, and in the southeastern Bering Sea (Alton and Sample 1975). Adults exhibit a benthic lifestyle. Rock sole spawn during the winter-early spring period of December-March. Spawning females deposit a mass of eggs which are demersal and adhesive (Alton and Sample 1975). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11° C to about 25 days at 2.9° C (Forrester 1964). Forrester and Thompson (1969) report that by age 1 they are found with adults on the continental shelf during summer.

In the springtime, after spawning, rock sole begin actively feeding and commence a migration to the shallow waters of the continental shelf. During this time they spread out and form much less dense concentrations than during the spawning period. Summertime trawl surveys indicate most of the population can be found at depths from 50-100 m (Armistead and Nichol 1993). The movement from winter/spring to summer grounds is in response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,00 eggs for fish 42 cm long. The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach age 1 (Forrester 1969). The estimated age of 50% maturity is 9 years (approximately 35 cm) for females and natural mortality rate is believed to range from 0.18 - 0.20. The upper size limit of juvenile rock sole is approximately 34 cm.

Sources of additional data

ADF&G, 211 Mission Road, Kodiak, AK 99615, Jim Blackburn (907) 486-1863

Univ. Alaska, Institute of Marine Science, Dr. Brenda L. Norcross (907) 474-7990

D.4.2 Fishery

Shallow water flatfish are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at ages ranging from 3 to 5 years. They are caught as bycatch in the pollock, Pacific cod and flathead sole fisheries and to a lesser extent in rex sole and rockfish fisheries.

D.4.3 Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder. Yellowfin sole adults feed mainly on bivalves, polychaetes, amphipods and echiurids. Rocksole adults feed on bivalves, polychaetes, amphipods and miscellaneous crustaceans.

D.4.4 Habitat and Biological Associations

Yellowfin sole

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime spawning and feeding on sandy substrates of the eastern Bering Sea shelf. Widespread distribution mainly on the middle and inner portion of the shelf. Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures, feeding diminishes.

Rock sole

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, juveniles inhabit shallow areas at least until age 1.

Adults: Summertime feeding on primarily sandy substrates of the eastern Bering Sea shelf. Widespread distribution mainly on the middle and inner portion of the shelf. Wintertime migration to deeper waters of the shelf margin for spawning and to avoid extreme cold water temperatures, feeding diminishes.

Habitat and Biological Associations: Yellowfin sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	summer	BAY, BCH	P			
Larvae	2-3 months?	U phyto/zooplankton?	summer autumn?	BAY, BCH, ICS	P			
Early Juveniles	to 5.5 years	polychaetes, bivalves, amphipods, echiurids	all year	BAY, ICS, OCS	D	S[1]		
Late Juveniles	5.5 to 10 years	polychaetes, bivalves, amphipods, echiurids	all year	BAY, ICS, OCS	D	S[1]		
Adults	10+ years	polychaetes, bivalves, amphipods, echiurids	spawning/feeding May-August non-spawning Nov.-April	BAY, BCH, ICS ICS, MCS, OCS	D	S[1]	ice edge	

[1]Pers. Comm. Dr. Robert McConnaughey (206) 526-4150

Habitat and Biological Associations: Rock sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	OCS	D			
Larvae	2-3 months?	U phyto/zooplankton?	winter/ spring	OCS, MCS, ICS	P			
Early Juveniles	to 3.5 years	polychaetes, bivalves, amphipods, misc. crust.	all year	BAY, ICS, OCS	D	S[1]		
Late Juveniles	to 9 years	polychaetes, bivalves, amphipods, misc. crust.	all year	BAY, ICS, OCS	D	S[1]		
Adults	9+ years	polychaetes, bivalves, amphipods, misc. crust.	feeding May-Sep spawning Dec-Apr	MCS, ICS MCS, OCS	D	S[1]	ice edge	

[1]Pers. Comm. Dr. Robert McConnaughey (206) 526-4150

D.4.5 Literature

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D.5 Deep water flatfish

The deep water flatfish management complex in the GOA is comprised of three species, Dover sole (*Microstomus pacificus*), Greenland turbot (*Reinhardtius hippglossoides*) and the deep sea sole (*Embassicthys bathbius*). Dover sole is the most abundant and commercially important species of this management complex in the GOA and the description of its habitat and life history are given herewith to represent the three species.

D.5.1 Life History and General Distribution

Dover sole are distributed in deep waters of the continental shelf and upper slope from northern Baja California to the Bering Sea and the western Aleutian Islands (Hart 1973, Miller and Lea 1972), and exhibit a widespread distribution throughout the GOA. Adults are demersal and are mostly found in water deeper than 300 meters. The spawning period off Oregon is reported to range from January through May (Hunter et al. 1992). Spawning in the GOA has been observed from January through August, with a peak period in May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown.. Larvae were captured in bongo nets only in summer over mid-shelf and slope areas (Kendall and Dunn 1985). The age or size at metamorphosis is unknown but the pelagic larval period is known to be protracted and may last as long as two years (Markle et al. 1992). Pelagic postlarvae as large as 48 mm have been reported and the young may still be pelagic at 10 cm (Hart 1973). Dover sole are batch spawners and Hunter et al. (1992) concluded that the average 1 kg. female spawns its 83,000 advanced yolked oocytes in about nine batches. Maturity studies from Oregon indicate that females were 50% mature at 33 cm total length. Juveniles less than 25 cm are rarely found with the adult population from bottom trawl surveys (Martin and Clausen 1995). The natural mortality rate used in recent stock assessments is 0.2 (Turnock et al. 1996).

D.5.2 Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 5. They are caught as bycatch in the rex sole, thornyhead and sablefish fisheries and are caught with these species and Pacific halibut in Dover sole directed fisheries.

D.5.3 Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder. Adults feed mainly on polychaetes, annelids, crustaceans and mollusks.

D.5.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for up to 2 years until metamorphosis occurs, juvenile distribution is unknown.

Adults: Winter and spring spawning and summer feeding on soft substrates (combination of sand and mud) of the continental shelf and upper slope. Shallower summer distribution mainly on the middle to outer portion of the shelf and upper slope (Livingston and Goiney 1983).

Habitat and Biological Associations: Dover sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	spring, summer	ICS?, MCS, OCS, UCS	P			
Larvae	up to 2 years	U phyto/zooplankton?	all year	ICS?, MCS OCS, UCS	P			
Juveniles	to 3 years	polychaetes, amphipods, annelids	all year	MCS?, ICS?	D	S, M		
Adults	3-5 years	polychaetes, amphipods, annelids	all year	MCS?, ICS?	D	S, M		

D.5.5 Literature

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D.6 Rex sole

D.6.1 Life History and General Distribution

Rex sole are distributed from Baja California to the Bering Sea and western Aleutian Islands (Hart 1973, Miller and Lea 1972), and are widely distributed throughout the GOA. Adults exhibit a benthic lifestyle and are generally found in water deeper than 300 meters. From over-winter grounds near the shelf margins, adults

begin a migration onto the mid and outer continental shelf in April or May each year. The spawning period off Oregon is reported to range from January through June with a peak in March and April (Hosie and Horton 1977). Spawning in the GOA was observed from February through July, with a peak period in April and May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets mainly in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown.. Larvae were captured in bongo nets only in summer over midshelf and slope areas (Kendall and Dunn 1985). Fecundity estimates from samples collected off the Oregon coast ranged from 3,900 to 238,100 ova for fish 24-59 cm (Hosie and Horton 1977). The age or size at metamorphosis is unknown Maturity studies from Oregon indicate that males were 50% mature at 16 cm and females at 24 cm. Juveniles less than 15 cm are rarely found with the adult population. The natural mortality rate used in recent stock assessments is 0.2 (Turnock et al. 1996).

D.6.2 Fishery

Rex sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3 or 4. They are caught as bycatch in the Pacific ocean perch, Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in rex sole directed fisheries.

D.6.3 Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder. Adults feed mainly on polychaetes, amphipods, euphausids and snow crabs

D.6.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for an unknown time period until metamorphosis occurs, juvenile distribution is unknown.

Adults: Spring spawning and summer feeding on a combination of sand, mud and gravel substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf.

Habitat and Biological Associations: Rex sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	Feb - May	ICS?, MCS, OCS	P			
Larvae	U	U phyto/zooplankton?	spring summer	ICS?, MCS, OCS	P			
Juveniles	2 years	polychaetes, amphipods, euphausiids, Tanner crab	all year	MCS, ICS, OCS	D	G, S, M		
Adults	2+ years	polychaetes, amphipods, euphausiids, Tanner crab	spawning: Feb-May non-spawning: May-January	MCS, OCS, USP MCS, OCS, USP	D	G, S, M		

D.6.5 Literature

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D.7 Flathead sole

D.7.1 Life History and General Distribution

Flathead sole are distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the GOA and the Bering Sea, the Kuril Islands and possibly the Okhotsk Sea (Hart 1973).

Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions in the GOA. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year for feeding. The spawning period may range from as early as January but is known to occur in March and April, primarily in deeper waters near the margins of the continental shelf. Eggs are large (2.75-3.75 mm) and females have egg counts ranging from about 72,000 (20 cm fish) to almost 600,000 (38 cm fish). Eggs hatch in 9 to 20 days depending on incubation temperatures within the range of 2.4 to 9.8°C and have been found in ichthyoplankton sampling on the southern portion of the Bering Sea shelf in April and May (Waldron 1981). Larvae absorb the yolk sac in 6 to 17 days but the extent of their distribution is unknown. The age or size at metamorphosis is unknown as well as the age at 50% maturity. Juveniles less than age 2 have not been found with the adult population, remaining in shallow areas. The natural mortality rate used in recent stock assessments is 0.2.

D.7.2 Fishery

Flathead sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3. Historically, the fishery has occurred throughout the mid and outer Bering Sea shelf during ice-free conditions (mostly summer and fall). They are caught as bycatch in Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in flathead sole directed fisheries.

D.7.3 Relevant Trophic Information

Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length. Adults feed mainly on ophiuroids, tanner crab, osmerids, bivalves and polychaetes.

D.7.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for an unknown time period until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Winter spawning and summer feeding on sand and mud substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf.

Habitat and Biological Associations: Flathead sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	ICS, MCS, OCS	P			
Larvae	U	U phyto/zooplankton?	spring summer	ICS, MCS, OCS	P			
Early Juveniles	to 2 years	polychaetes, bivalves, ophiuroids, pollock, Tanner crab	all year	MCS, ICS, OCS	D	MS[1]		
Late Juveniles	3 years	polychaetes, bivalves, ophiuroids, pollock, Tanner crab	all year	MCS, ICS, OCS	D	MS[1]		
Adults	U	polychaetes, bivalves, ophiuroids, pollock, Tanner crab	spawning Jan-Apr non-spawning May-Dec	MCS, OCS, ICS ICS, MCS, OCS	D	MS[1]	ice edge	

[1]Pers. Comm. Dr. Robert McConnaughey (206) 526-4150

D.7.5 Literature

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D.8 Arrowtooth flounder

D.8.1 Life History and General Distribution

Arrowtooth flounder are distributed in North American waters from central California to the eastern Bering Sea on the continental shelf and upper slope.

Adults exhibit a benthic lifestyle and occupy separate winter and summer distributions on the eastern Bering Sea shelf. From over-winter grounds near the shelf margins and upper slope areas, adults begin a migration onto the middle and inner shelf in April or early May each year with the onset of warmer water temperatures. A protracted and variable spawning period may range from as early as September through March (Rickey 1994, Hosie 1976). Little is known of the fecundity of arrowtooth flounder. Larvae have been found on the continental shelf east of Kodiak Island during winter and spring (Kendall and Dunn 1985). The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach the 10-15 cm range (Martin and Clausen 1995). The estimated length at 50% maturity is 28 cm for males (4 years) and 37 cm for females (5 years) from samples collected off the Washington coast (Rickey 1994). The natural mortality rate used in stock assessments is 0.2 (Turnock et al. 1996).

D.8.2 Fishery

Arrowtooth flounder are caught in bottom trawls usually in pursuit of other higher value bottom-dwelling species. Historically have been undesirable to harvest due to a flesh softening condition caused by protease enzyme activity. Recruitment begins at about age 3 and females are fully selected at age 10. They are caught as bycatch in Pacific cod, bottom pollock, sablefish and other flatfish fisheries.

D.8.3 Relevant Trophic Information

Arrowtooth flounder are very important as a large, aggressive and abundant predator of other groundfish species. Groundfish predators include Pacific cod and pollock, mostly on small fish.

D.8.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, juveniles usually inhabit shallow areas until about 10 cm in length.

Adults: Widespread distribution mainly on the middle and outer portions of the continental shelf, feeding mainly on walleye pollock and other miscellaneous fish species when arrowtooth flounder attain lengths greater than 30 cm. Wintertime migration to deeper waters of the shelf margin and upper continental slope to avoid extreme cold water temperatures and for spawning.

Habitat and Biological Associations: Arrowtooth flounder

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter, spring?	ICS, OCS	P			
Larvae	2-3 months?	U phyto/zooplankton?	Spring summer?	BAY, ICS, OCS	P			
Early Juveniles	to 2 years	euphausiids, crustaceans, amphipods, pollock	all year	ICS, OCS, USP	D	G, MS[1]		
Late Juveniles	males: 2-4 years females: 2-5 years	euphausiids, crustaceans, amphipods, pollock	all year	ICS, OCS, USP	D	G, MS[1]		
Adults	males: 4+ years females: 5+ years	pollock, misc. fish, Gadidae sp., euphausiids	spawning Nov-Mar non-spawning Apr-Oct	OCS, USP ICS, OCS, USP, BAY	D	G, MS[1]	ice edge	

[1]Pers. Comm., Dr. Robert McConnaughey (206) 526-4150

D.8.5 Literature

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D.9 Pacific ocean perch

D.9.1 Life History and General Distribution

Pacific ocean perch has a wide distribution in the North Pacific from southern California around the Pacific rim to northern Honshu Is., Japan, including the Bering Sea. The species appears to be most abundant in northern British Columbia, the GOA, and the Aleutian Islands. Adults are found primarily offshore along the continental slope in depths 180-420 m. Seasonal differences in depth distribution have been noted by many investigators. In the summer, adults inhabit shallower depths, especially those between 180 and 250 m. In the fall, the fish apparently migrate farther offshore to depths of ~300-420 m. They reside in these deeper depths until about May, when they return to their shallower summer distribution. This seasonal

pattern is probably related to summer feeding and winter spawning. Although small numbers of Pacific ocean perch are dispersed throughout their preferred depth range on the continental slope, most of the population occurs in patchy, localized aggregations. At present, the best evidence indicates that Pacific ocean perch is mostly a demersal species. A number of investigators have speculated that there is also a pelagic component to their distribution, especially at night when they may move off-bottom to feed, but hard evidence for this is lacking.

There is much uncertainty about the life history of Pacific ocean perch, although generally more is known than for other rockfish species. The species appears to be viviparous, with internal fertilization and the release of live young. Insemination occurs in the fall, and sperm are retained within the female until fertilization takes place ~2 months later. The eggs develop and hatch internally, and parturition (release of larvae) occurs in April-May. Information on early life history is very sparse, especially for the first year of life. Positive identification of Pacific ocean perch larvae is not possible at present, but the larvae are thought to be pelagic and to drift with the current. Transformation to an adult form and the assumption of a demersal existence may take place within the first year. Small juveniles probably reside inshore in very rocky, high relief areas, and by age 3 begin to migrate to deeper offshore waters of the continental shelf. As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood.

Pacific ocean perch is a very slow growing species, with a low rate of natural mortality (estimated at 0.05), a relatively old age at 50% maturity, 10.5 years for females in the GOA, and a very old maximum age of 98 years in Alaska. Despite their viviparous nature, the fish is relatively fecund with number of eggs/female in Alaska ranging from 10,000-300,000, depending upon size of the fish. The upper size limit of juvenile fish is 38 cm for females, and unknown for males, although presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

<u>Sources of additional distribution data</u>

Eggs and Larvae:

NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, Bruce Wing, (907) 789-6043

NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall (206) 526-4108

Canada Dept. of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B.C., Bruce Leaman, (604) 756-7176.

Juveniles:

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D.9.2 Fishery

Pacific ocean perch are caught almost exclusively with bottom trawls. Age at 50% recruitment has been estimated to be between 9 and 10 years in the GOA. The fishery in the Gulf in recent years has been concentrated in the summer months, especially July, due mostly to management regulations. Reflecting the summer distribution of this species, the fishery in the GOA is concentrated in a relatively narrow depth band at 190-350 m along the continental slope. Major fishing grounds are at the entrance of large gullies, where

the continental slope is more gradual and a greater area of habitat is found at the preferred depth range. The major grounds include Ommaney Trough, Yakutat Canyon, Amatuli Trough, off Portlock and Albatross Banks, Shelikof Trough, off Shumagin Bank, and south of Unimak and Unalaska Islands.

For Council-managed species, the major bycatch species in the GOA Pacific ocean perch trawl fishery in 1995 included (in descending order by percent): other species of rockfish, arrowtooth flounder, and sablefish. Among the other species of rockfish, shortraker/rougheye were most common.

D.9.3 Relevant Trophic Information

All food studies of Pacific ocean perch have shown them to be overwhelmingly planktivorous. Small juveniles eat mostly calanoid copepods, whereas larger juveniles and adults consume euphausiids as their major prey items. Adults, to a much lesser extent, may also eat small shrimp and squids. It has been suggested that Pacific ocean perch and walleye pollock compete for the same euphausiid prey. Consequently, the large removals of Pacific ocean perch by foreign fishermen in the GOA in the 1960s may have allowed walleye pollock stocks to greatly expand in abundance.

Documented predators of adult Pacific ocean perch include Pacific halibut and sablefish, and it is likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon, and benthic juveniles are eaten by lingcod and other large demersal fish.

D.9.4 Habitat and Biological Associations

Egg/Spawning: Little information is known. Insemination is thought to occur after adults move to deeper offshore waters in the fall. Parturition is reported to occur from 20-30 m off bottom at depths of 360-400 m.

Larvae: Little information is known. Earlier information suggested that after parturition, larvae rise quickly to near surface, where they become part of the plankton. More recent data from British Columbia indicates that larvae may remain at depths >175 m for some period of time (perhaps two months), after which they slowly migrate upward in the water column.

Juveniles: Again, information is very sparse, especially for younger juveniles. After metamorphosis from the larval stage, juveniles may reside in a pelagic stage for an unknown length of time. They eventually become demersal, and at age 1-3 probably live in very rocky inshore areas. Afterward, they move to progressively deeper waters of the continental shelf. Older juveniles are often found together with adults at shallower locations of the continental slope in the summer months.

Adults: Commercial fishery data have consistently indicated that adult Pacific ocean perch are found in aggregations over reasonably smooth, trawlable bottom of the continental slope. Generally, they are found in shallower depths (180-250 m) in the summer, and deeper (300-420 m) in the fall, winter, and early spring. In addition, investigators in the 1960s and 1970s speculated that the fish sometimes inhabited the mid-water environment off bottom and also might be found in rough, untrawlable areas. Hard evidence to support these latter two conjectures, however, has been lacking. The best information available at present suggests that adult Pacific ocean perch is mostly a demersal species that prefers a flat, pebbled substrate along the continental slope. More research is needed, however, before definitive conclusions can be drawn as to its habitat preferences.

Habitat and Biological Associations: Pacific ocean perch

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	Internal incubation: ~90 days	NA	Winter	NA	NA	NA	NA	NA
Larvae	U; assumed between 60 -180 days	U; assumed to be micro-zooplankton	Spring-summer	ICS, MCS, OCS, USP, LSP, BSN	P	NA	U	U
Juveniles	3-6 months to 10 years	early: calanoid copepods late: euphausiids	All year	ICS, MCS, OCS, USP	?P (early juvenile only), D	R (<age 3)	U	U
Adults	10-98 years of age	Euphausiids	Insemination (fall); Fertilization, incubation (winter); Larval release (spring); Feeding in shallower depths (summer)	OCS, USP	D, SD	CB, G,?M, ?SM,?MS	U	U

D.9.5 Literature

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D.10 Northern rockfish

D.10.1 Life History and General Distribution

Northern rockfish range from northern British Columbia through the GOA and Aleutian Islands to eastern Kamchatka, including the Bering Sea. The species is most abundant from about Portlock Bank in the central GOA to the western end of the Aleutian Islands. Within this range, adult fish appear to be concentrated at discrete, relatively shallow offshore banks of the outer continental shelf. Typically, these banks are separated

from land by an intervening stretch of deeper water. The preferred depth range is ~75-125 m in the GOA, and ~100-150 m in the Aleutian Islands. The fish appear to be demersal, although small numbers are occasionally taken in pelagic tows. In common with many other rockfish species, northern rockfish tend to have a localized, patchy distribution, even within their preferred habitat, and most of the population occurs in aggregations. Most of what is known about northern rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on northern rockfish is extremely sparse. The fish are assumed to be viviparous, as are other *Sebastes*, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring, and is mostly completed by summer. Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage is unknown, but the fish apparently metamorphose to a pelagic juvenile stage, which also has been described. There is no information on when the juveniles become benthic or what habitat they occupy. Older juveniles are found on the continental shelf, generally at locations inshore of the adult habitat.
Northern rockfish is a slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50% maturity (12.8 years for females in the GOA), and maximum age of 57 years in Alaska. No information on fecundity is available. The approximate upper size limit of juvenile fish for the GOA: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Sources of additional data

Eggs and Larvae:	None at present
Older juveniles and adults:	NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, David Clausen, (907) 789-6049.

D.10.2 Fishery

Northern rockfish are caught almost exclusively with bottom trawls. Age at 50% recruitment is unknown. The fishery in the GOA in recent years has mostly occurred in the summer months, especially July, due to management regulations. Catches are concentrated at a number of relatively shallow, offshore banks of the outer continental shelf. These include: Portlock Bank, Albatross Bank, the “Snakehead” south of Kodiak Island, Shumagin Bank, and Davidson Bank in the GOA. Outside of these banks, catches are generally sparse. The majority of the catch comes from depths of 75-125 m in the GOA.

For Council-managed species, the major bycatch species in the GOA northern rockfish trawl fishery in 1993-95 included (in descending order by percent): dusky rockfish, Pacific ocean perch, and other species of rockfish. Of these, dusky rockfish was by far the most common bycatch, comprising a mean of 16-19% of the catch of northern rockfish. There is no information available on the bycatch of non-NPFMC-managed species in the GOA northern rockfish fishery.

D.10.3 Relevant Trophic Information

Although no comprehensive food study of northern rockfish has been done, several smaller studies have all shown euphausiids to be the predominate food item of adults in the GOA. Copepods, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities.

Predators of northern rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth flounder.

D.10.4 Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring.

Larvae: No information known.

Juveniles: No information known for small juveniles (<20 cm), except that juveniles apparently undergo a pelagic phase immediately after metamorphosis from the larval stage. Larger juveniles have been taken in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds.

Adults: Commercial fishery and research survey data have consistently indicated that adult northern rockfish are primarily found over reasonably flat, trawlable bottom of offshore banks of the outer continental shelf at depths of 75-150 m. Preferred substrate in this habitat has not been documented, but observations from trawl surveys suggest that large catches of northern rockfish are often associated with hard bottoms. Generally, the fish appear to be demersal, and most of the population occurs in large aggregations. There is no information on seasonal migrations. Northern rockfish often co-occur with dusky rockfish.

Habitat and Biological Associations: Northern Rockfish

Stage - EFH Level	Duration or Age	Diet/ Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	?Spring-summer	U	P (assumed)	NA	U	U
Juveniles	From end of larval stage to ?	U	All year	ICS, MCS, OCS,	?P (early juv. only), D	U (juv.< 20 cm); substrate (juv.>20 cm)	U	U
Adults	to 13 yrs	U	All year	OCS		CB, R	U	U

D.10.5 Literature

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D.11 Shortraker Rockfish and Rougheye Rockfish

D.11.1 Life History and General Distribution

Shortraker and rougheye rockfishes are found along the northwest slope of the eastern Bering Sea, throughout the Aleutian Islands and south to Point Conception, California. Both species are semi-demersal and can be found at depths ranging from 25 to 875 m; however, commercial concentrations usually occur at depths from 100 to 500 m. Though relatively little is known about their biology and life history, both species appear to be K-selected with late maturation, slow growth, extreme longevity, and low natural mortality. Shortraker and rougheye rockfish attain maturity relatively late in life, at about 20+ years of age. Both species are among the largest *Sebastes* species in Alaskan waters, attaining sizes of up to 104 cm for shortraker and 96 cm for rougheye rockfish. Shortraker rockfish have been estimated to attain ages in excess of 120 years and rougheye rockfish in excess of 140 years. Natural mortality for both species is low, estimated to be on the order of 0.01 to 0.04. For shortraker rockfish, length at 50% sexual maturity is about 45 cm and about 44 cm for rougheye rockfish.

<u>Sources of additional distribution data</u>

Larvae:

NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall, 206-526-4108.

D.11.2 Fishery

Trawl and longline gear are the primary methods of harvest. Even though both species are found to as far south as Point Conception, California, commercial quantities are primarily harvested from northern Washington throughout Alaskan waters. Depths of commercial harvests usually occur from about 100 to 500 m. Both species are associated with a variety of habitats from soft to rocky habitats along the continental slope, although boulders and sloping terrain appear to be a desirable habitat feature for both species. Trawling in such habitats often requires specialized fishing skills to avoid gear damage and to keep the trawl in the proper fishing configuration. Age at recruitment is uncertain, but is probably on the order of 20+ years for both species. Shortraker and rougheye rockfish are often caught as bycatch in trawl and longline fisheries for sablefish and halibut.

D.11.3 Relevant Trophic Information

Shortraker and rougheye rockfishes prey primarily on shrimps, squids, and myctophids. It is uncertain what are the main predators on both species.

D.11.4 Habitat and Biological Associations

Egg/Spawning: The timing of reproductive events is apparently protracted. One study indicated that vitellogenesis was present for four to five months and lasted from about July until late October and November. Parturition apparently occurs mainly in early spring through summer.

Larvae: No information is available regarding the habitats and biological associations of shortraker and rougheye rockfish larvae.

Juveniles: Very little information is available regarding the habitats and biological associations of shortraker and rougheye rockfish juveniles. It is suspected, however, that the juveniles of both species occupy shallower habitats than that of the adults.

Adults: Adults are semi-demersal and can be found at depths ranging from 25 to 875 m. Submersible observations indicate that adults occur over a wide range of habitats. Soft substrates of sand or mud usually had the highest densities; whereas hard substrates of bedrock, cobble or pebble usually had the lowest adult densities. Habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders.

Habitat and Biological Associations: Shortraker and Rougheye Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	U	U	U	U	U	U	
Larvae	U	U	Spawning: early spring through summer	U	U	U	U	
Juveniles	U	U; Shrimp & amphipods?	U	U; MCS, OCS?	U	U	U	
Adults	15+ years of age	Shrimp, Squid Myctophids	Year-round?	OCS, USP	SD	M, S, R, SM, CB, MS, G	U	

D.11.5 Literature

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D.12 Dusky rockfish

Note: The taxonomy of dusky rockfish is unclear. Two varieties occur which are likely distinct species: an inshore, shallow water, dark-colored variety; and a lighter-colored variety found in deeper water offshore. A taxonomic study is in progress that will probably describe the light variety as a new species. To avoid confusion, and because the light variety appears to be more abundant and is the object of a large, directed trawl fishery, this discussion of essential habitat will deal only with "light" dusky rockfish.

D.12.1 Life History and General Distribution

Light dusky rockfish range from Dixon Entrance at the U.S./Canada boundary, around the arc of the GOA, and westward throughout the Aleutian Islands. They are also found in the eastern Bering Sea north to about Zhemchug Canyon west of the Pribilof Is. Their distribution south of Dixon Entrance in Canadian waters is uncertain; dusky rockfish have been reported as far south as Johnstone Strait, Vancouver Is., but it is likely these were of the dark variety. The center of abundance for light dusky rockfish appears to be the GOA. The species is much less abundant in the Aleutian Islands and Bering Sea. Adult light dusky rockfish have a very patchy distribution, and are usually found in large aggregations at specific localities of the outer continental shelf. These localities are often relatively shallow offshore banks. Because the fish are taken with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no evidence of a pelagic tendency based on the information available at present. Most of what is known about light dusky rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on light dusky rockfish is extremely sparse. The fish are assumed to be viviparous, as are other *Sebastes*, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring, and is probably completed by

summer. Another, older source, however, lists parturition as occurring "after May." Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage, and whether a pelagic juvenile stage occurs, are unknown. There is no information on habitat and abundance of young juveniles (<25 cm fork length), as catches of these have been virtually nil in research surveys. Even the occurrence of older juveniles has been very uncommon in surveys, except for one year. In this latter instance, older juveniles were found on the continental shelf, generally at locations inshore of the adult habitat.

Light dusky rockfish is a slow growing species, with a low rate of natural mortality estimated at 0.09. However, it appears to be faster growing than many other rockfish species. Maximum age is 49-59 years. No information on age of maturity or fecundity is available. The approximate upper size limit of juvenile fish for the GOA is 47 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Sources of additional data

Eggs, Larvae, and Juveniles: None at present.

Adults: Rebecca Reuter, c/o NMFS, Alaska Fisheries Science Center, REFM Division, (206) 526-6546.

D.12.2 Fishery

Light dusky rockfish are caught almost exclusively with bottom trawls. Age at 50% recruitment is unknown. The fishery in the GOA in recent years has mostly occurred in the summer months, especially July, due to management regulations. Catches are concentrated at a number of relatively shallow, offshore banks of the outer continental shelf, especially the "W" grounds west of Yakutat, and Portlock Bank. Other fishing grounds include Albatross Bank, the "Snakehead" south of Kodiak Island, and Shumagin Bank. Outside of these banks, catches are generally sparse. Catch distribution by depth has not been summarized, but most of the fish are apparently taken at depths of 75-200 m.

For NPFMC-managed species, the major bycatch species in the GOA light dusky rockfish trawl fishery in 1993-95 included (in descending order by percent): "other" species of slope rockfish, northern rockfish, and Pacific ocean perch. There is no information available on the bycatch of non-NPFMC-managed species in the GOA light dusky rockfish fishery.

D.12.3 Relevant Trophic Information

Although no comprehensive food study of light dusky rockfish has been done, one smaller study in the GOA showed euphausiids to be the predominate food item of adults. Larvaceans, cephalopods, pandalid shrimp, and hermit crabs were also consumed.

Predators of light dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth flounder.

D.12.4 Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring, and may extend into summer.

Larvae: No information known.

Juveniles: No information known for small juveniles <25 cm fork length. Larger juveniles have been taken infrequently in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds.

Adults: Commercial fishery and research survey data suggest that adult light dusky rockfish are primarily found over reasonably flat, trawlable bottom of offshore banks of the outer continental shelf at depths of 75-200 m. Type of substrate in this habitat has not been documented. During submersible dives on the outer shelf (40-50m) in the eastern Gulf, light dusky rockfish were observed in association with rocky habitats and in areas with extensive sponge beds where adult duskys were observed resting in large vase sponges (pers. Comm. V. O'Connell). Generally, the fish appear to be demersal, and most of the population occurs in large aggregations. Light dusky rockfish are the most highly aggregated of the rockfish species caught in GOA trawl surveys. Outside of these aggregations, the fish are sparsely distributed. Because the fish are taken with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no evidence of a pelagic tendency based on the information available at present. There is no information on seasonal migrations. Light dusky rockfish often co-occur with northern rockfish.

Habitat and Biological Associations: Dusky Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	?Spring-summer	U	P (assumed)	NA	U	U
Juveniles	U	U	All year	ICS, MCS, OCS,	U (small juv.< 25 cm): ?D (Larger juv.)	U (juv.< 25 cm); ?Trawlable substrate (juv.>25 cm)	U	U
Adults	U	U	U	U	U	CB, R, G	U	U

D.12.5 Literature

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D.13 Demersal shelf rockfish

Managed in the Southeast Outside District of the Eastern regulatory area. Descriptions in text are for yelloweye rockfish, see table for other species. Species representatives are:

Yelloweye rockfish (primary, described below), *Sebastes ruberrimus*

Quillback rockfish, *Sebastes maliger*

Rosethorn rockfish, *Sebastes helvomaculatus*

Tiger rockfish, *Sebastes nigrocinctus*

Canary rockfish, *Sebastes pinniger*

China rockfish, *Sebastes nebulosus*

Copper rockfish, *Sebastes caurinus*

D.13.1 Life History and General Distribution

Demersal shelf rockfish are distributed from Ensendada, northern Baja California to Umnak I. and Unalaska I., Aleutians in depths from 60 to 1800 feet but commonly in 300 to 600 ft in rocky, rugged habitat (Allen and Smith, 1988, Eschmeyer et al 1983). Little is known about the young of the year and settlement. Young juveniles between 2.5 cm and 10 cm have been observed in areas of high and steep relief, in depths deeper than 15 m. Subadult and adult fish are generally solitary, occurring in rocky areas and high relief with refuge space, particularly overhangs, caves and crevices (O'Connell and Carlile 1993). Yelloweye are ovoviviparous. Parturition occurs in southeast Alaska between April and July with a peak in May (O'Connell 1987). Fecundity ranges from 1,200,000 to 2,700,000 eggs per season (Hart 1942, O'Connell unpublished data). Yelloweye feed on a variety of prey, primarily fishes (including other rockfishes, herring, and sandlance) as well as caridean shrimp and small crabs. Yelloweye are a K-selected species with late maturation, slow growth, extreme longevity, and low natural mortality. They reach a maximum length of about 91 cm and growth slows considerably after age 30. Approximately 50% are mature at 45 cm and 22 years, natural mortality (M) is estimated to be 0.02, and maximum age reported is 118 years (O'Connell and Fujioka 1991, O'Connell and Funk, 1987).

D.13.2 Fishery

Demersal shelf rockfish are the target of a directed longline fishery and are the primary bycatch species in the longline fishery for Pacific halibut. They recruit into the fishery at about age 18 to 20 at a length between

45 and 50 cm. The commercial fishery grounds are usually areas of rocky bottom between 20 and 100 nm. The directed fishery now occurs between November and March both because of higher winter prices and limitations imposed due to the halibut IFQ regulations.

D.13.3 Relevant Trophic Information

Yelloweye rockfish eat a large variety of organisms, primarily fishes includ small rockfishes, herring and sandlance, as well as caridean shrimp and small crabs (Rosenthal et al 1988). They also opportunistically consume lingcod eggs. Young rockfishes are in turn eaten by a variety of predators including lingcod, large rockfish, salmon, and halibut.

D.13.4 Habitat and Biological Associations

Young juveniles between 2.5 cm (1 inch) and 10 cm (4 inches) have been observed in areas of high relief (vertical walls, cloud sponges, fjord-like areas) in depths deeper than 15 m (personal communication Jeff Christiansen, The Seattle Aquarium). Subadult (late juveniles) and adult fish are generally solitary, occurring in rocky areas and high relief with refuge spaces particularly overhangs, caves and crevices (O'Connell and Carlile 1993). Not infrequently an adult yelloweye rockfish will cohabitate a cave or refuge space with a tiger rockfish. Habitat specific density data show an increasing density with increasing habitat complexity: deep water boulder fields consisting of very large boulders have significantly higher densities than other rock habitats (O'Connell and Carlile 1993). Although yelloweye do occur over cobble and sand bottoms, generally this is when foraging, and often these areas directly interface with a rock wall or outcrop.

Habitat and Biological Associations: Yelloweye Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	NA							
Larvae	<6 mo?	Copepod?	Spring/ Summer	U	N?	U	U	
Juveniles	to 10 yrs	U		ICS, MCS, OCS, BAY, IP, Other?	D	R, C, Other?	U	
Adults	10-18 yrs	U		ICS, MCS, OCS, BAY, IP, Other?	D	R, C, Other?	U	

Habitat and Biological Associations: Other Demersal Shelf Rockfish species. Larvae and juvenile, EFH level 0, late juvenile and adult, EFH level 1; location primarily inner and outer continental shelf and the upper slope, over rock and cobble bottom.

Species	Range/Depth	Maximum Age	Trophic	Parurition	Known Habitat
Quillback	Kodiak Island to San Miguel Island, CA To 274 m (commonly 12-76 m)	At least 32 50% SM=30 cm	Main prey = crustaceans, herring, Sandlance	Spring (Mar-Jun)	Juveniles have been observed at the margins of kelp beds, adults occur over rock bottom, or over cobble/sand next to reefs
Copper	Shelikof St to central Baja, CA Shallow to 183 m (commonly to 122 m)	At least 31 years 50% SM=5 yr	Crustaceans Octopi Small fishes	Mar-Jul	Juveniles have been observed near eelgrass beds and in kelp, in areas of mixed sand and rock. Adults are in rocky bays and shallow coastal areas, generally less exposed than the other DSR
Tiger	Kodiak Is and Prince William Sound to Tanner-Cortes Banks, CA From 33 to 183 m	To 116 yrs	Invertebrates, primarily crustaceans	Early spring	Juveniles and adults in rocky areas: most frequently observed in boulder areas, generally under overhangs.
China	Kachemak Bay to San Miguel Island, CA To 128 m	To 72 yrs	Invertebrates, Brittle stars are significant component of diet	Apr-Jun	Juveniles have been observed in shallow kelp beds, adults in rocky reefs and boulder fields. Some indications that adults have a homesite.
Rosethorn	Kodiak Is to Guadalupe Is, Baja, CA To 25 m to 549 m	To 87 yrs Mature 7-10 yrs		Feb-Sept (May)	Observed over rocky habitats and in rock pavement areas with large sponge cover
Canary	Shelikof St to Cape Colnett, Baja, CA To 424 m (commonly to 137 m)	To 75 yrs 50% sm = 9	Macroplankton and small fishes		Occur over rocky and sand/cobble bottoms, often hovering in loose schools over soft bottom near rock outcrops. Schools often associate with schools of yellowtail and silvergrey.

D.13.5 Literature

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D.14 Thornyhead Rockfish

D.14.1 Life History and General Distribution

Thornyheads of the northeastern Pacific Ocean are comprised of two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). The longspine thornyhead is not common in the GOA. The shortspine thornyhead is a demersal species which inhabits deep waters from 93 to 1,460 m from the Bering Sea to Baja California. This species is common throughout the GOA, eastern Bering Sea and Aleutian Islands. The population structure of shortspine thornyheads, however, is not well defined. Thornyheads are slow-growing and long-lived with maximum age in excess of 50 years and maximum size greater than 75 cm and 2 kg. Thornyheads spawn buoyant masses of eggs during the late winter and early spring that resemble bilobate "balloons" which float to the surface. Juvenile shortspine thornyheads have a pelagic period of about 14-15 months and settle out at about 22 to 27 mm. Fifty percent of female shortspine thornyheads are sexually mature at about 21 cm and 12-13 years of age. Female shortspine thornyheads appear to be mature at about 21-22 cm.

Sources of additional distribution data

Larvae:

NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall, 206-526-4108.

D.14.2 Fishery

Trawl and longline gear are the primary methods of harvest. The bulk of the fishery occurs in late winter or early spring through the summer. In the past, this species was seldom the target of a directed fishery. Today thornyheads are one of the most valuable of the rockfish species, with most of the domestic harvest exported to Japan. Thornyheads are taken with some frequency in the longline fishery for sablefish and cod and is often part of the bycatch of trawlers concentrating on pollock and Pacific ocean perch.

D.14.3 Relevant Trophic Information

Shortspine thornyheads prey mainly on epibenthic shrimp and fish. Yang (1993) showed that shrimp were the top prey item for shortspine thornyheads in the GOA. Differences in abundance of the main prey between the GOA and Aleutian Islands areas might be the main reason for the observed diet differences. Predator size might by another reason for the difference since the average shortspine thornyhead in the Aleutian Islands area was larger than that in the GOA (33.4 cm vs 29.7 cm).

D.14.4 Habitat and Biological Associations

Egg/Spawning: Eggs float in masses of various sizes and shapes. Frequently the masses are bilobed with the lobes 15 cm to 61 cm in length, consisting of hollow conical sheaths containing a single layer of eggs in a gelatinous matrix. The masses are transparent and not readily observed in the daylight. Eggs are 1.2 to 1.4 mm in diameter with a 0.2 mm oil globule. They move freely in the matrix. Complete hatching time is unknown but is probably more than 10 days.

Larvae: Three day-old larvae are about 3 mm long and apparently float to the surface. It is believed that the larvae remain in the water column for about 14-15 months before settling to the bottom.

Juveniles: Very little information is available regarding the habitats and biological associations of juvenile shortspine thornyheads.

Adults: Adults are demersal and can be found at depths ranging from about 90 to 1,500 m. Groundfish species commonly associated with thornyheads include: arrowtooth flounder (*Atheresthes stomias*), Pacific ocean perch (*Sebastes alutus*), sablefish *(Anoplopoma fimbria*), rex sole (*Glyptocephalus zachirus*), Dover sole (*Microstomus pacificus*), shortraker rockfish (*Sebastes borealis*), rougheye rockfish (*Sebastes aleutianus*), and grenadiers (family Macrouridae).

Habitat and Biological Associations: Thornyhead Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	U	Spawning: late winter, early spring	U	P	U	U	
Larvae	<15 Months	U	early spring - summer	U	P	U	U	
Juveniles	> 15 months (?) when settling to bottom occurs	U; Shrimp, Amphipods, Mysids, Euphausiids?	U	MCS, OCS, USP	D	M, S, R, SM, CB, MS, G	U	
Adults	U	Shrimp, small crabs, fish (cottids)	Year-round?	MCS, OCS, USP, LSP	D	M, S, R, SM, CB, MS, G	U	

D.14.5 Literature

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D.15 Atka mackerel

D.15.1 Life History and General Distribution

Atka mackerel are distributed from the GOA to the Kamchatka Peninsula, most abundant along the Aleutians. Adult Atka mackerel occur in large localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are pelagic during much of the year, but migrate annually to moderately shallow waters where they become demersal during spawning. Spawning peaks in June through September, but may occur intermittently throughout the year. Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Eggs hatch in 40-45 days, releasing planktonic larvae which have been found up to 800 km from shore. Little is known of the distribution of young Atka mackerel prior to their appearance in trawl surveys and the fishery at about age 2-3 years. Atka mackerel exhibit intermediate life history traits. The approximate upper size limit of Atka mackerel is 35 cm. R-traits include young age at maturity (approximately 50% are mature at age 3), fast growth rates, high natural mortality (M=0.3) and young average and maximum ages (about 5 and 14 years, respectively). K-selected traits include low fecundity (only about 30,000 eggs/female/year, large egg diameters (1-2 mm) and male nest-guarding behavior).

<u>Sources of additional distribution data</u>

Larvae:

NMFS, Alaska Fishery Science Center, FOCI program, Rick Brodeur 206-526-4318

Juveniles:

NMFS, Alaska Fishery Science Center, NMML, Richard Merrick 206-526-6173

D.15.2 Fishery

Atka mackerel recruit at about age 3 in bottom trawls, and some pelagic trawls. Trawling is conducted in the GOA at depths between about 70-225 m, in trawlable areas on rocky, uneven bottom, along edges, and in lee of submerged hills during periods of high current. Historically fishery occurred east into the GOA as far as Kodiak Island (through the mid-1980s), but is no longer there. The fishery has been on ‘bycatch only’ status in the GOA for many years.

D.15.3 Relevant Trophic Information

Atka mackerel are important food for Steller sea lions in the Aleutian Islands, particularly during summer, and for other marine mammals (minke whales, Dall's porpoise and northern fur seal). Juveniles eaten by thick billed murres and tufted puffins. Main groundfish predators are Pacific halibut, arrowtooth flounder, and Pacific cod.

D.15.4 Habitat and Biological Associations

Egg/Spawning: Eggs deposited in nests built and guarded by males on rocky substrates or on kelp in shallow water.

Larvae/Juveniles: Planktonic larvae have been found up to 800 km from shore, usually in upper water column (neuston), but little is known of the distribution of Atka mackerel until they are about 2 years old and appear in fishery and surveys.

Adults: Adults occur in localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are semi-demersal/pelagic during much of the year, but migrate annually to moderately shallow waters where the males become demersal during spawning; females move between nesting and offshore feeding areas.

Habitat and Biological Associations: Atka mackerel

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	40-45 days	NA	summer	IP, ICS	D	G, R, K	U	develop 3-20˚C optimum 9-13˚C
Larvae	up to 6 months	U copepods?	fall-winter	U	U N?	U	U	2-12˚C optimum 5-7˚C
Juveniles	½-2 years	U; copepods, euphausiids?	all year	U	U	U	U	3-5˚C
Adults	3+ years	copepods, euphausiids, meso-pelagic fish (myctophids)	spawning May-Oct non-spawning Nov-Apr tidal/diurnal, year-round?	ICS, MCS, IP MCS, OCS, IP ICS, MCS, OCS, IP	D (males) SD (females) SD/D all sexes D when currents high/day; SD when slack tides/ night	G, R, K	F, E	3-5˚C all stages >17 ppt only

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D.16 Skates

The species representatives for skates are:

Alaska skate (*Bathyraja parmifera)*

Aleutian skate (*Bathyraja aleutica)*

Bering skate or sandpaper skate (*Bathyraja interrupta)*

Mud skate (*Bathyraja tanaretzi)*

Black or roughtail skate (*Bathyraja trachura)*

Commander skate (*Bathyraja lindberghi)*

Whiteblotched skate (*Bathyraja maculata)*

Big skate (*Raja binoculata*)

Longnose skate (*Raja rhina*)

Based on the 1999 Alaska Fisheries Science Center GOA bottom trawl survey results, the majority of the skate biomass is big skate (50%) and longnose skate (33%).

D.16.1 Life History and General Distribution:

Skates (Rajidae) that occur in the BSAI and GOA are grouped into two genera: *Bathyraja sp.*, or soft-nosed species (rostral cartilage slender and snout soft and flexible), and *Raja* sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). They are dorso-ventrally compressed (flat) animals with large pectoral wings attached to the sides of the head, and long, narrow whiplike tails. Skates are long-lived and have low fecundity. Reproduction is ovoviparous; fertilization is internal and eggs (usually one in each case, except for 1-7 in big skate egg cases) are deposited in horny cases for incubation.

Skates, as a group, represent the highest proportion of estimated non-target species catch weight (28 percent) during 1997 to 1999) in both the BSAI and GOA combined. The biomass of all skate species combined as estimated by the Alaska Fisheries Science Center (AFSC) bottom trawl surveys has generally increased in both areas over the past 15 to 20 years, although it has declined somewhat from the 1990 peak in the eastern Bering Sea (NMFS 1999). Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. The approximate upper size limit of juvenile fish is nknown for most species. For big skates, age and length at maturity are 8-12 years and 109-130 cm. For longnose skates, age and length at maturity are 7-10 years and 74-100 cm. (Zeiner and Wolf 1993).

Skate species distributions from Meckelenberg, Mecklenberg, and Thorsteinson 2002:

Alaska skate:	mostly 90-250 m on shelf in eastern Bering Sea (EBS) and Aleutian Islands (AI) and western GOA (GOA);
Aleutian skate:	throughout EBS, AI, and GOA, 100-1400 m;
Bering skate:	throughout EBS, AI, and GOA, 90-460 m;
Mud skate:	Not confirmed to occur in the GOA;
Black skate:	In AI, EBS and GOA, 400-1500 m;
Commander skate:	EBS, AI and not confirmed in the GOA, 120-2000 m;
Whiteblotched skate:	EBS and AI, not confirmed in the GOA, 100-1100 m;
Big skate:	EBS, AI, and GOA, 22-190 m; and
Longnose skate:	EBS, AI and GOA 20-650 m.

Source of Additional Data

William Raschi, Bucknell University

D.16.2 Fishery

Skates are caught as bycatch in both longline and trawl fisheries, primarily in the Pacific cod, rex sole and sablefish fisheries. They generally are discarded (and may survive depending on catch handling practices), although skates caught incidentally are sometimes retained and processed. Markets for skate products are currently limited in the North Pacific, but skates are subject to directed fisheries in other areas (e.g., Martin and Zorzi 1993, Agnew et al. 1998).

In 2003, a directed fishery for skates developed in the GOA. Skates were removed from the “other species” list in the FMP in 2004 under Amendment 63 to allow for separate management for the directed fishery. Skates are primarily directly fished during the closure of the longline or trawl Pacific cod directed fisheries. Harvest has been concentrated in the Central regulatory area on Big and longnose skate species.

D.16.3 Relevant Trophic Information

Skates feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

D.16.4 Habitat and Biological Associations

Egg/Spawning: Deposit eggs in horny cases on shelf and slope.

Juveniles and Adults: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown. Adults found across wide areas of shelf and slope; surveys found most skates at depths <500 m in the GOA and EBS, but >500 m in the AI. In the GOA, most skates found between 4-7° C, but data are limited.

Habitat and Biological Associations: Skates

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	NA	U	MCS, OCS, USP	D	U	U	
Larvae	NA	NA	NA	NA	NA	NA	NA	
Juveniles	U	Invertebrates, small fish	all year	MCS, OCS, USP	D	U	U	
Adults	U	Invertebrates, small fish	all year	MCS, OCS, USP	D	U	U	

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D.17 Capelin

The species representative for capelin is *Mallotus villosus*.

D.17.1 Life History and General Distribution

Capelin is a short-lived marine (neritic), pelagic, filter-feeding schooling fish distributed along the entire coastline of Alaska and the Bering Sea, and south along British Columbia to the Strait of Juan de Fuca; they are circumpolar. In the North Pacific, capelin grow to a maximum of 25 cm and 5 years of age. They spawn

at ages 2-4 in spring and summer (May-Aug – earlier in south, later in north) when about 11-17 cm, on coarse sand/fine gravel beaches, especially in Norton Sound, northern Bristol Bay, and along the Alaska Peninsula. Age at 50% maturity is 2 years. The approximate upper size limit of juvenile capelin is 13 cm. Their level of fecundity is 10,000-15,000 eggs per female. Eggs hatch in 2-3 weeks. Most capelin (60-70%) die after spawning. Larvae and juveniles are distributed on inner-mid shelf in summer (rarely found in waters deeper than about 200 m), and juveniles and adults congregate in fall in mid-shelf waters east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands, and north into the Gulf of Anadyr. Distributed along outer shelf and under ice edge in winter. Larvae, juveniles and adults have diurnal vertical migrations following scattering layers - night near surface, at depth during the day. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Sources of additional distribution data

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961

Jim Blackburn, ADFG, Kodiak AK 907-486-1861

D.17.2 Fishery

Capelin are not a target species in groundfish fisheries of the GOA.

D.17.3 Relevant Trophic Information

Capelin are important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts also comprise significant portions of the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the Bering Sea (Allen 1987).

D.17.4 Habitat and Biological Associations

Egg/Spawning: Spawn adhesive eggs (about 1 mm in diameter) on fine gravel or coarse sand (0.5-1 mm grain size) beaches intertidally to depths of up to 10 m in May-July in Alaska (later to the north in Norton Sound). Hatching occurs in 2-3 weeks. Most intense spawning when coastal water temperatures are 5-9˚C.

Larvae: After hatching, 4-5 mm larvae remain on the middle-inner shelf in summer; distributed pelagically; centers of distribution are unknown, but have been found in high concentrations north of Unimak Island.

Juveniles: In fall, juveniles are distributed pelagically in mid-shelf waters (50-100 m depth; -2-3˚C), and have been found in highest concentrations east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Adults: Found in pelagic schools in inner-mid shelf in spring-fall, feed along semi-permanent fronts separating inner, mid, and outer shelf regions (~50 and 100 m). In winter, found in concentrations under ice-edge and along mid-outer shelf.

Habitat and Biological Associations: Capelin

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	2-3 weeks to hatch	NA	May-August	BCH (to 10 m)	D	S, CB		5-9˚C peak spawning
Larvae	4-8 months?	Copepods phytoplankton	summer/fall/ winter	ICS, MCS	N, P	U NA?	U	
Juveniles	1.5+ years up to age 2	Copepods Euphausiids	all year	ICS, MCS	P	U NA?	U; F?; Ice edge in winter	
Adults	2 years ages 2-4+	Copepods, Euphausiids, polychaetes, small fish	spawning May-Aug non-spawning Sep-Apr	BCH (to 10 m) ICS, MCS, OCS	D, SD P	S, CB NA?	F; Ice edge in winter	-2 - 3˚C Peak distributions in Bering Sea?

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D.18 Eulachon

The species representative for eulachon is the candlefish *(Thaleichthys pacificus*).

D.18.1 Life History and General Distribution

Eulachon is a short-lived anadromous, pelagic schooling fish distributed from the Pribilof Islands in the eastern Bering Sea, throughout the GOA, and south to California. They are consistently found pelagically in Shelikof Strait (hydroacoustic surveys in late winter-spring) and between Unimak Island and the Pribilof Islands (bycatch in groundfish trawl fisheries) from the middle shelf to over the slope. In the North Pacific, eulachon grow to a maximum of 23 cm and 5 years of age. Eulachon spawn at ages 3-5 in spring and early summer (April-June) when about 14-20 cm in rivers on coarse sandy bottom. Age at 50% maturity is 3 years. The approximate upper size limit of is 14 cm. Fecundity is approximately 25,000 eggs per female. Eggs adhere to sand grains and other substrates on river bottom. Eggs hatch in 30-40 days in BC at 4-7˚C. Most

eulachon die after first spawning. Larvae drift out of rivers and develop at sea. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Sources of Additional Data

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961

Jim Blackburn, ADFG, Kodiak AK 907-486-1861

D.18.2 Fishery

Eulachon are not a target species in groundfish fisheries of GOA.

D.18.3 Relevant Trophic Information

Eulachon may be important prey for marine birds and mammals, as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts also comprise significant portions of the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the Bering Sea (Allen 1987).

D.18.4 Habitat and Biological Associations

Egg/Spawning: Anadromous; return to spawn in spring (May-June) in rivers; demersal eggs adhere to bottom substrate (sand, cobble, etc.). Hatching occurs in 30-40 days.

Larvae: After hatching, 5-7 mm larvae drift out of river and develop pelagically in coastal marine waters; centers of distribution are unknown.

Juveniles and Adults: Distributed pelagically in mid-shelf to upper slope waters (50-1000 m water depth), and have been found in highest concentrations between the Pribilof Islands and Unimak Island on the outer shelf, and in Shelikof east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Habitat and Biological Associations: Eulachon (Candlefish)

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	30-40 days	NA	Apr-Jun	Rivers, FW	D	S (CB?)		4-8˚C for egg development
Larvae	1-2 months?	Copepods, phytoplankton, mysids, larvae	summer/fall	ICS ?	P?	U NA?	U	
Juveniles	2.5+ years up to age 3	Copepods, Euphausiids	all year	MCS, OCS, USP	P	U NA?	U F?	
Adults	3 years ages 3-5+	Copepods, Euphausiids	spawning: May-Jun non-spawning: Jul-Apr	Rivers-FW MCS, OCS, USP	D P	S (CB?) NA?	F?	

D.18.5 Literature

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D.19 Sculpins

The species representatives for sculpins are:

Yellow Irish lord (*Hemilepidotus jordani)*

Red Irish lord (*Hemilepidotus hemilepidotus*)

Butterfly sculpin (*Hemilepidotus papilio*)

Bigmouth sculpin (*Hemitripterus bolini*)

Great sculpin (*Myoxocephalus polyacanthocephalus*)

Plain sculpin (*Myoxocephalus jaok*)

D.19.1 Life History and General Distribution

The Cottidae (sculpins) is a large circumboreal family of demersal fishes inhabiting a wide range of habitats in the north Pacific Ocean and Bering Sea. Most species live in shallow water or in tidepools, but some inhabit the deeper waters (to 1000 m) of the continental shelf and slope. Most species do not attain a large size (generally 10-15 cm), but those that live on the continental shelf and are caught by fisheries can be 30-50 cm; the cabezon is the largest sculpin and can be as long as 100 cm. The upper size limit of juvenile fish is unknown. Most sculpins spawn in the winter. All species lay eggs, but in some genera, fertilization is internal. The female commonly lays demersal eggs amongst rocks where they are guarded by males. Egg incubation duration is unknown; larvae were found across broad areas of the shelf and slope, and were found all year-round, in ichthyoplankton collections from the GOA. Larvae exhibit diel vertical migration (near surface at night and at depth during the day). Sculpins generally eat small invertebrates (e.g., crabs, barnacles, mussels), but fish are included in the diet of larger species; larvae eat copepods.

Yellow Irish lords: distributed from subtidal areas near shore to the edge of the continental shelf (down to 200 m) throughout the Bering Sea, Aleutian Islands, and eastward into the GOA as far as Sitka, AK; up to 40 cm in length. 12-26 mm larvae collected in spring on the western GOA shelf.

Red Irish lords: distributed from rocky, intertidal areas to about 100 m depth on the middle continental shelf (most shallower than 50 m), from California (Monterey Bay) to Kamchatka; throughout the Bering Sea and GOA; rarely over 30 cm in length. Spawns masses of pink eggs in shallow water or intertidally. Larvae were 7-20 mm long in spring in the western GOA.

Butterfly sculpins: distributed primarily in the western north Pacific and northern Bering Sea, from Hokkaido, Japan, Sea of Okhotsk, Chukchi Sea, to southeast Bering Sea and in Aleutian Islands; depths of 20-250 m, most frequent 50-100 m.

Bigmouth sculpin: distributed in deeper waters offshore, between about 100-300 m in the Bering Sea, Aleutian Islands, and throughout the GOA; up to 70 cm in length.

Great sculpin: distributed from the intertidal to 200 m, but may be most common on sand and muddy/sand bottoms in moderate depths (50-100 m); up to 80 cm in length. Found throughout the Bering Sea, Aleutian Islands, and GOA, but may be less common east of Prince William Sound. *Myoxocephalus* spp. larvae ranged in length from 9-16 mm in spring ichthyoplankton collections in the western GOA.

Plain sculpin: distributed throughout the Bering Sea and GOA (not common in the Aleutian Islands) from intertidal areas to depths of about 100 m, but most common in shallow waters (<50 m); up to 50 cm in length. *Myoxocephalus* spp. larvae ranged in length from 9-16 mm in spring ichthyoplankton collections in the western GOA.

Sources for Additional Data

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961

Jim Blackburn, ADFG, Kodiak AK 907-486-1861

D.19.2 Fishery

Sculpins are not a target of groundfish fisheries of the GOA, but sculpin bycatch (second to skates in weight amongst the Other Species) has ranged from 500-1,400 mt per year from 1992-95. Bycatch occurs principally in bottom trawl fisheries for flatfish, Pacific cod and pollock, but also while longlining for Pacific cod; almost all is discarded. Annual sculpin bycatch in the BSAI ranges between 1-4% of annual survey biomass estimates, however little is known of the species distribution of the bycatch.

D.19.3 Relevant Trophic Information

Sculpins feed on bottom invertebrates (e.g., crabs, barnacles, mussels and other molluscs); larger species eat fish.

D.19.4 Habitat and Biological Associations

Egg/Spawning: Lay demersal eggs in nests guarded by males; many species in rocky shallow waters near shore.

Larvae: Distributed pelagically and in neuston across broad areas of shelf and slope, but predominantly on inner and middle shelf; have been found all year-round.

Juveniles and Adults: Sculpins are demersal fish, and live in a broad range of habitats from rocky intertidal pools to muddy bottoms of the continental shelf, and rocky, upper slope areas. Most commercial bycatch occurs on middle and outer shelf areas used by bottom trawlers for Pacific cod and flatfish.

Habitat and Biological Associations: Sculpins

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	winter?	BCH, ICS (MCS, OCS?)	D	R (others?)	U	
Larvae	U	copepods	all year?	ICS, MCS, OCS, USP	N, P	NA?	U	
Juveniles and Adults	U	bottom invertebrates (crabs, molluscs, barnacles) and small fish	all year	BCH, ICS, MCS, OCS, UPS	D	R, S, M, SM	U	

D.19.5 Literature

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D.20 Sharks

The species representatives for sharks are:

Lamnidae: Salmon shark (*Lamna ditropis*)

Squalidae: Sleeper shark (*Somniosus pacificus*)
Spiny dogfish (*Squalus acanthias*)

D.20.1 Life History and General Distribution

Sharks of the order Squaliformes (which includes the two families Lamnidae and Squalidae) are the higher sharks with five gill slits and two dorsal fins. The Lamnidae are large, ovoviviparous (with small litters, 1-4; embryos nourished by intrauterine cannibalism), widely migrating sharks that are highly aggressive predators (salmon and white sharks). The Lamnidae are partly warm-blooded; the heavy trunk muscles are warmer than water for greater power and efficiency.

Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the GOA (where they occur all year and are probably most abundant in our area), the Bering Sea and off Japan. In groundfish fishery and survey data, they occur near coast to the outer shelf, particularly near Kodiak Island. Upper size limit of juvenile sharks in not known. They can be up to 3 m in length.

The Pacific sleeper shark is distributed from California around the Pacific rim to Japan and in the Bering Sea principally on the outer shelf and upper slope (but has been observed nearshore), generally demersal (but also seen near surface). Other members of the Squalidae are ovoviviparous, but fertilization and development of sleeper sharks are not known; adults are up to 8 m in length. In groundfish fishery and survey data, they occur near coast to the outer shelf, particularly near Kodiak Island.

Spiny dogfish (or closely related species?) are widely distributed through the Atlantic, Pacific and Indian Oceans. In the north Pacific, they may be most abundant in the GOA. They are a pelagic species, found at surface and to depths of 700 m; mostly 200 m or less on shelf and neritic, they are often found in aggregations. Spiny dogfish are ovoviviparous, with litter size proportional to size of female, from 2-9; gestation may be 22-24 months. Young are 24-30 cm at birth, with growth initially rapid, then slowing dramatically. Maximum adult size is about 1.6 m, and 10 kg; maximum age about 40 years. 50% of females are mature at 94 cm and 29 years old; males, at 72 cm and 19 years old. Females give birth in shallow coastal waters, usually in Sept-Jan. Tagging experiments indicate local indigenous populations in some areas and widely migrating groups in others. May move inshore in summer and offshore in winter.

Source of Additional Data

William Raschi, Bucknell University

D.20.2 Fishery

Sharks are not a target of groundfish fisheries of the GOA, but shark bycatch has ranged from 300-700 mt per year from 1992-95 principally by pelagic trawl fishery for pollock, longline fisheries for Pacific cod and sablefish, and bottom trawl fisheries for pollock, flatfish and cod; almost all discarded.

D.20.3 Relevant Trophic Information

Salmon sharks are believed to eat primarily fish, including salmon, sculpins and gadids. Pacific sleeper sharks are voracious, omnivorous predators of flatfish, cephalopods, rockfish, crabs, seals, salmon; they may also prey on pinnipeds. Dogfish eat a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus).

D.20.4 Habitat and Biological Associations

Egg/Spawning: Salmon sharks and spiny dogfish are ovoviviparous; reproductive strategy of sleeper sharks is not known. Spiny dogfish give birth in shallow coastal waters, while salmon sharks probably offshore and pelagic.

Juveniles and Adults: Spiny dogfish are widely dispersed throughout the water column along the shelf in the GOA; apparently not as commonly found at depths > 200 m. Salmon sharks are found throughout the GOA; epipelagic, primarily over the shelf/slope in the GOA. Sleeper sharks are widely dispersed on the shelf/upper slope in the GOA; generally demersal.

Habitat and Biological Associations: Sharks

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Juvenile/Adults:								
Salmon shark	U	fish (salmon, sculpins, gadids)	all year	OCS, USP	P	NA	U	
Sleeper shark	U	omnivorous: flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	OCS, USP	D	U	U	
Spiny dogfish	40 years	fish (smelts, herring, sand lance, other small schooling fish), crustaceans (crabs, euphausiids, shrimp), cephalopods (octopus)	all year	OCS; give birth ICS in fall/winter?	P	U	U	Euhaline 4-16˚C

D.20.5 Literature

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Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

D.21 Squid

The species representatives for squid are:

Gonaditae:	Red or magistrate armhook squid (*Berryteuthis magister*)
Onychoteuthidae:	Boreal clubhook squid (*Onychoteuthis banksii borealjaponicus)*
	Giant or robust clubhook squid (*Moroteuthis robusta*)
Sepiolidae:	eastern Pacific bobtail squid (*Rossia pacifica*)

D.21.1 Life History and General Distribution:

Squid are members of the molluscan class Cephalopoda, along with octopus, cuttlefish and nautiloids. In the BSAI and GOA, gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities > 30 ppt. Fertilization is internal, and development is direct ("larval" stages are only small versions of adults). The eggs of inshore neritic species are often enveloped in a gelatinous matrix attached to rocks, shells or other hard substrates, while the eggs of some offshore oceanic species are extruded as large, sausage-shaped drifting masses. Little is known of the seasonality of reproduction, but most species probably breed in spring-early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2-3 years, but the giant *Moroteuthis robusta* clearly lives longer.

B magister: widely distributed in the boreal north Pacific from California, throughout the Bering Sea, to Japan in waters of depth 30-1500 m; adults most often found at mesopelagic depths or near bottom on shelf, rising to the surface at night; juveniles are widely distributed across shelf, slope and abyssal waters in meso- and epipelagic zones, and rise to surface at night. The species migrates seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. The upper size limit of juvenile fish for *B. magister* is approximately 20 cm mantle length for males, 25 cm mantle length for females; both at approximately 1 year of age.The maximum size for females is 50 cm mantle length and for males is 40 cm mantle length. Spermatophores transferred into the mantle cavity of female, and eggs are laid on the bottom on the upper slope (200-800 m). Fecundity is estimated at 10,000 eggs/female. Spawning of eggs occurs in Feb-Mar in Japan, but apparently all year-round in the Bering Sea. Eggs hatch after 1-2 months of incubation; development is direct. Adults are gregarious prior to mating, and most die afterwards.

O. banksii borealjaponicus: an active, epipelagic species, distributed in the north Pacific from the Sea of Japan, throughout the Aleutian Islands and south to California, but is absent from the Sea of Okhotsk and not common in the Bering Sea. Juveniles can be found over shelf waters at all depths and near shore. Adults apparently prefer the upper layers over slope and abyssal waters; diel migrators and gregarious. Development includes a larval stage; maximum size is about 55 cm.

M. robusta: a giant squid, lives near the bottom on the slope, and mesopelagically over abyssal waters; rare on the shelf. It is distributed in all oceans, and is found in the Bering Sea, Aleutian Islands and GOA. Mantle length can be up to 2.5 m long; with tentacles at least 7 m, but most are about 2 m long.

R. pacifica: a small (maximum length with tentacles of less than 20 cm) demersal, neritic and shelf, boreal species, distributed from Japan to California in the North Pacific and in the Bering Sea in waters of about 20-300 m depth. Other *Rossia* spp. deposit demersal egg masses.

Source of additional information

Beth Sinclair, NMFS, Seattle, WA 206-526-6466

D.21.2 Fishery

Squid are not currently a target of groundfish fisheries of the GOA. A Japanese fishery catching up to 9,000 mt of squid annually existed until the early 1980s for *B. magister* in the Bering Sea and *O. banksii borealjaponicus* in the Aleutian Islands. Since 1990, annual squid bycatch has been about 1,000 mt or less in the BSAI; trawl fisheries for rockfish and pollock (mostly near the edge of the shelf and on the upper slope) catch most of the squid bycatch.

D.21.3 Relevant Trophic Information

The principal prey items of squid are small forage fish pelagic crustaceans (e.g., euphausiids and shrimp), and other cephalopods; cannibalism is not uncommon. After hatching, small planktonic zooplankton (copepods) are eaten. Squid are preyed upon by marine mammals, seabirds, and, to a lesser extent by fish, and occupy an important role in marine food webs worldwide. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break (e.g., Buldir Island, Pribilof Islands) are known to feed heavily on squid (Hatch et al. 1990; Byrd et al. 1992; Springer 1993). In the GOA, only about 5% of the diets of most groundfish consisted of squid (Yang 1993). However, squid play a larger role in the diet of salmon (Livingston and Goiney 1983).

D.21.4 Habitat and Biological Associations for *B. magister*

Egg/Spawning: Eggs are laid on the bottom on the upper slope (200-800 m); incubate for 1-2 months.

Young Juveniles: Distributed epipelagically (top 100 m) from the coast to open ocean.

Old Juveniles and Adults: Distributed mesopelagically (most from 150-500 m) on the shelf (summer only?), but mostly in outer shelf/slope waters (to lesser extent over the open ocean). Migrate to slope waters to mate and spawn demersally.

Habitat and Biological Associations: *Berryteuthis magister* (red squid)

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	1-2 months	NA	varies	USP, LSP	D	M, SM, MS	U	
Young juveniles	4-6 months	zooplankton		All shelf, slope, BSN	P, N	NA	UP, F?	
Older Juveniles and Adults	1-2 years (may be up to 4 years)	euphausiids, shrimp, small forage fish, and other cephalopods	summer	All shelf, USP, LSP, BSN	SP	U	UP, F?	
			winter	OS, USP, LSP, BSN	SP	U	UP, F?	Euhaline waters, 2-4˚C

D.21.5 Literature

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D.22 Octopus

The species representatives for octopus are:

Octopoda: Octopus *(Octopus gilbertianus; O. dofleini*)

Vampyromorpha: Pelagic octopus (*Vampyroteuthis infernalis*)

D.22.1 Life History and General Distribution

Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish and nautiloids. In the BSAI, the most commonly encountered octopods are the shelf demersal species *O. gilbertianus* and *O. dofleini*, and the bathypelagic finned species, *V. infernalis*. Octopods, like other cephalopods are dioecious, with fertilization of eggs (usually within the mantle cavity of the female) requiring transfer of spermatophores during copulation. Octopods probably do not live longer than about 2-4 years, and females of some species (e.g., *O. vulgaris*) die after brooding their eggs on the bottom.

O. gilbertianus: Medium sized octopus (up to 2 m in total length) distributed across the shelf (to 500 m depth) in the eastern and western Bering Sea (where it is the most common octopus), Aleutian Islands, and GOA (endemic to the North Pacific). Little is known of its reproductive or trophic ecology, but eggs laid on the bottom and tended by females. Lives mainly among rocks and stones.

O. dofleini: Giant octopus (up to 10 m in total length, though mostly about 3-5 m) distributed in the southern boreal region from Japan and Korea, through the Aleutian Islands, Gulf Alaska, and south along the Pacific coast of North America to California. Inhabits the sublittoral

to upper slope. Egg length 6-8 mm; laid on bottom. Copulation may occur in late fall-winter, but oviposition the following spring; each female lays several hundred eggs.

V. infernalis: Relatively small (up to about 40 cm total length) bathypelagic species, living at depths well below the thermocline; may be most commonly found at 700-1500 m. Found throughout the world's oceans. Eggs are large (3-4 mm in diameter) and are shed singly into the water. Hatched juveniles resemble adults, but with different fin arrangements, which change to the adult form with development. Little is known of their food habits, longevity, or abundance.

D.22.2 Fishery

Octopods are not currently a target of groundfish fisheries of the GOA. Bycatch has ranged between 40-100 mt in the GOA, chiefly in the pot fishery for Pacific cod and bottom trawl fisheries for cod and flatfish, but sometimes in the pelagic trawl pollock fishery. Directed octopus landings have been less than 8 mt/year for 1988-95. Age and size at 50% recruitment is unknown. Most of the bycatch occurs on the outer continental shelf (100-200 m depth), around Kodiak Island.

D.22.3 Relevant Trophic Information

Octopods are eaten by pinnipeds (principally Steller sea lions, and spotted, bearded, and harbor seals) and a variety of fishes, including Pacific halibut and Pacific cod (Yang 1993). When small, octopods eat planktonic and small benthic crustaceans (mysids, amphipods, copepods). As adults, octopus eat benthic crustaceans (crabs) and molluscs (clams).

D.22.4 Habitat and Biological Associations

Egg/Spawning: shelf; eggs laid on bottom, maybe preferentially among rocks and cobble.

Young Juveniles: semi-demersal; widely dispersed on shelf, upper slope

Old Juveniles and Adults: demersal, widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud.

Habitat and Biological Associations: *Octopus dofleini*, *O. gilbertianus*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U; (1-2 months?)	NA	spring-summer?	U; (ICS, MCS?)	D	R, G?	U	Euhaline waters
Young juveniles	U	zooplankton	summer-fall?	U; (ICS, MCS, OCS, USP?)	D, SD	U	U	Euhaline waters
Older Juveniles and Adults	U ; (2-3 years? for *O.gilbertianus*; older for *O.dofleini*)	crustaceans, molluscs	all year	ICS, MCS, OCS, USP	D	R, G, S, MS?	U	Euhaline waters

D.22.5 Literature

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

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Yang, M.S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Appendix E Maps of Essential Fish Habitat

Maps of essential fish habitat (EFH) are included in this section for the following species (life stage is indicated in parentheses):

Walleye pollock (eggs)

Walleye pollock (larvae)

Walleye pollock (juveniles)

Walleye pollock (adults)

Pacific cod (adults and late juveniles)

Dover sole (adults and late juveniles)

Yellowfin sole (adults and late juveniles)

Rock sole (adults and late juveniles)

Rex sole (adults and late juveniles)

Flathead sole (adults and late juveniles)

Arrowtooth flounder (adults and late juveniles)

Sablefish (adults and late juveniles)

Pacific ocean perch (adults and late juveniles)

Shortraker and rougheye rockfish (adults and late juveniles)

Northern rockfish (adults and late juveniles)

Dusky rockfish (adults and late juveniles)

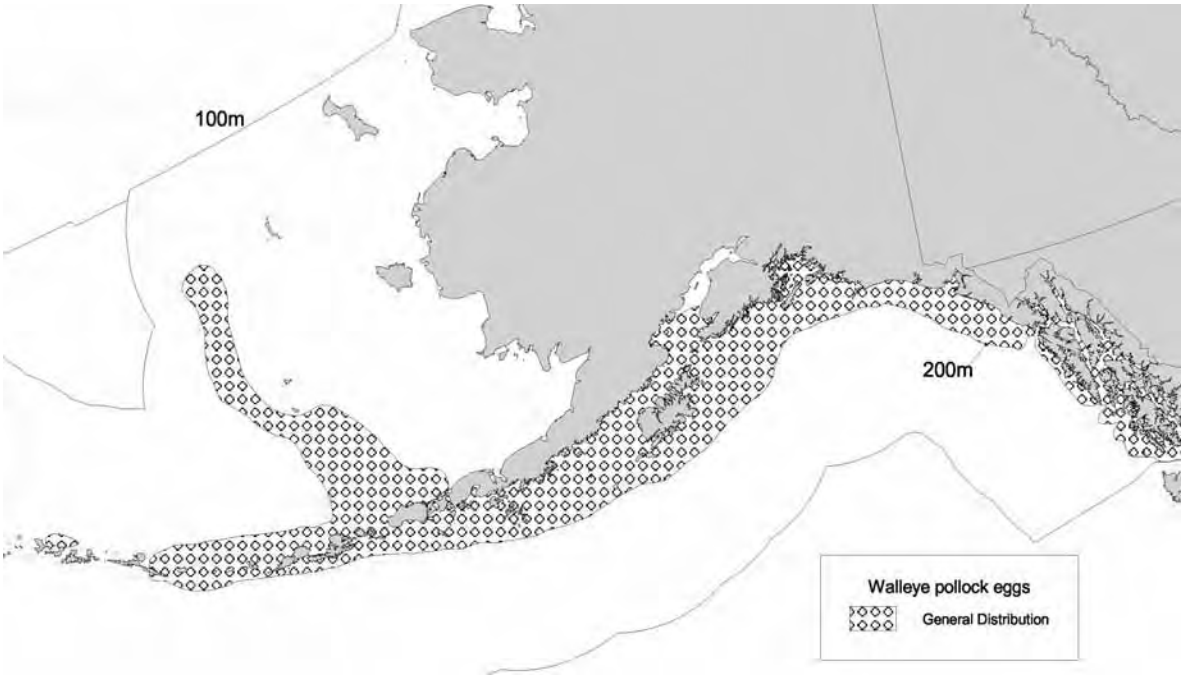
Yelloweye rockfish (adults and late juveniles)

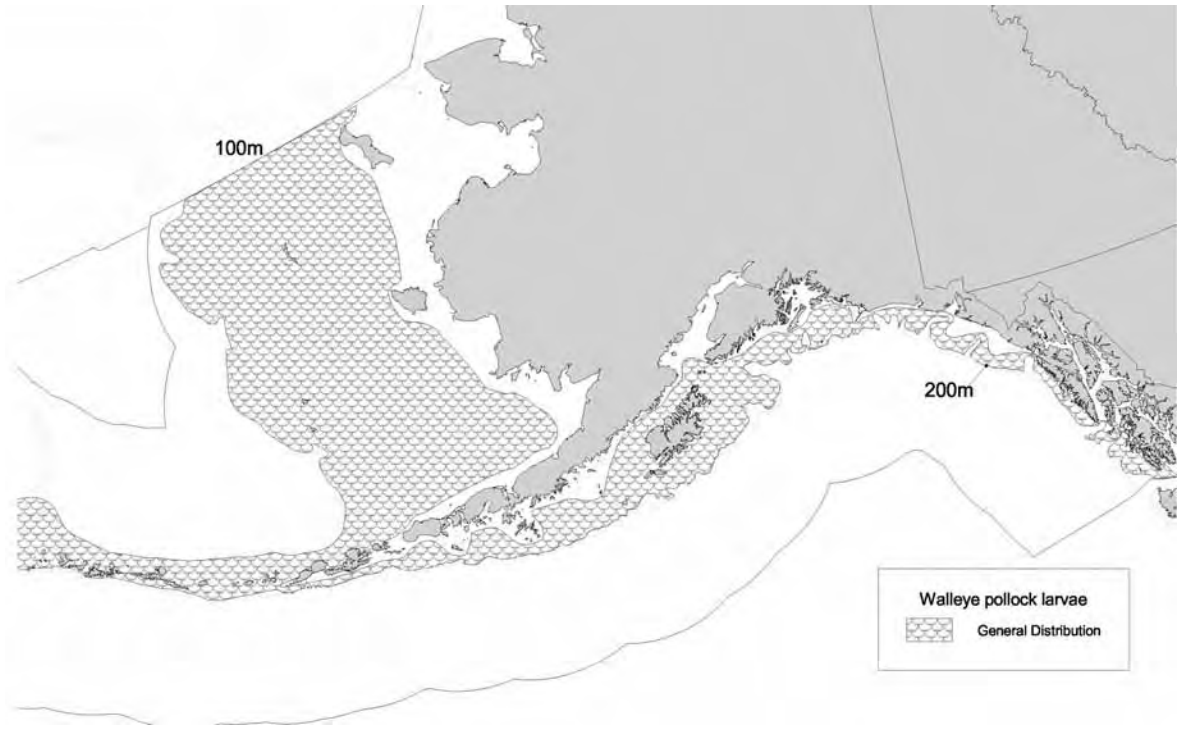
Thornyhead rockfish (adults and late juveniles)

Atka mackerel (adults and late juveniles)

Skates species (adults and late juveniles)

Sculpin species (adults and late juveniles)


100m
200m
Walleye pollock eggs
General Distribution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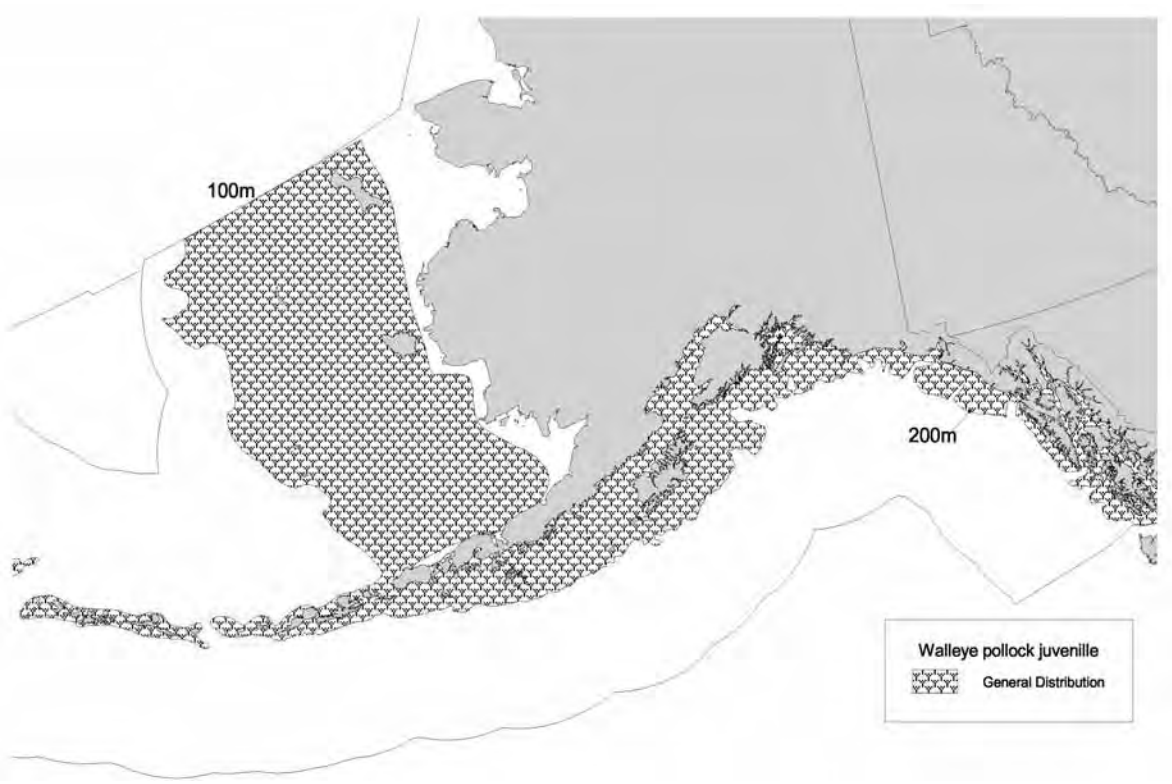
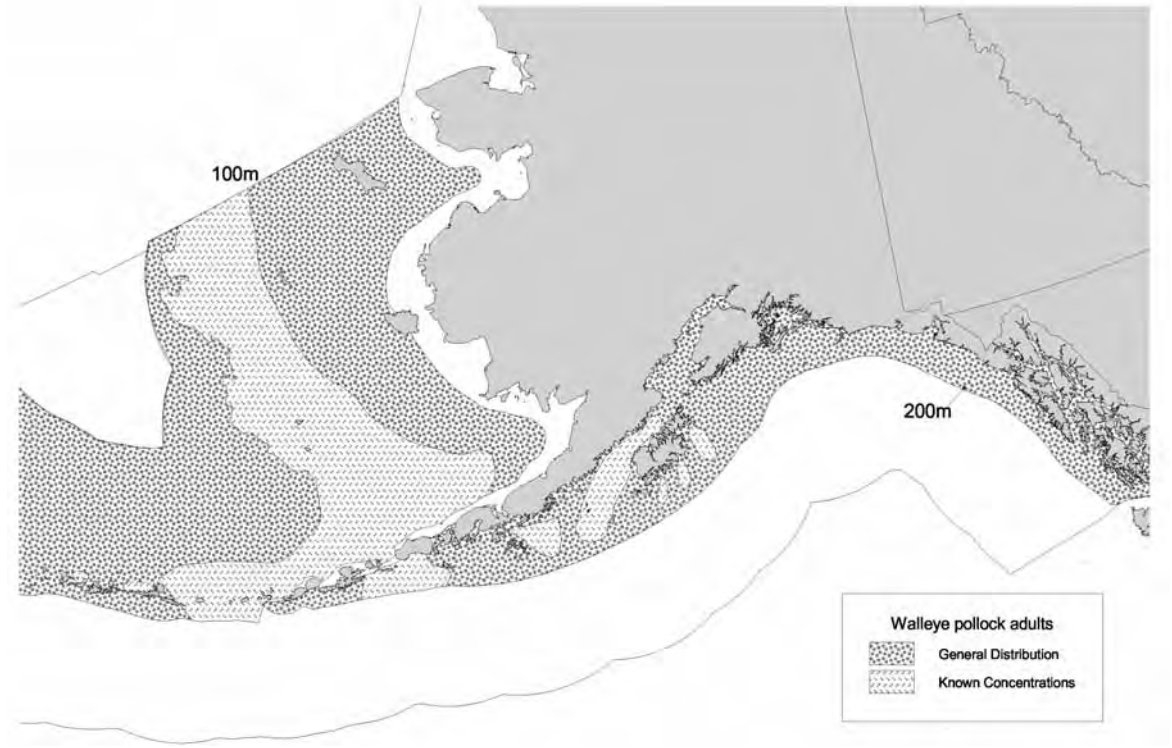
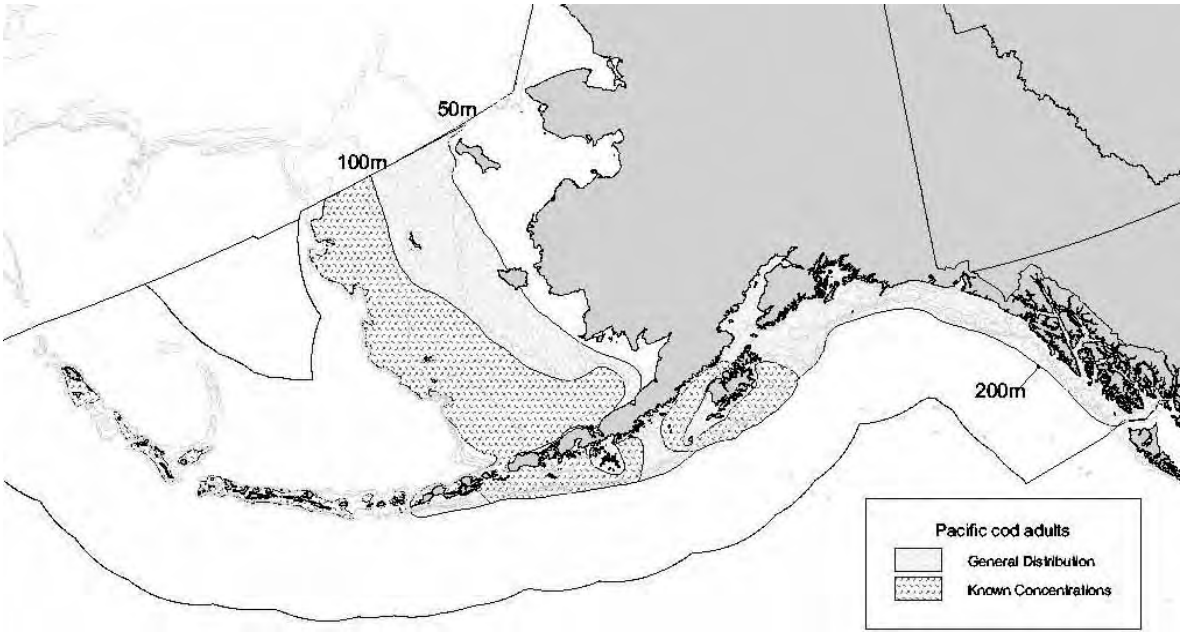
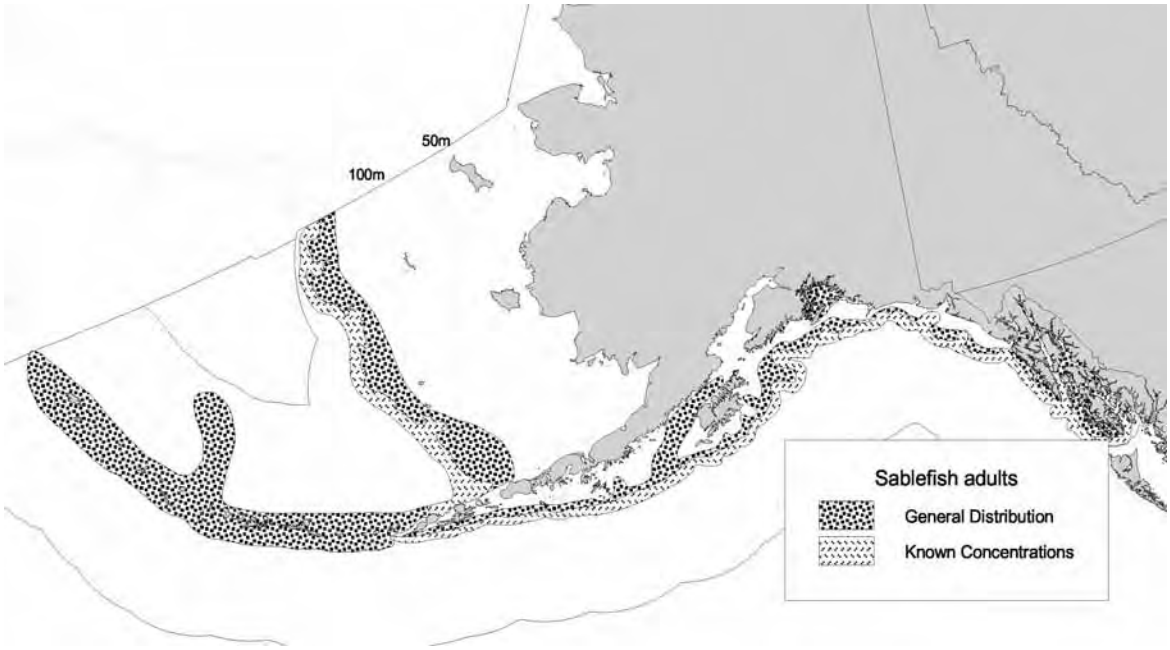
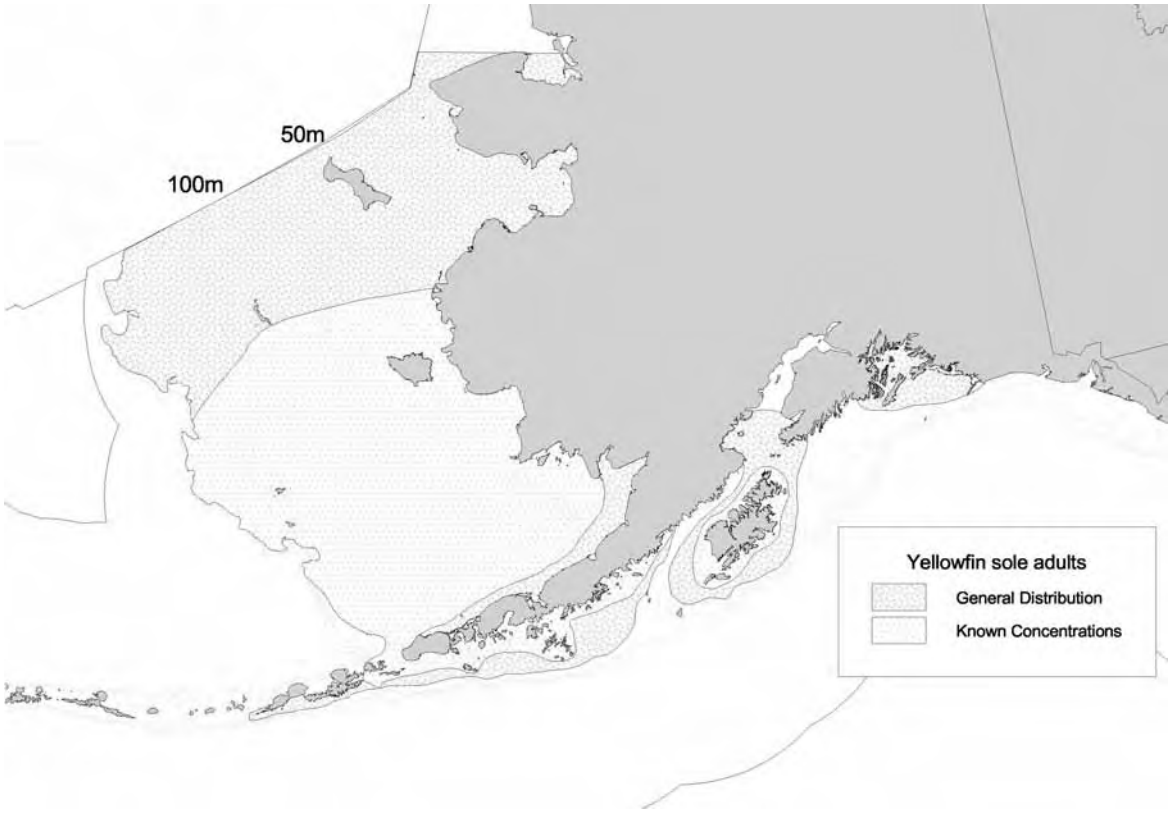
200m
Walleye pollock larvae
General Distribution

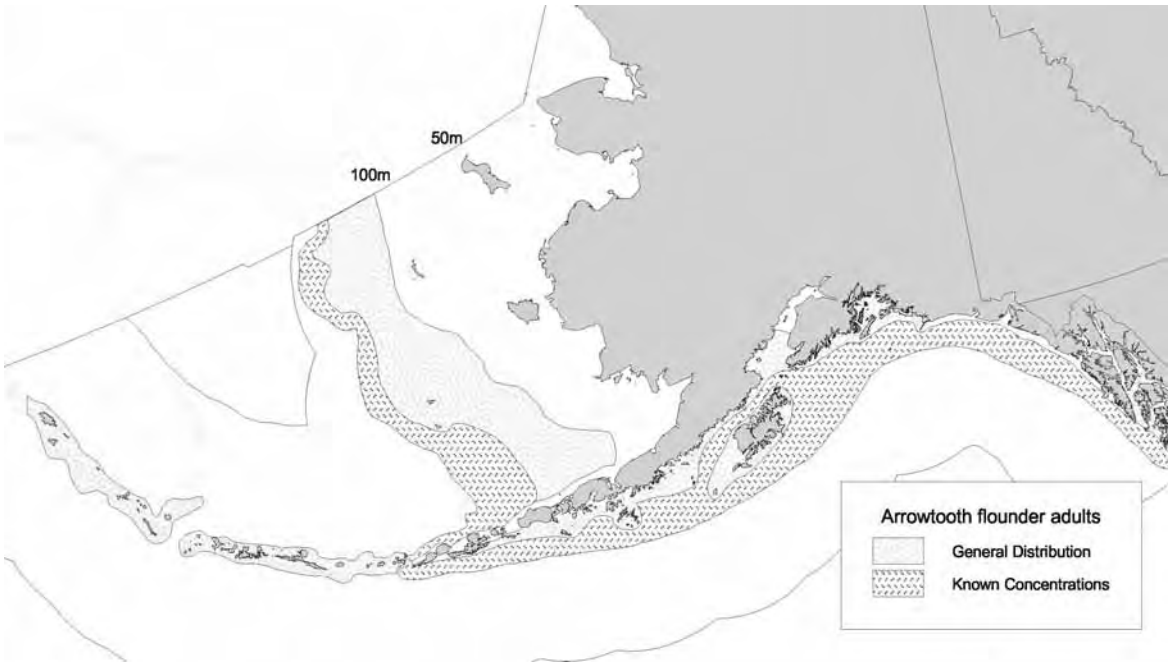

100m
200m
Walleye pollock juvenille
General Distribution

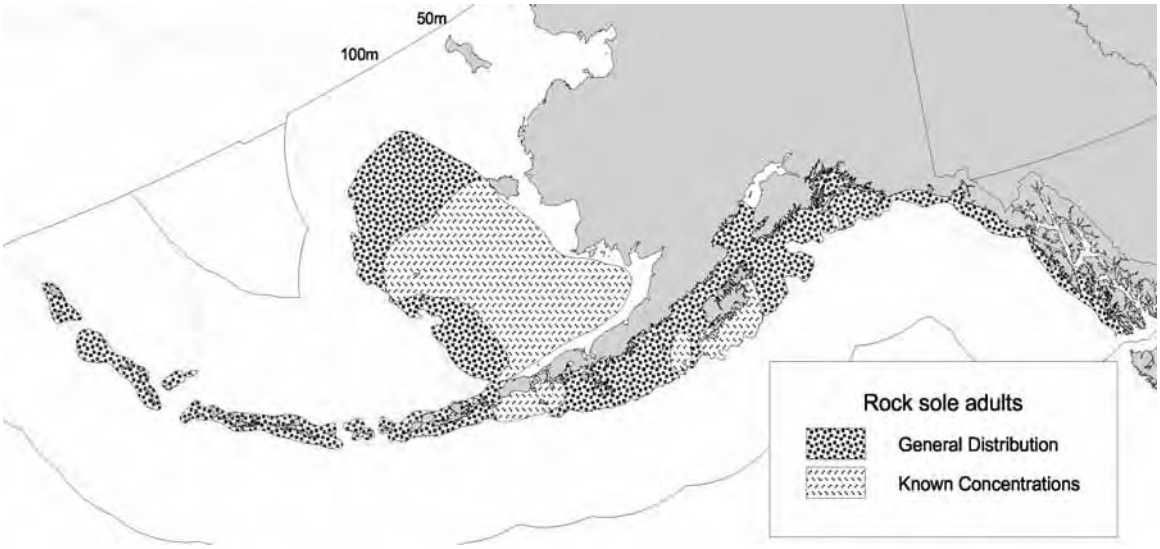

100m
200m
Walleye pollock adults
General Distribution
Known Concentrations


50m
100m
200m
Pacific cod adults
General Distribution
Known Concentrations


50m
100m
Sablefish adults
General Distribution
Known Concentrations


50m
100m
Yellowfin sole adults
General Distribution
Known Concentrations


50m
100m
Arrowtooth flounder adults
General Distribution
Known Concentrations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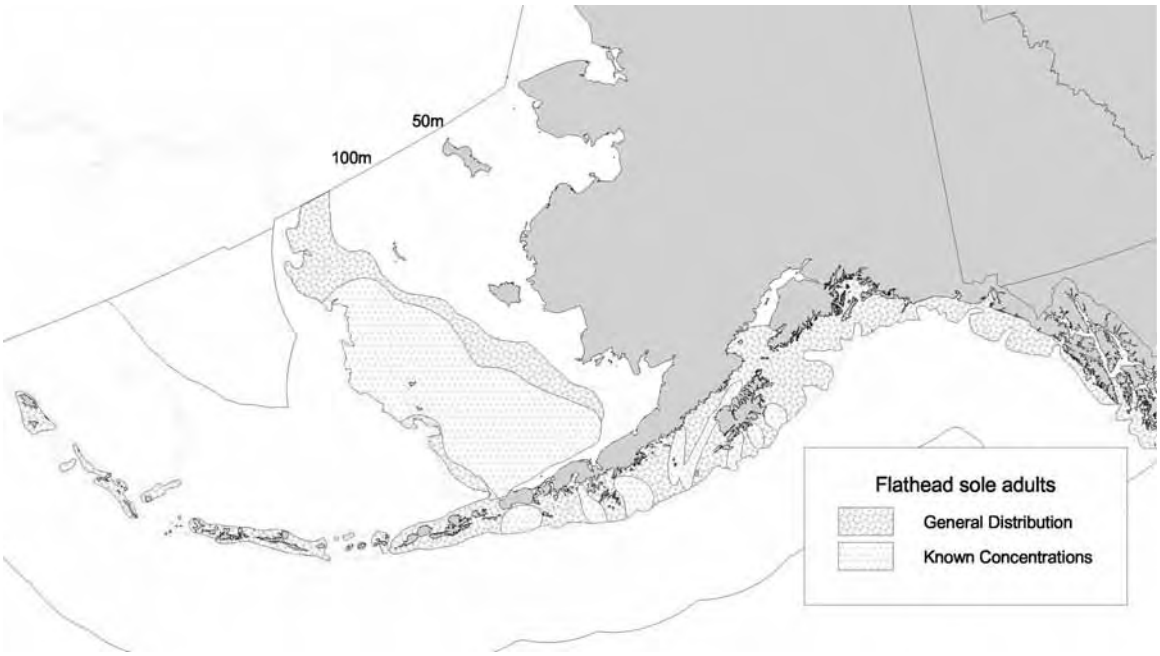
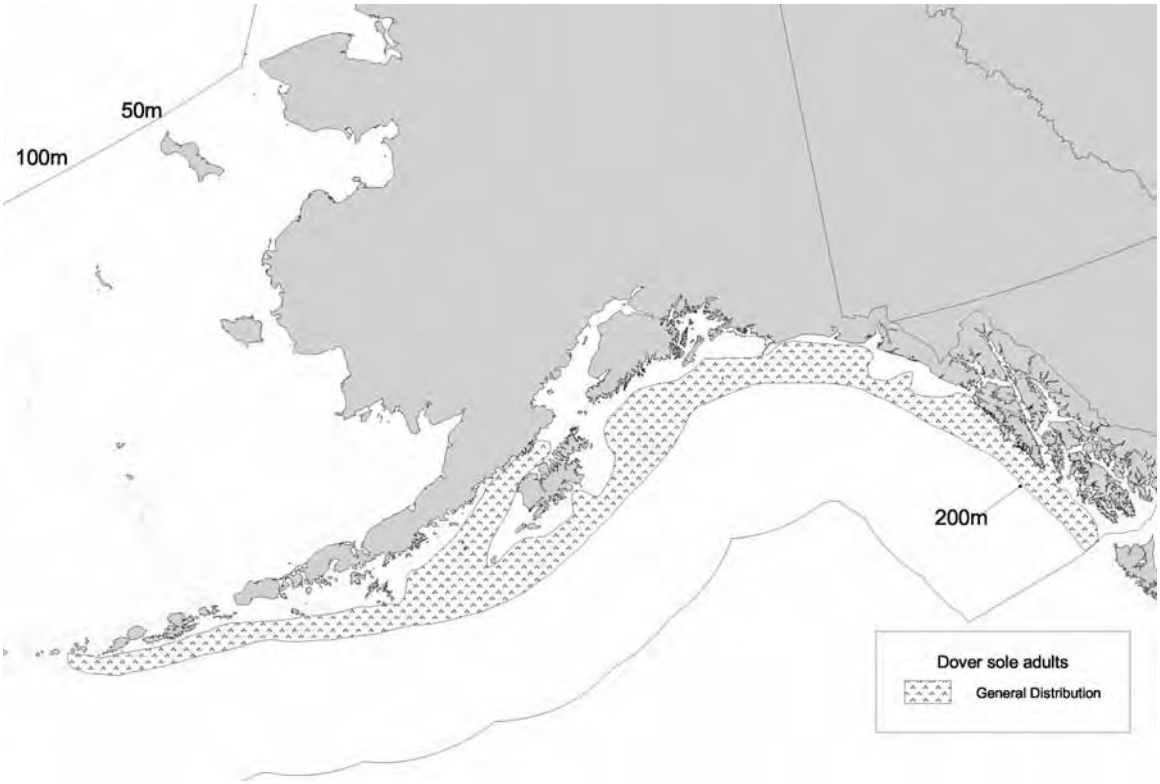
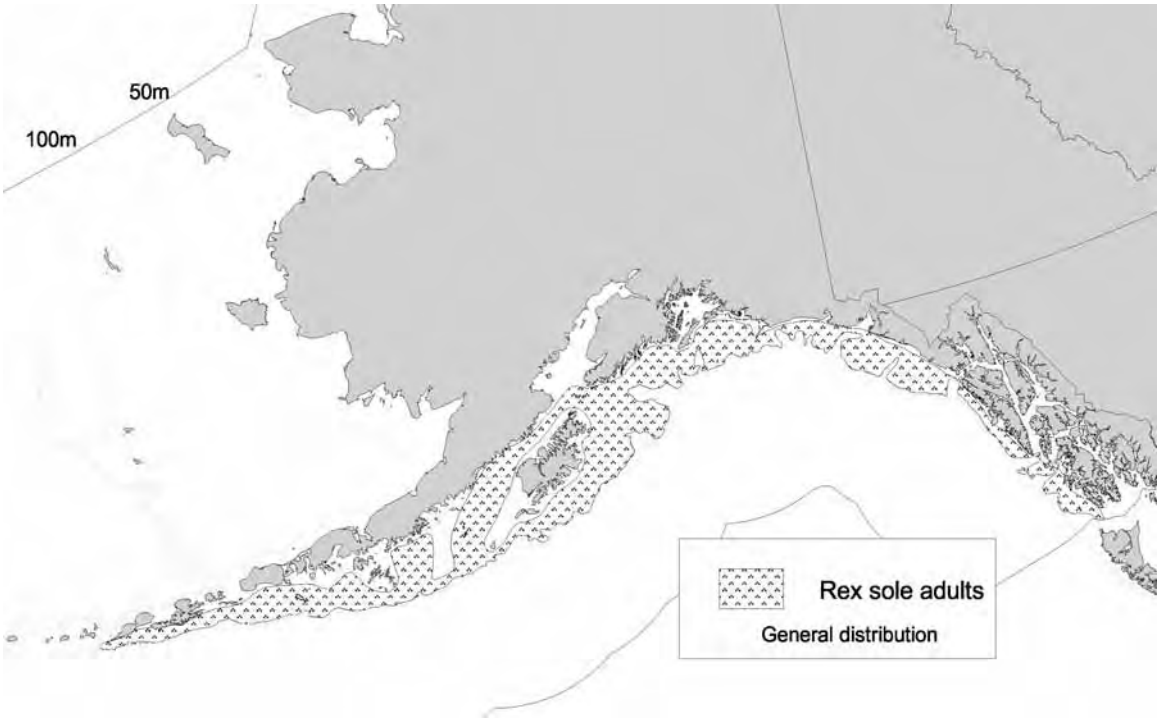
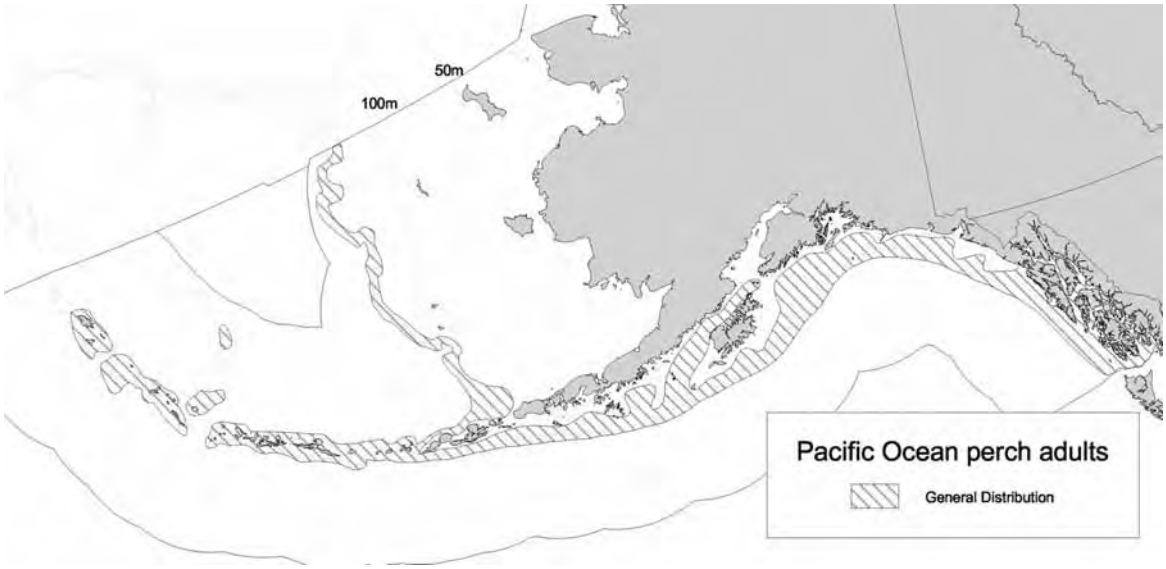
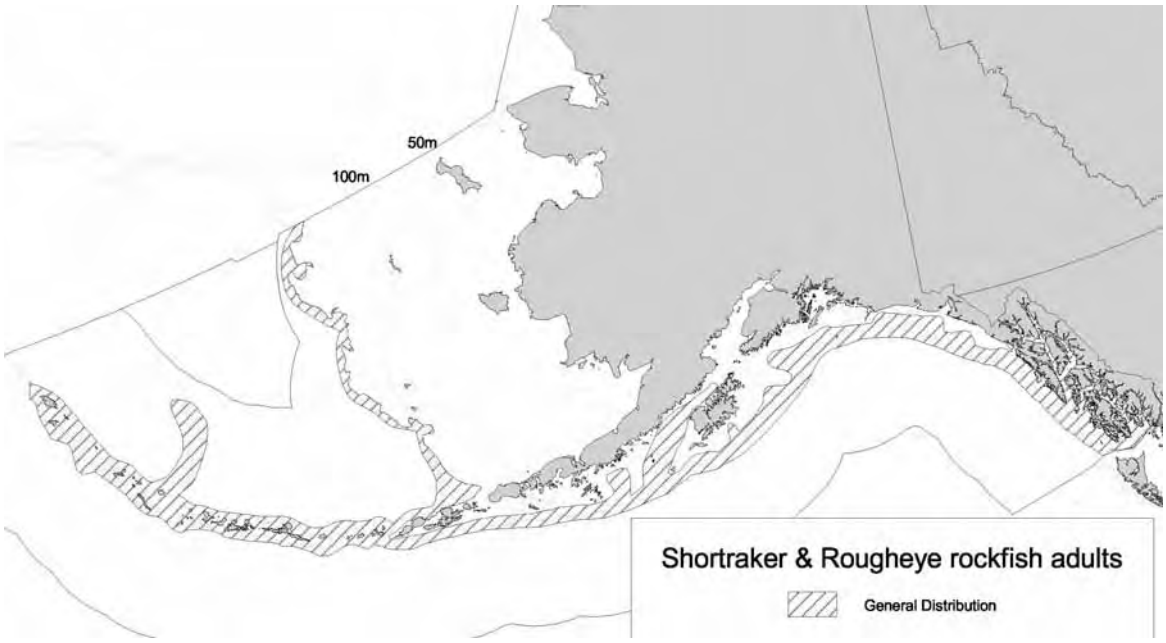
100m
Rock sole adults
General Distribution
Known Concentrations

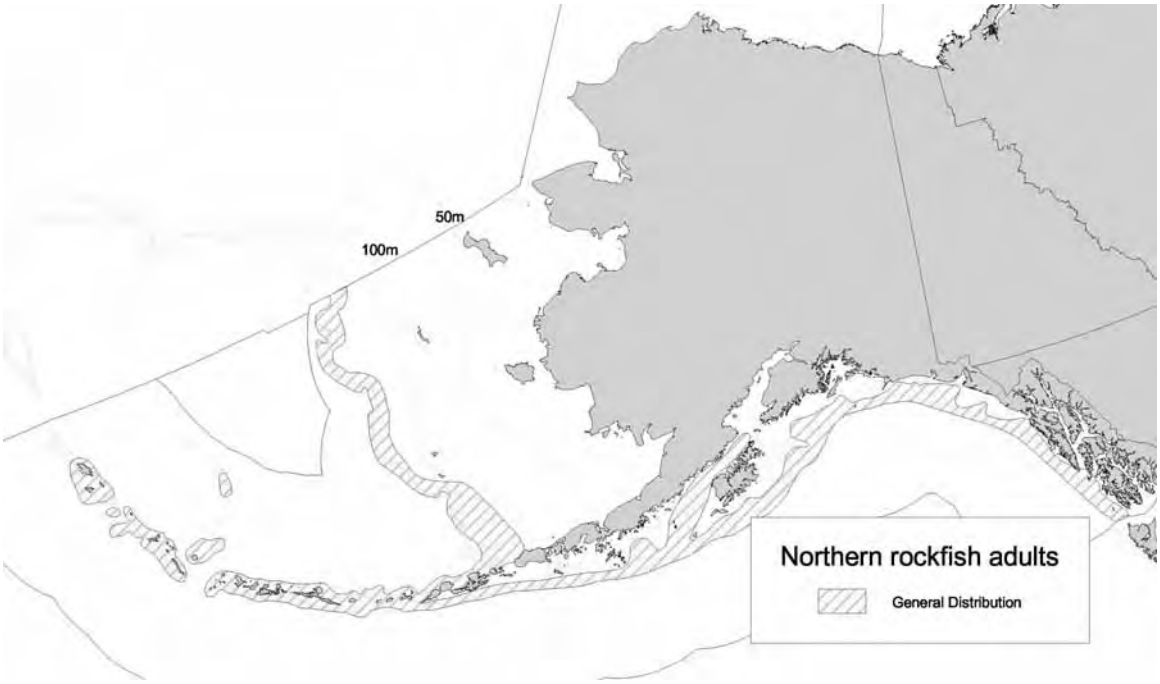

50m
100m
Flathead sole adults
General Distribution
Known Concentrations

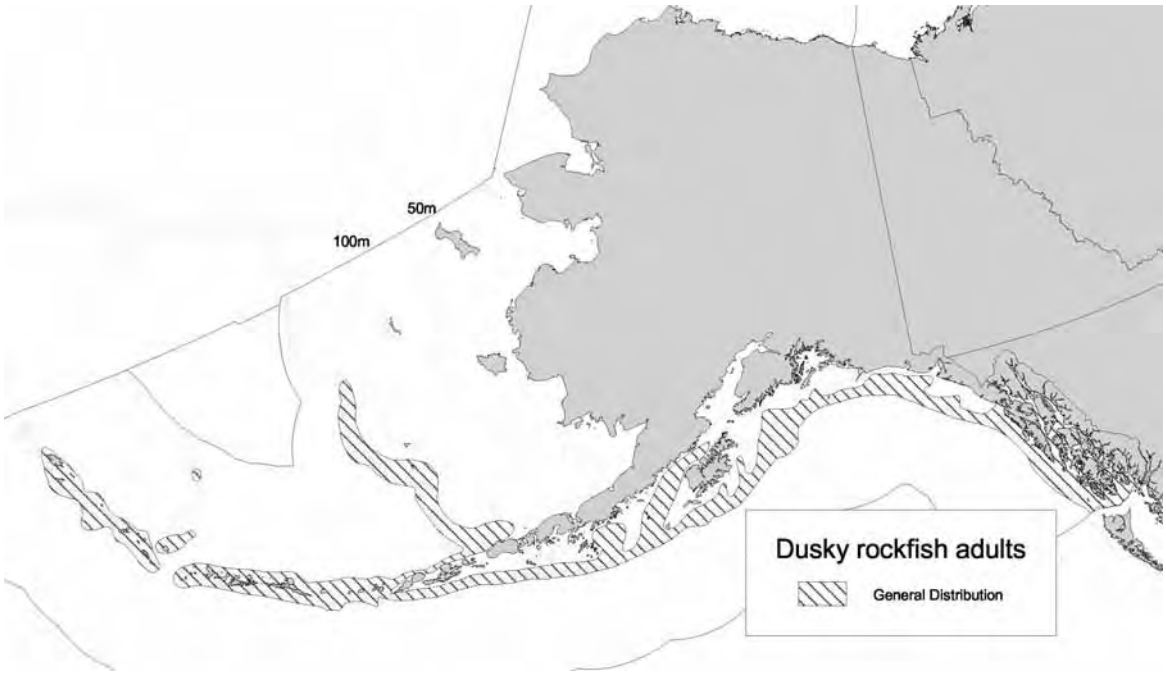

50m
100m
200m
Dover sole adults
General Distribution

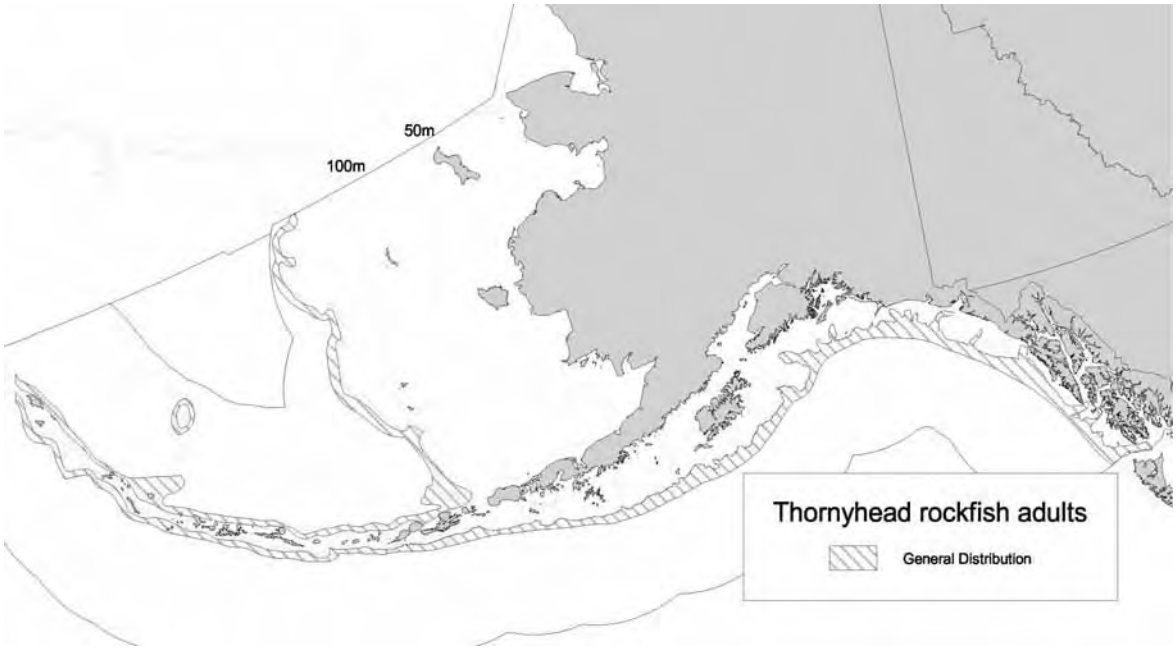

50m
100m
Rex sole adults
General distribution

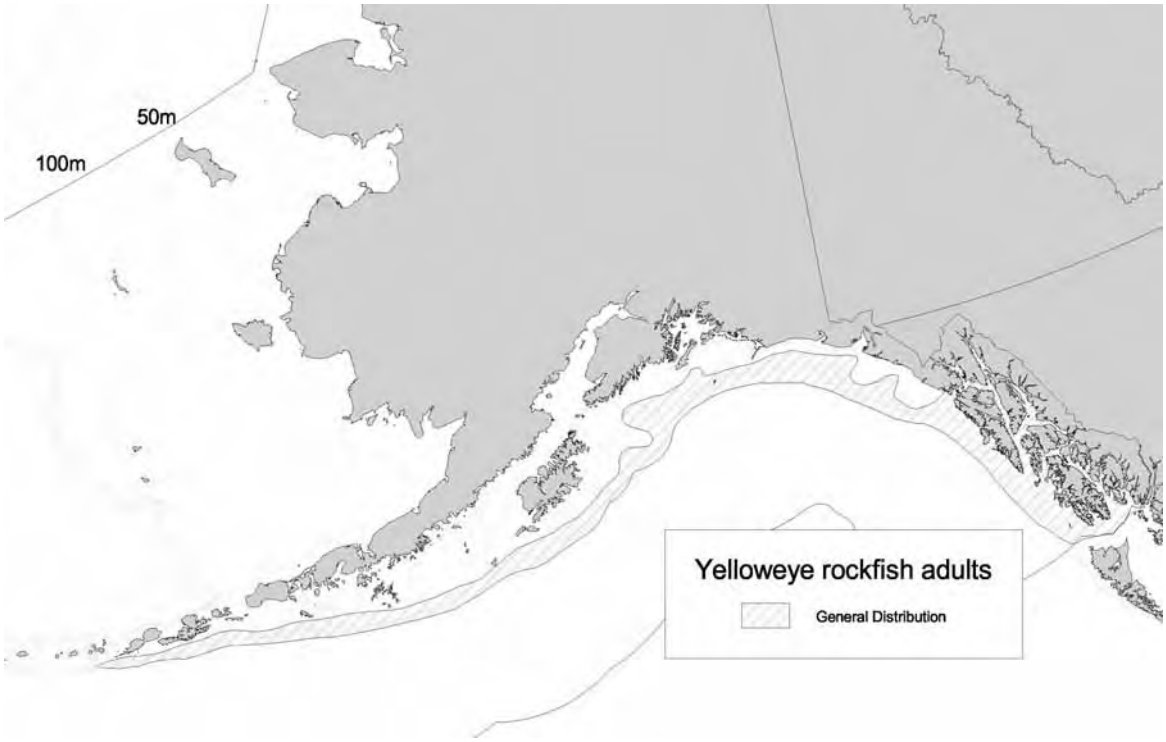

50m
100m
Pacific Ocean perch adults
General Distribution

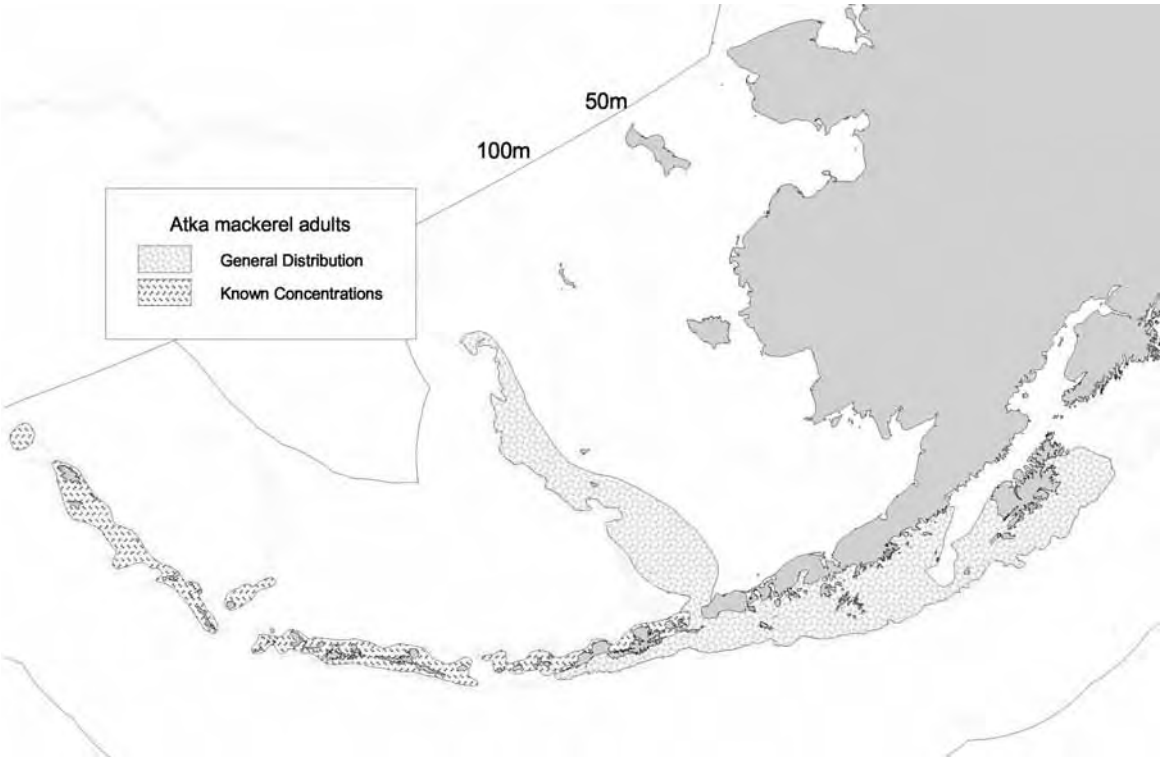

50m
100m
Shortraker & Rougheye rockfish adults
General Distribution

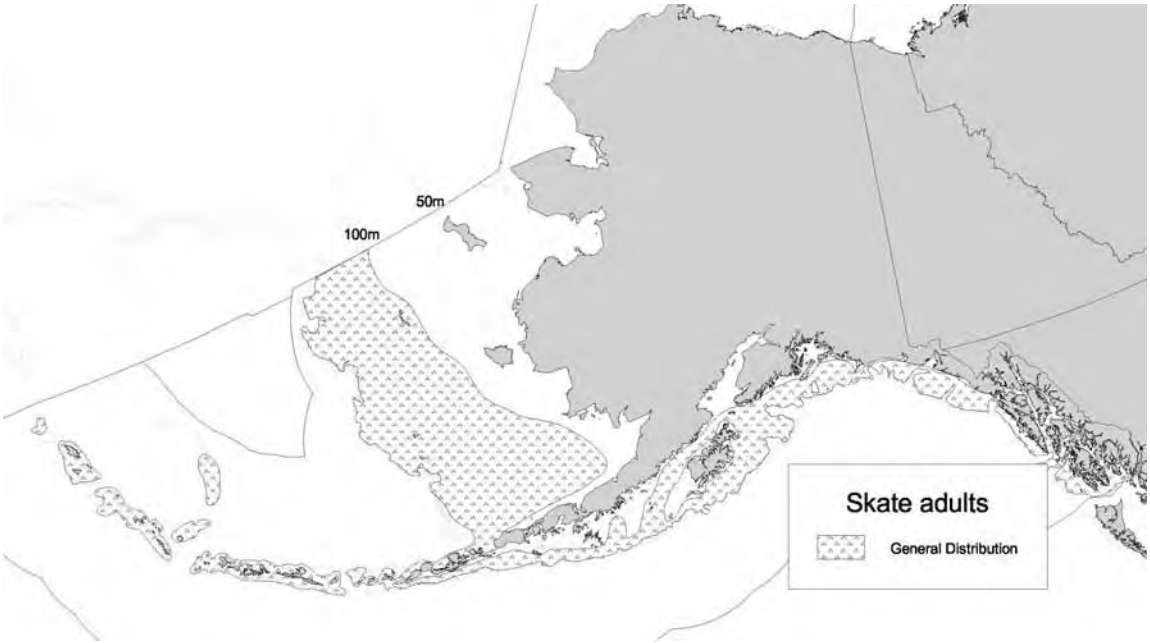

50m
100m
Northern rockfish adults
General Distribution

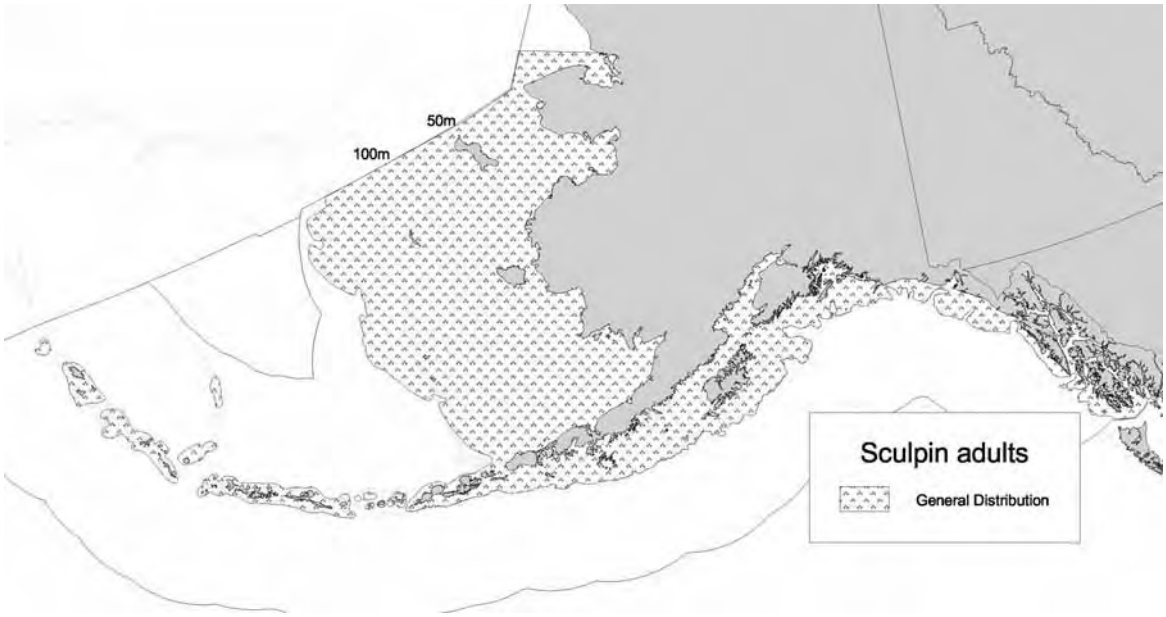

50m
100m
Dusky rockfish adults
General Distribution


50m
100m
Thornyhead rockfish adults
General Distribution


50m
100m
Yelloweye rockfish adults
General Distribution


50m
100m
Atka mackerel adults
General Distribution
Known Concentrations


50m
100m
Skate adults
General Distribution


50m
100m
Sculpin adults
General Distribution

Appendix F Adverse Effects on Essential Fish Habitat

This appendix includes a discussion of fishing (Section F.1) and non-fishing (Section F.2) activities that may adversely affect essential fish habitat (EFH) for Gulf of Alaska (GOA) groundfish, as well as a discussion of the potential impact of cumulative effects on EFH (Section F.3).

F.1 Fishing Activities that may Adversely Affect Essential Fish Habitat

F.1.1 The Effects of Fishing on Fish Habitat: An Executive Summary

A paper entitled "The Effects of Fishing on Fishing Habitat" was published in 1999 by Peter Auster and Richard Langton, prepared under contract from the American Fisheries Society. The paper summarizes and reviews the literature on fishing impacts as they relate to EFH. Interested persons may obtain this paper and other cited documents from the Council office.

The paper discusses the studies within four broad subject areas: effects of gear on non-landed target species, effects on structural components of habitat, effects on benthic community structure, and effects on ecosystem level processes. Although a vast majority of the scientific studies on gear impacts have focused on trawl gear, the authors have attempted to analyze the impacts of habitat disturbance, rather than focus on the impacts of each gear type on habitat. Towards that end, the authors have developed a conceptual model to assist managers with understanding how fishing gear could impact different habitats. Figure F-1 illustrates this. In very complex habitats, such as piled boulders or cobble with epifauna (corals, bryozoans, anenemones, etc.), even relatively low levels of fishing effort can drastically alter the habitat. On more simple habitats, such as bedforms (such as sand or silt bottoms), fishing has a relatively minor effect on the habitat complexity. An abstract of the Auster and Langton paper is provided below.

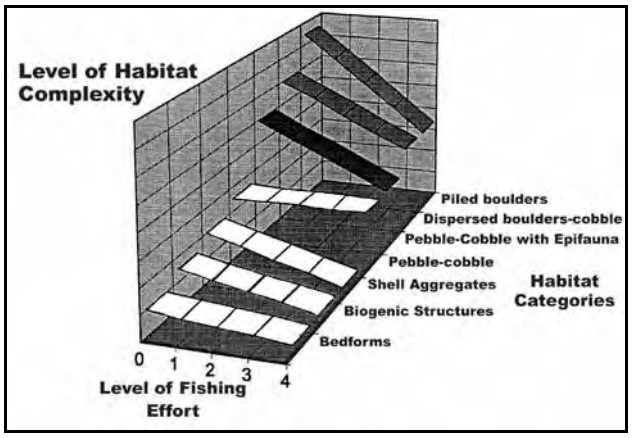


Figure F-1 Conceptual model of how fishing could differentially affect habitat depending on its complexity.

Abstract
The Sustainable Fisheries Act of 1996 mandates that regional fishery management Councils designate EFH for each of the species which are managed, assess the effects of fishing on EFH, and develop conservation measures for EFH where needed. This synthesis of effects of fishing on fish habitat was produced to aid the fishery management councils in assessing the impacts of fishing activities. A wide range of studies were

reviewed that reported effects of fishing on habitat (i.e., structural habitat components, community structure, and ecosystem processes) for a diversity of habitats and fishing gear types. Commonalities of all studies included immediate effects on species composition and diversity and a reduction in habitat complexity. Studies of acute effects were found to be a good predictor of chronic effects. Recovery after fishing was more variable, depending on habitat type, life history strategy of component species, and the natural disturbance regime. The ultimate goal of gear impact studies should not be to retrospectively analyze environmental impacts but ultimately to develop the ability to predict outcomes of particular management regimes. Synthesizing the results of these studies into predictive numerical models is not currently possible. However, conceptual models are presented which coalesce the patterns found over the range of observations. Conceptual models can be used to predict effects of gear impacts within the framework of current ecological theory. Initially, it is useful to consider fishes' use of habitats along a gradient of habitat complexity and environmental variability. A model is presented of gear impacts on a range of seafloor types and is based on changes in the structural habitat values. Disturbance theory provides the framework for predicting effects of habitat change based on spatial patterns of disturbance. Alternative community state models, and type 1-type 2 disturbance patterns, may be used to predict the general outcome of habitat management. Primary data are lacking on the spatial extent of fishing induced disturbance, the effects of specific gear types along a gradient of fishing effort, and the linkages between habitat characteristics and the population dynamics of fishes. Adaptive and precautionary management practices will therefore be required until empirical data becomes available for validating model predictions.

F.1.2 The Effects of Fishing Gear on Benthic Communities

Portions of the following section have been excerpted from the following paper:

> *Vining, I., D. Witherell, and J. Heifetz. 1997. The effects of fishing gear on benthic communities. p.13-25. Ecosystem Considerations for 1998. North Pacific Fishery Management Council, Anchorage, Alaska.*

In recent years, there has been a growing awareness and concern about the effects of resource extraction on ecosystems. Fishery managers around the world are beginning to incorporate, or at a minimum acknowledge, the effects of fishing on marine ecosystems. The groundfish fisheries in Alaska are no exception. Concern has been expressed by scientists, conservationists, fishermen, and others about potential negative effects of fishing gear on bottom habitat, particularly with regard to habitat alteration. In this chapter, we provide a review of scientific studies done to date on the effects of fishing gear on benthic communities of the GOA area.

Fisheries in the North Pacific are numerous and utilize different gear types. The fisheries and associated gear for the Bering Sea and Aleutian Islands (BSAI) and GOA fisheries are listed in Table F-1. Federal regulation 50 CFR 679.2 specifies the following authorized gear types: dive, fixed gear, hook-and-line, jig, longline, longline pot, non-pelagic trawl, pelagic trawl, pot-and-line, scallop dredge, and troll gear. In this section, we summarize potential effects only for primary gears used in the groundfish fisheries.

Table F-1 Fishing Gear used in the North Pacific, by fishery.

FMP	Fishery	Gear
BSAI and GOA	groundfish	trawl, longline, jig, pot
BSAI and GOA	halibut	longline, hook&line, troll, jig
BSAI and GOA	scallop	dredge
BSAI	crab	pot
BSAI and GOA (State managed)	salmon	gill net, seine, troll line, fish wheels, or spears
non-FMP (State)	herring	trawl, seine, gill net, pound net
non-FMP (State)	shrimp	pots, trawls
non-FMP (State)	razor clam	shovel, fork
non-FMP (State)	sea urchin	handpicking, aided by diving gear or abalone iron
non-FMP (State)	octopus	pot
non-FMP (State)	abalone	diving gear and abalone iron
non-FMP (State)	sea cucumber	handpicking, aided by diving gear

If the gear, habitat, and communities were homogeneous, studies designed to measure the effect of fishing on benthic communities would be much simpler. However, there is heterogeneity in all aspects of fishing, as well as the habitat and communities affected by fishing gear. When studying gear effect, many questions need to be answered, such as: Do all gears have similar effects? How much actual damage is being done? How long will the damage last? How will damage be measured? Does the extent and longevity of damage depend on bottom type? Does the fishing affect all organisms in the community equally? The purpose of this section is to review the completed work or the work in progress to answer some of these questions, and summarize conclusions. A summary of literature used for this paper is provided in Table F-2 found in Section F.1.4.

F.1.2.1 Trawl Gear

Concerns over the effects of trawling are not new, nor limited to the North Pacific. Trawling was an issue, as early as 1350, when it was banned in the United Kingdom to protect fry of fish (de Groot 1984). Since 1938, studies have been conducted on the east coast of Canada and United States, to evaluate possible effects of trawling on the benthic communities (Ketchen 1947; Graham 1955; Messieh et al. 1991). There has also been an extensive investigation in the North Sea by the Netherlands Institute for Sea Research evaluating the effects of beam-trawl fisheries on the bottom fauna (BEON-RAPPORT 8 1990; Bergman and Hup 1992). The effects of trawling are also being studied in New Zealand and Australia, with special attention being paid to hard-bottom trawling (Hutchings 1990; Jones 1992).

There are people who considered the negative effect of trawl gear “common sense” and “intuitive,” and have written articles pointing to likely ways the gear is having a negative effect on the environment (Apollonio 1989; McAllister 1991; Russell 1997). The scientific community, in general, also tends to accept that trawling alters the bottom habitat (Auster et al. 1996). The root of the problem and the cause of controversy lies in the definition of “negative effect” and the degree of change in the benthic habitat or communities before the change is “destructive.”

The otter trawl is the principle gear used in bottom trawl fisheries in the GOA, and advancements in fishing gear and vessel technology have made gear more efficient. These advances mean that heavier nets are dragging over seabeds, and possibly altering the sea-floor more than was observed in earlier studies. Also, larger ships, with greater horsepower and larger, stronger nets are exploring and fishing areas not previously

available to the industry (Auster et al. 1996). A further consideration is the domestication of the groundfish industry in the GOA since the Magnuson-Stevens Act of 1976, which changed the character of trawling in Alaska from large foreign factory vessels to a mixture of a domestic catcher-processors and numerous smaller catcher vessels.

Physical effects of trawling include plowing and scraping the sea-floor, resuspension of sediment, and lowering of habitat complexity. Plowing and scraping effects depend on towing speed, substrate type, strength of tides and currents, and gear configuration (Jones 1992). It has been found that otter doors tend to penetrate the substrate 1 cm - 30 cm; 1 cm on sand and rock substrates, and 30 cm in some mud substrates (Krost et al. 1990; Jones 1992; Brylinsky et al. 1994). Another factor which will cause variation in the depth of the troughs made by the otter doors is the size (weight) of the doors, i.e., the heavier the doors the deeper the trough (Jones 1992). These benthic troughs can last as little as a few hours or days in mud and sand sediments, over which there is strong tide or current action (Caddy 1973; Jones 1992), or they can last much longer, from between a few months to over 5 years, in seabeds with a mud or sandy-mud substrate at depths greater than 100 m, with weak or no current flow (Krost et al. 1990; Jones 1992; Brylinsky et al. 1994).

Another aspect of plowing and scraping is the alteration done by the footrope. Once again, different types of footropes will cause more or less alteration. Those footropes which are designed to roll over the sea-floor (the type generally on soft bottoms, employed in the GOA), cause little physical alteration, other than smoothing the substrate and minor compression (Brylinsky et al. 1994; Kaiser and Spencer 1996). However, since a trawler may re-trawl the same area several times, these minor compressions can cause a “packing” of the substrate (Schwinghammer et al. 1996). Further compression of the substrate can occur as the net becomes full and is dragged along the bottom.

The trawling of an area can cause resuspension of both inorganic and organic sediments. Churchill (1989) found that trawling can be a significant contributor to the time-averaged suspended sediment load over heavily trawled areas, especially at depths where bottom stress due to tidal and current action is generally weak. In the GOA, there is relatively weak current and tidal action near the sea-floor over much of the groundfish fishing grounds, with a variety of seabed types such as gravely-sand, silty-mud, and muddy to sandy gravel, as well as areas of hard-rock (Hampton et al. 1986).

The reduction in habitat complexity can be examined in two broad categories: (1) small localized changes, and (2) larger area changes. The small localized changes refer to the smoothing of patchy biogenic depressions and movement of boulders (Auster et al. 1996). The broader area changes refer to the general reductions in habitat complexity with increases in trawling activity (Auster et al. 1996; Schwinghammer et al. 1996).

Mortality can be incurred to those organisms incidentally captured (bycatch), and discarded back into the sea. The mortality rate of the bycatch depends on the species, age and size of a species, the type of gear, the time and type of shipboard handling, and the size of the haul, along with ocean and atmospheric conditions (Hill and Wassenberg 1990; Stevens 1990; Fonds 1991). It is difficult to generalize the fate of bycaught benthic organisms returned to the sea or compare results from different studies on this subject. In addition, studies have only focused on the survival of fish and crab discards.

Several studies have examined the mortality of crabs taken as bycatch in North Pacific trawl fisheries. Blackburn and Schmidt (1988) made observations on instantaneous mortality of crab taken by domestic trawl fisheries in the Kodiak area. They found mortality for soft-shell red king crab averaged 21%, hard-shelled

red king crab 1.2%, and 12.6% for Tanner crab. Another trawl study indicated that trawl induced instantaneous mortalities aboard ship were 12% for Tanner crab and 19% for red king crab (Owen 1988).

Damage or mortality of benthic organisms can occur due to the passage of the trawl over the seabed without actually catching the organisms. Non-retained organisms may be subject to mortality from contact with trawl doors, bridles, footrope, or trawl mesh, as well as exposure to silt clouds produced by trawl gear. Mortality of fish escaping from trawl codends may range from none to 100%, and may depend on numerous factors, including fish species, tow size and duration, the size and type of mesh used (Sangster 1992). Mortality can occur due to contusions, a build-up of lactic acid, scale loss and mucus removal, and skin damage due to abrasion and collision with net walls (Sangster 1992; Chopin and Arimoto 1995).

Studies of fish escapement mortality have exhibited a wide range of results. Very low escapement mortality was observed for Alaskan pollock under experimental conditions (Efanov and Istomin 1988). Main and Sangster (1988) observed that mortality of haddock passing through a diamond mesh codend exhibited delayed mortality: 33% mortality after 11 days and 82% mortality after 108 days. DeAlteris and Reifsteck (1993) observed escapement mortality of scup (Stenotomus chrysops) to be 0% to 50%, and less than 4% for winter flounder (Plueronectes americanus) tested by an experimental codend. Bergman et al. (1989) studied the mortality of fishes escaping from commercial beam trawls, and observed mortalities of dab (Limanda limanda), plaice, and sole totaled 44%, 15%, and 0%, respectively, after being held in a cage for 24 hours. Van Beek et al. (1989) also studied the mortality of sole escaping from beam trawls, and their results indicated that 40% of the sole died after escaping through the meshes. Mortality of herring (Clupea harengus) escaping from trawl codends can be higher than for groundfish. Suuronen et al. (1992) observed mortality of codend escapees to be very high (85-90%), with most deaths occurring 3-8 days after escape. Another study of herring showed lower mortality (3-30%) for herring escaping from codends (Efanov 1981).

Besides direct mortality from being caught and handled, there will be further mortality due to relocation into unsuitable habitat and predation while returning to the sea floor. This type of mortality will also depend on many conditions such as depth, type of species, age and size of species, predator concentration and oceanic conditions. Although there are few studies which have considered these sources of mortality, neither relocation nor predation will likely result in 100% mortality (Hill and Wassenberg, 1990).

Similar to the mortality of bycatch, the survival of benthic organisms in the path of the trawl will depend on several factors. The mortality rate will depend on the species, species age and size, the type of gear, the size of the haul, substrate morphology, and ocean conditions. The most severe damage done to benthic organisms by otter trawls is from the trawl doors, especially sedentary organisms that live in the upper 5 cm of the seabed (Rumohr and Krost, 1991). Rumohr and Krost (1991) further found that thin-shelled bivalves such as *Syndosmya alba*, *Mya* sp. and *Macoma calcarea*, as well as starfish sustain heavy damage due to the trawl doors, whereas thick-shelled bivalves such as *Astarte borealis* and *Corbula gibba* were less likely to be damaged. In another experiment, hard-shelled red king crab were tethered in the path of an Aleutian combination trawl (Donaldson 1990). Only 2.6% of the crabs that were interacted with the trawl, but not retained, were injured, suggesting a low mortality rate. Other organisms found to be affected by the passage of trawls and specifically the trawl doors are diatoms, nematodes and polychaetes (Brylinsky et al. 1994).

The immediate effect of trawling on hard-bottom seabeds can be intense in certain vulnerable habitats. It was found that from a single tow using roller gear, 3.9% of the octocorals and 30.4% of the stony coral were damaged, as well as 31.7% of the sponges (van Dolah et al. 1987). A similar study in Florida found that 80% of the stony coral and 38% of the soft corals were damaged, as well as 50% of the sponges. However, the

trawls in this study were a ridged roller gear assemblage (Tilmant 1979). Both of these studies were in sub-tropical areas. No studies were found assessing trawling in temperate or subarctic hard-bottom habitat, however current work on this is being carried out in the GOA (Heifetz 1997).

Although mortality from bycatch or trawl passage appears to be fairly high for various organisms, some studies have found recolonization can occur over a relatively short time period. Nematodes and polychaetes returned to their pre-trawled levels in less than 7 weeks and diatoms increased in abundance in trawl troughs within 80 days (Brylinsky et al. 1994). Small epibenthic species that have been resuspended can recover to pre-trawl densities in 24 hours (Rumohr and Krost 1991). The sponges and most of the corals damaged in the hard-bottom studies, returned to their pre-study levels in approximately a year.

One of the principle concerns associated with trawling is the potential effects on benthic organisms that fish depend on for food. At least in the short term, prey items immediately available to fish do not appear to be reduced. Caddy (1973) found that fish and crabs were attracted to the trawl path, presumably to feed on exposed or dead benthos, within 1 hour after fishing. Other studies have also observed increases in scavenging in the wake of beam-trawls (Kaiser and Spencer 1994; Kaiser and Spencer 1996a). Furthermore, the densities of some of the species examined in the study, were 30 times greater than outside the trawl tracks. In Kiel Bay (Baltic Sea), it was believed that cod fed extensively on Arctica islandica which were crushed or broken by trawl doors (Rumohr and Krost 1991; Jones 1992).

Minor short-term changes in individual species distribution are not likely to greatly affect the entire ecosystem, excessively. The ecosystem is in a constant flux, with many natural phenomena making changes to the environment (de Groot 1984; Brylinsky et al. 1994). The specific question is whether fishing causes long-term changes (negative) in the benthic community structure.

There have been changes to benthic communities from trawling due to habitat alteration. The trawl doors may be the most damaging to benthic organisms on a short-term basis. However, even in deep areas where the troughs may be recognized after long periods (5 years), the doors do not likely have an excessive long-term effect on the overall area, because the relatively small trough is between 0.2 - 2 m (Krost et al. 1990; Rumohr and Krost 1991; Brylinsky et al. 1994). The greater long-term damage to the habitat may be caused by the net and footrope due to their much larger width at 3-166 m (1.5-90 fathoms), with many between 20-50 m (Grahm 1955, Chris Blackburn, Alaska Groundfish Databank, Kodiak, AK, personal communication). The smoothing caused by multiple trawls (as discussed earlier) removes patchy biogenic depressions and moves boulders, both of which are extremely important habitat to juvenile fish and crustaceans (Armstrong et al. 1993; Auster et al. 1996). Multiple trawls in an area also pack down and lower the complexity of the substrate which will likely reduce the exchange capacity and lead to less species diversity (Jones 1992; Kaiser and Spencer 1996b; Schwinghamer et al. 1996). Some studies have concluded that trawling tends to favor fast-growing, fast-reproducing and relatively short-lived (r-selected) species, such as polychaetes, at the expense of slow-growing, slow-reproducing and relatively long-lived (k-selected) species such as crustaceans (Reise 1982; de Groot 1984; Kaiser and Spencer 1996b).

Sediment resuspension, as discussed above, has an effect on the benthic communities as well. Increased sediment suspension can cause reduction of light levels on the seabed, smother benthos following resettlement, create anaerobic conditions near the seabed, and reintroduce toxins that may have settled out of the water column (Churchill 1989; Jones 1992, Messieh et al. 1991).

F.1.2.2 Longline Gear

Very little information exists regarding the effects of longlining on benthic habitat. Observations of halibut longline gear made by NMFS scientists during submersible dives off southeast Alaska provide some information (NPFMC 1992). The following is a summary of these observations: "Setline gear often lies slack on the sea-floor and meanders considerably along the bottom. During the retrieval process, the line sweeps the bottom for considerable distances before lifting off the bottom. It snags on whatever objects are in its path, including rocks and corals. Smaller rocks are upended, hard corals are broken, and soft corals appear unaffected by the passing line. Invertebrates and other light weight objects are dislodged and pass over or under the line. Fish, notably halibut, frequently moved the groundline numerous feet along the bottom and up into the water column during escape runs disturbing objects in their path. This line motion was noted for distances of 50 feet or more on either side of the hooked fish."

Some crabs are caught incidentally by longline gear in pursuit of groundfish, and a portion of these crabs die. No field or laboratory studies have been made to estimate mortality of crab discarded in longline fisheries. However, based on condition factor information from the trawl survey, mortality of crab bycatch has been estimated and used in previous analyses (NPFMC 1993). Discard mortality rates were estimated at 37% for red king crab and 45% for *C. bairdi* Tanner crab taken in longline fisheries. No observations had been made for snow crab, but mortality rates may be similar to Tanner crab.

Mortality of groundfish discarded in longline fisheries has not been studied extensively in Alaska. Studies with Pacific halibut have shown that discards may have high mortality if not released carefully from hooks. Additionally, some species such as rockfish may not survive changes in pressure when they are hauled up quickly from the bottom. Mortality of discarded halibut has been estimated to be about 15% for most longline fisheries (Williams 1997).

F.1.2.3 Pot Gear

Pot gear is used in the North Pacific to harvest crabs and groundfish. This gear type likely affects habitat during the process of setting and retrieving pots; however, no research has been conducted to date.

Like other fisheries, pot fisheries incur some bycatch of incidental fish and crab. The groundfish pot fishery targets Pacific cod, but takes other species such as crab and flatfish which are discarded. Mortality of bycaught fish in groundfish pot fisheries has not been studied, with the exception of Pacific halibut. Based on viability data, it has been estimated that mortality of halibut bycaught in groundfish pot fisheries averages about 7% (Williams 1997).

There are a variety of effects caused by handling, ranging from sublethal (reduced growth rates, molting probabilities, visual acuity from bright lights, and vigor) to lethal effects. Several laboratory and field studies have been conducted to determine mortality caused by handling juvenile and female crab taken in crab fisheries. Studies have shown a range of mortality due to handling based on gear type, species, molting stage, number of times handled, temperature, and exposure time (Murphy and Kruse 1995). Byersdorfer and Watson (1992, 1993) examined red king crab and Tanner crab taken as bycatch during the 1991 and 1992 red king crab test fisheries. Instantaneous handling mortality of red king crab was <1% in 1991, and 11.2% in 1992. Stevens and MacIntosh (1993) found average overall mortality of 5.2% for red king crabs and 11% for Tanner crabs on one commercial crab vessel. Authors recommend these results be viewed with caution, noting that experimental conditions were marginal. Mortality for red king crab held 48 hours was 8%

(Stevens and MacIntosh 1993, as cited in Queirolo et al. 1995). A laboratory study that examined the effects of multiple handling indicated that mortality of discarded red king crabs was negligible (2%), although body damage increased with handling mortality (Zhou and Shirley 1995a).

Delayed mortality of crabs due to handling does not appear to be influenced by method of release. In an experiment done during a test fishery, red king crab thrown off the deck while the vessel was moving versus those gently placed back into the ocean showed no differences in tag return rates (Watson and Pengilly 1994). Handling methods on mortality has been shown to be non-significant in laboratory experiments with red king crab (Zhou and Shirley 1995a, 1995b) and Tanner crab (MacIntosh et al. 1995). Although handling did not cause mortality, injury rates were directly related to the number of times handled.

Mortality of crabs is also related to time out of water and air temperature. A study of red king and Tanner crabs found that crabs exposed to air exhibited reduced vigor and righting times, feeding rates (Tanner crabs), and growth (red king crabs) (Carls and Clair 1989). Cold air resulted in leg loss or immediate mortality for Tanner crabs, whereas red king crabs exhibited delayed mortality that occurred during molting.

F.1.2.4 Dredge Gear

Dredging for scallops may affect groundfish habitat by causing unobserved mortality to marine life and modification of the benthic community and sediments. Similar to trawling, dredging places fine sediments into suspension, buries gravel below the surface and overturns large rocks that are embedded in the substrate (NEFMC 1982, Caddy 1973). Dredging can also result in dislodgement of buried shell material, burying of gravel under re-suspended sand, and overturning of larger rocks with an appreciable roughening of the sediment surface (Caddy 1968). A study of scallop dredging in Scotland showed that dredging caused significant physical disturbance to the sediments, as indicated by furrows and dislodgement of shell fragments and small stones (Eleftheriou and Robertson 1992). The authors note, however, that these changes in bottom topography did not change sediment disposition, sediment size, organic carbon content, or chlorophyll content. Observations of the Icelandic scallop fishery off Norway indicated that dredging changed the bottom substrate from shell-sand to clay with large stones within a 3-year period (Aschan 1991). Mayer et al. (1991), investigating the effects of a New Bedford scallop dredge on sedimentology at a site in coastal Maine, found that vertical redistribution of bottom sediments had greater implications than the horizontal translocation associated with scraping and plowing the bottom. The scallop dredge tended to bury surficial metabolizable organic matter below the surface, causing a shift in sediment metabolism away from aerobic respiration that occurred at the sediment-water interface and instead toward subsurface anaerobic respiration by bacteria (Mayer et al. 1991). Dredge marks on the sea floor tend to be short-lived in areas of strong bottom currents, but may persist in low energy environments (Messieh et al. 1991).

Two studies have indicated that intensive scallop dredging may have some direct effects on the benthic community. Eleftheriou and Robertson (1992), conducted an experimental scallop dredging in a small sandy bay in Scotland to assess the effects of scallop dredging on the benthic fauna. They concluded that while dredging on sandy bottom has a limited effect on the physical environment and the smaller infauna, large numbers of the larger infauna (mollusks) and some epifaunal organisms (echinoderms and crustaceans) were killed or damaged after only a few hauls of the dredge. Long-term and cumulative effects were not examined, however. Achan (1991) examined the effects of dredging for islandic scallops on macrobenthos off Norway. Achan found that the faunal biomass declined over a four-year period of heavy dredging. Several species, including urchins, shrimp, seastars, and polychaetes showed an increase in abundance over the time period.

In summary, scallop gear, like other gear used to harvest living aquatic resources, may effect the benthic community and physical environment relative to the intensity of the fishery.

Adverse effects of scallop dredges on benthic communities in Alaska may be lower in intensity than trawl gear. Studies on effects of trawl and dredge gear have revealed that, in general, the heavier the gear in contact with the seabed, the greater the damage (Jones 1992). Scallop dredges generally weigh less than most trawl doors, and the relative width they occupy is significantly smaller. A 15' wide New Bedford style scallop dredge weighs about 1,900 lbs (Kodiak Fish Co. data). Because scallop vessels generally fish two dredges, the total weight of the gear is 3,800 lbs. Trawl gear can be significantly heavier. An 850 HP vessel pulling a trawl with a 150' sweep may require a pair of doors that weigh about 4,500 pounds. Total weight of all trawl gear, including net, footrope, and mud gear would weigh even more (T. Kandianis, personal communication). Hence, based on weight of gear alone, scallop fishing may have less effect than bottom trawling, however its effects may be more concentrated.

F.1.2.5 Salmon Fishing Gear

Directed fisheries on salmon in Alaska include marine commercial and recreational hook-and-line fisheries; marine commercial gill-net and seine fisheries; and estuarine and riverine gill-net (both set-net and drift), recreational, personal use, and subsistence fisheries. Two types of impacts can occur: (1) direct effects of the fishing gear on habitat; and (2) bycatch or entanglement of non-target species. In the marine fisheries, direct impact of the gear on marine habitats is limited, but some localized effects can occur, such as trolling weights damaging coral or purse seines damaging kelp beds or benthic structure. Bycatch and entanglement of non-target species can occur in the marine fisheries, such as bycatch of demersal rockfish in hook-and-line fisheries, and entanglement of seabirds and marine mammals in net fisheries.

F.1.2.6 Summary of the Impacts of Fishing on Habitat

Alterations to natural communities are inevitable when harvesting marine organisms with any gear type. The removal of any organism has, by itself, an effect. It has been suggested that though there is some alteration due to fishing, it is simply a necessity to harvest the resource (de Groot 1984). Furthermore, some studies have shown that the community will return to relatively pristine conditions in a relatively short time period following a fishing closure, if there was an effect at all (Graham 1955; van Dolah et al. 1987; Rumohr and Krost 1991; Jones 1992; Brylinsky et al. 1994). On the other hand, there is also the suggestion that pre-fishing, “pristine” conditions are not known, since almost all study areas have had some form of fishing prior to the study (Auster et al. 1996). Lastly, there are also studies that conclude that trawling, in some situations, may cause long-term changes in habitat and community structure (Auster et al. 1996; Kaiser and Spencer 1996b; Schwinghamer et al. 1996).

To further confuse the issue, nothing is static. The fishing industry makes regular alterations to gear and fishing techniques. The oceanic and atmospheric conditions change continually, on both local and global scales, all of which may affect groundfish or the benthic communities upon which they depend. Lastly, other human induced actions such as pollution, mining and petroleum exploration can affect benthic communities as well. However, declines of some fisheries being observed around the world have served to emphasize that all sources of potential effects should be considered by managers aiming for sustainability.

F.1.3 Loss of prey

Loss of prey is an adverse effect on EFH because one component of EFH is that it be necessary for feeding. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to prey species' habitat that are known to cause a reduction in the population of the prey species, may be considered adverse effects on a managed species and its EFH. Adverse effects on prey species and their habitats may result from fishing and non-fishing activities.

Appendix D contains tables that identify, if known, those prey species that comprise the diet of GOA groundfish managed under the FMP. Additional information on the habitat needs of prey species that are part of the Forage Fish species category can also be found in that appendix.

F.1.4 Literature of Scientific Studies on Fishing Threats to Habitat

Table F-2 summarizes scientific studies on threats to habitat. The bibliography is found in Section F.1.4.1.

Table F-2 Summary of literature cited. Those studies done in the Gulf of Alaska are shown in bold.

Authors	Year	Gear Type	Location	Fishery	Main Emphasis of Citation
Apollonio	1989	Otter Trawl	Northwest Atlantic	Groundfish	Habitat and Benthic Alterations
Armstrong et al.	1993	Bottom Trawl	Bering Sea	Groundfish	Bycatch
Auster, et.al.	1996	Otter Trawl	Gulf of Maine	Groundfish	Habitat and Benthic Alterations
BEON-Rapport 8	1990	Beam Trawl	North Sea	Groundfish	Habitat and Benthic Alterations
Bergman and Hup	1992	Beam Trawl	North Sea	Groundfish	Habitat and Benthic Alterations
Bergman, et. al.	1989	Beam Trawl	North Sea	Groundfish	Habitat and Benthic Alterations
Blackburn and Schmidt	**1993**	**Otter Trawl**	**GOA (Kodiak area)**	**Survey**	**Bycatch**
Brylinsky, et. al.	1994	Otter Trawl	Bay of Fundy	Flounder	Habitat and Benthic Alterations
Caddy	1973	Otter Trawl	Gulf of St. Lawrence	Groundfish	Habitat and Benthic Alterations
Churchill	1989	Otter Trawl	Mid-Atlantic Bight	Groundfish	Sediment Resuspension
de Groot	1984	Beam + Otter Trawl	North Sea	Groundfish	Habitat and Benthic Alterations
Efanov and Istomin	1988				Bycatch
Fonds, M.(ed.)	1991	Beam Trawl	North Sea		Bycatch
Fukuhara and Worlund	1973	Otter Trawl	Bering Sea	Groundfish	Bycatch
Gibbs, et. al.	1980	Otter Trawl	New South Wales	Shrimp	Habitat and Benthic Alterations
Graham	1955	Otter Trawl	North Sea	Plaice	Habitat and Benthic Alterations
Heifetz (ed.)	1997	Otter Trawl	BSAI/GOA	Groundfish	Habitat and Benthic Alterations
Hill and Wassenberg	1990	Otter Trawl	South Pacific	Shrimp	Bycatch
Hutchings	1990	Otter Trawl	Australia	Shrimp	Habitat and Benthic Alterations
Jones	1992	Beam + Otter Trawl	World Wide	Multiple	Habitat, Bycatch, Alterations
Kaiser and Spencer	1994				Bycatch
Kaiser and Spencer	1996	Beam Trawl			Bycatch
Kaiser and Spencer	1996	Beam Trawl	Europe Shelf	Groundfish	Habitat and Benthic Alterations
Ketchen	1947	Otter Trawl	Western N. Atlantic	Groundfish	Habitat and Benthic Alterations
Krost, et. al.	1990	Otter Trawl	Western Baltic	Groundfish	Habitat and Benthic Alterations
Main and Sangster	1998	Otter Trawl	North Atlantic	Groundfish	Bycatch
Mayer et.al.	1991	Otter Trawl	Gulf of Maine	Groundfish	Sediment Resuspension
McAllister	1991	Trawls (in general)	World Wide	Groundfish	Habitat and Benthic Alterations
Messieh, et.al.	1991	Otter Trawl	Eastern Canada	Groundfish	Habitat and Benthic Alterations
NRC	1988	Otter Trawl	Bering Sea	Groundfish	Bycatch
Owen	**1988**	**Otter Trawl**	**GOA (Kodiak area)**	**Survey**	**Bycatch**
Rumohr and Krost	1991	Trawls (in general)	Western Baltic	Groundfish	Habitat and Benthic Alterations
Russell	1997	Trawls (in general)	Georges Bank	Groundfish	Habitat and Benthic Alterations
Sangster	1992				Bycatch
Schwinghamer et.al.	1996	Otter Trawl	Grand Banks	Groundfish	Habitat and Benthic Alterations
Stevens	1990	Otter Trawl	Bering Sea	Sole	Bycatch
Suuronen et.al.	1993				Bycatch
van Beek et.al.	1989	Otter + Beam Trawl	North Sea	Flatfish	Bycatch
van Dolah et.al.	1987	Roller Trawl	Coast of Georgia	Survey	Habitat and Benthic Alterations
Williams	**1997**	**Otter Trawl**	**BSAI/GOA**	**Groundfish**	**Bycatch**

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F.2 Non-fishing related activities that may adversely affect Essential Fish Habitat

An ***Adverse Impact***, by definition, means any impact which reduces quality and/or quantity of EFH. A reduction of quality and/or quantity of EFH can be described by a direct, cumulative, and/or natural adverse impact. A ***direct impact*** to a defined EFH will result in loss of its ability to provide specific habitat for a species. ***Cumulative impacts*** are linked to the quantity and location of impacts within a given geographic area. For the purposes of this analysis, cumulative impacts are impacts on the environment that result from the incremental impact of an action when added to other past, present and reasonable foreseeable future action or threat[1], regardless of who undertakes such action. Impacts like these can build on one another, especially in developed areas or communities. Equally important are ***natural adverse impacts***, such as storm damage or climate-based environmental shifts, that can also contribute to the loss of EFH. Significant loss of EFH will reduce the species ability to reproduce, survive, or exist.

Species dependent on coastal areas during various stages of their life, particularly during juvenile rearing and adult reproduction, are more vulnerable to habitat alterations than are species that remain offshore. Also, the effects of habitat alteration on offshore species are not as apparent as they are in coastal areas. Concern is

[1] See attached **Non-fishing Adverse Impacts to Habitat** worksheet. The worksheet is an professional interpretative summary of broad category threats that are described in further detail throughout the Non-fishing Adverse Impacts Section.

warranted, however, to the degree that (1) the offshore environment is subject to habitat degradation from either inshore activities or offshore uses, and (2) to the extent that some species living offshore depend directly or indirectly on coastal habitats for a critical life stage such as reproduction or as a source of food.

This section discusses types of activities that have a potential to cause habitat degradation that could affect fishery populations. This discussion is designed to identify those areas of uncertainty that may reasonably deserve attention in the future and not to be a conclusive review of impacts to EFH. Whether the likelihood and level of these activities or events cause harm to species habitats can be decided when the details of a proposed activity's location, magnitude, timing, and duration are more fully known. At present, human activities that adversely affect habitats are found near commercial fishing efforts, industrial growth areas, and community developments.

F.2.1 Dredging, Fill, Excavation

Potential impacts: excavation and maintenance of channels (includes disposal of excavated materials); construction of ports, mooring and cargo handling facilities; construction and operation of ship repair facilities; and construction of channel stabilization structures such as jetties and revetments. Impacts of disposing of dredged material are discussed in Section F.2.7.

Specific projects involving offshore marine disposals may directly impact EFH by overburdening and covering marine habitats. Because of the desirability of finding protection from Bering Sea storms, suitable port development sites often are valuable to the fishery fleet infrastructure. Recently, once such project in King Cove, Alaska, potentially could impact 20+ acres of marine habitat. This site was investigated and found not to be EFH for two species of crab, nevertheless the impact warranted investigation. Construction of a port facilities are planned for the City of Nome, Sand Point, and St. Paul, Alaska. In other areas, shallow water depth requires construction of long structures projected seaward in order to provide direct access from the uplands to deeper-draft ocean going vessels. These causeways alter the physical processes of the shoreline such as currents and disruption of fish migration. Another project in the village of Unalaska, required an extension of the airport runway into water depths approximately 50-feet, and received the necessary permits for construction. Beyond these specific projects, development activity in the coastal areas of the Bering Sea and the Aleutian Islands has been largely limited to construction of erosion control measures and breakwaters (e.g., the city of Bethel). As human population increase, so will the desire to have new harbor developments. In Alaska, there are over 40 known Ports of Call. Many villages lack large enough harbors for trade and therefore are not a port. All these require routine dredging ranging from 1-20 year intervals.

From a broad perspective, the environmental effects of dredging can include:

- Direct removal/burial of organisms as a result of dredging and placement of dredged material;
- Turbidity/siltation effects, including increased light attenuation from turbidity;
- Contaminant release and uptake, including nutrients, metals, and organics;
- Release of oxygen consuming substances;
- Noise disturbance to aquatic and terrestrial organisms; or
- Alteration to hydrodynamic regimes and physical habitat.

Port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size. Elimination or degradation of aquatic and upland habitats are commonplace since port expansion almost always requires the use of open water, submerged bottoms, and riparian zones. Ancillary port related activities and development often utilize even larger areas, many of which provide water quality and other functions needed to sustain living marine resources. Vessel repair facilities utilize highly toxic cleaners, paints, and lubricants that can contaminate waters and sediments. Modern pollution containment and abatement systems and procedures can prevent or minimize toxic substance releases; however, constant and diligent pollution control efforts must be implemented.

Even with the use of approved practices and disposal sites, ocean disposal of dredged materials is expected to cause environmental harm since contaminants will continue to be released, productive bottoms will still be filled, and localized turbidity plumes and reduced oxygen zones will persist. Dredging discharge increases turbidity and sediment – this is considered by some to be the most prevalent form of pollution in Alaska waters (Lloyd et al. 1987) and has contributed to the absence of grayling in some streams (LaPerriere et al. 1985). The effects of new disposal techniques such as creation of near shore berms and such "beneficial uses" of dredged material as creation of shallow water habitats and emergent wetlands are, in many cases, unclear and resulting long-term geomorphological and ecological change could be harmful to certain species and environments.

Return of materials dredged from the ocean to the water column is considered a discharge activity. Depending upon the chemical constituency of the local bottom sediments and any alterations of dredged materials prior to discharge, living marine resource in the area may be exposed to elevated levels of heavy metals. For example, scallop populations are vulnerable to pollution, even in offshore habitats where dumping and runoff can have an effect (Gould and Fowler 1991). Ocean dumping of sediments may bury or damage scallops by abrasion and gill clogging (Larsen and Lee 1978). Scallops are efficient at concentrating PCBs and heavy metals, including silver, copper, and nickel (Pesch et al. 1979), mercury (Klein and Goldberg 1970), cadmium (Vattutone et al. 1976), and chromium (Mearns and Young 1977). At certain levels of concentration, heavy metals can be lethal or have adverse effects at lesser concentrations. Sublethal concentrations of copper produced substantial kidney and gonad damage in sea scallops, whereas cadmium induced hormonal changes such as early gonad maturation (Gould et al. 1985).

Natural deposits of mercury are know to occur in marine bottom sediments. The levels of mercury in Norton Sound (Nelson *et al.* 1975) exceed the 3.7 ug/l set by the EPA Marine Quality Standards as the maximum allowable concentration. Wood (1974) demonstrated that mercury available to the aquatic environment in any form can result in steady-state concentrations of methyl, dimethyl, and metallic mercury through microbial catalysis and chemical equilibrium. Large-scale gold dredging projects in eastern Norton Sound will result in the discharge and resuspension of sediments that could introduce mercury to the water column.

F.2.2 Marine Mining

Potential threats include: removal of substrates that serve as habitat for fish and invertebrates; creation (or conversion) of habitats to less productive or uninhabitable sites such as anoxic holes or silt bottom; burial of productive habitats in the vicinity of the mine site or in near shore disposal sites (as in beach nourishment); release of harmful or toxic materials either in association with actual mining, or in connection with machinery and materials used for mining; creation of harmful turbidity levels; adverse modification of hydrologic conditions so as to cause erosion of desirable habitats.

Mining activity, such the extraction of gravel and gold in the Bering Sea, and placer mining spread throughout the state, can lead to the direct loss of EFH for certain species. Gravel is obtained by mining gravel beaches along the Bristol Bay coast (e.g., Goodnews Bay, Kangirlvar Bay) and in the lower reaches of the Yukon and Kuskokwim Rivers. Mining of large quantities of beach gravel can significantly affect the removal, transport, and deposition of sand and gravel along shore, both at the mining site and down current. During mining, water turbidity increases and the resuspension of organic materials could affect less motile organisms (i.e., eggs and recently hatched larvae) in the area. Benthic habitats could be damaged or destroyed by these actions. Neither the future extent of this activity nor the effects of such mortality on the abundance of marine species is known.

Dredging for gold has been attempted at various sites along the Aleutians and the world's largest mechanical dredge was operated offshore near the city of Nome. A similar proposal, which has received all of the necessary permits to proceed, will entail dredging 21,000 acres of sea bottom in Norton Sound for the purpose of recovering gold. Such activity has the potential to cause physical damage directly and indirectly to benthic habitat, juvenile fish, and adult life stages.

Mining practices that can impact EFH include physical and chemical impacts from intertidal dredging and chemicals such as flocculates. However, tailings and discharge waters from settling ponds can result in loss of EFH and life stages of managed species. Placer mining can introduce levels of heavy metals and arsenic that are naturally found within the stream bed sediments. The impact degrades the water quality and levels can become high enough to prove lethal.

The number of individual mining operations for a given area must be monitored. For instance, three mining operations in an intertidal area could impact EFH, whereas one may not. Also, disturbance of previously contaminated mining areas threaten an additional loss of EFH.

F.2.3 Fish Processing Waste - Shoreside and Vessel Operation

Potential threats include: direct and/or non-point source discharge of nutrients, chemicals, fish by-products, and stick water; overburdening of original habitats; particle suspension.

Fish waste from shoreside and vessel processing has occurred in marine waters since the 1800s. It is a direct impact to the marine environments by degrading water quality factors. Some fish waste is biodegradable such as heads, viscera, and bones. Other fish parts that are ground to fine particles and become suspended. Another byproduct of processing is fish meal waste called stick water, which is a fine gel or slime. Stick water can concentrate on surface waters and move onshore to cover intertidal areas. Seafood processing has been conducted for years in processing ports in Alaska. Crab and fish have been processed in various ports such as Kodiak, Dutch Harbor, St. Paul, and Akutan by floating and shoreside processors with little impact upon habitat for crab and other species. However, localized damage to benthic environment consisting of up to several acres of bottom being driven anoxic by rotting processing waste and piles of waste up to 26 feet deep have been recorded. Discharges from these processors now require National Pollutant Discharge Elimination System (NPDES) permits from the Environmental Protection Agency. At-sea floating processors are covered by a general NPDES permit which requires that processing waste be ground into finer than one-half inch particles and discharged below the surface (personal communication, Dr. Bruce Duncan, U.S. Environmental Protection Agency, 701 C Street, Box 19, Anchorage, AK 99513).

Although seafood has been processed at sea by foreign fishing vessels in the past without apparent harm to the marine habitat, there has been one instance reported of unusual quantities of fish carcasses (not ground in conformance with the general NPDES permit) accompanied by dead scallops brought up in scallop dredges (Capt. Louie Audet, F/V Shayline Nicholas). It will be important to be alert to similar possible perturbations of the environment resulting from at-sea processing discharges.

Over time, suspended particles will accumulate. Juvenile and adult stages of flatfish are drawn to these areas for food sources. One effect of this attraction may lead to increased predation on juvenile fish species by other flatfishes, diving seabirds, and marine mammals drawn to the food source. However, due to the difficulty in monitoring these outfalls, impacts to species can go undetected.

Fish waste disposal at marinas can also degrade water quality where large numbers of fish are landed and cleaned, or where fish landings are limited but water circulation is poor (USEPA 1993). In sufficient quantity, fish waste disposal can cause dissolved oxygen depression, contamination, and odor problems in coastal waters (USEPA 1993).

F.2.4 Timber Harvest

Potential threats include: increase in bedload suspended sediments and turbidity from construction of logging roads, in-water stream crossings, exposed slope erosion, removal of streamside vegetation; alter streamflow; introduce excessive nutrients, decrease large woody debris; increase streambank erosion; alter temperature, and have toxic effects on biota.

Forest road construction can destabilize slopes and increase erosion and sedimentation. This erosion occurs in two forms, as mass soil movement (i.e., landslides) and as surface erosion. Both types can introduce debris and sediment into adjacent streams for many years after initial construction. Erosion is most severe where poor construction practices are allowed, inadequate attention is paid to proper road drainage, and where construction occurs in inclement weather. After construction, unpaved logging roads can be a chronic source of sediment to streams. Juvenile salmon avoid habitat areas with suspended sediment (Bisson and Bilby 1982)

Stream crossings by forest roads may block fish migration. Culverts are often installed as an economical alternative to bridges, although bridges are usually less disruptive to the stream environment. Culverts are a serious threat to salmon unless specifically designed, installed, and maintained to accommodate fish passage.

Removal of streamside vegetation during timber harvest activities increases solar radiation to the stream and results in warmer water during summer, especially in small streams. The magnitude of temperature change depends on the amount of timber harvested adjacent to the stream (Meehan et al, 1969; Brown and Krygier, 1970) and time for regrowth of riparian areas. In Southeast Alaska, Meehan et al., (1969) found that maximum temperature in logged streams exceeded those of unlogged control streams by up to 5ºC, but the temperature did not reach lethal levels. The increased water temperature, however, frequently exceeded the optimum for pink and chum salmon documented by Reiser and Bjornn (1979).

High summer air temperature has been associated with adult salmon mortality. The Alaska Department of Fish and Game compiled a list of 43 streams that had mortality of pink and chum salmon in 1977 associated with high water temperature and low flow. The largest clear-cut in Alaska is located in the Staney Creek

watershed. In 1979, 15,000 pink salmon died there before spawning, a result of warm water and low oxygen. In northern areas, the removal of riparian vegetation may cause lower stream temperature during winter, increasing the formation of frazil and anchor ice.

By removing vegetation, timber harvest temporarily reduces transpiration losses from the watershed, thereby elevating water content of soil and increasing run-off during base-flow periods. The elevated water content can reduce soil strength and destabilize slopes, causing increased sediment and debris inputs to streams (Swanston 1974). Sediment deposition in streams can reduce benthic community production (Culp and Davies, 1983) and can cause mortality of incubating salmon eggs and alevins, and habitat loss for juvenile salmon (Heifetz et al. 1996). Cumulative sedimentation from logging activities can significantly reduce the egg-to-fry survival of coho and chum salmon (Cederholm et al. 1981; Cederholm and Reid 1987; Hartman et al. 1987). Where egg-to-fry survival is impaired by habitat deterioration, escapement goals may have to be increased to offset the effect of decreased spawning success.

Converting large portions of old-growth forests to rapidly growing second-growth forests can permanently reduce summer stream flows and thus permanently reduce salmonid production (Myren and Ellis, 1984). The studies of streams in second-growth forests have demonstrated that the input of large, potentially stable debris (logs and stumps) into salmon habitat from second-growth is reduced relative to inputs from old growth stands (Bisson et al. 1987). Further, the initial high productivity of prey organisms in streams running through open canopy (clear-cut) is short-lived and eventually the quantity of food organisms declines as the canopy closes (Sedell and Swanson, 1984).

F.2.5 Non-point Source Pollution and Urbanization

Potential threats: direct and/or non-point source discharge of fill, nutrients, chemicals, cooling water, air emissions, and surface and ground waters into streams, rivers, estuaries and ocean waters; conversion of wetlands to sites for residential and related purposes such as roads, bridges, parking lots, commercial facilities; elevation in inorganic and organic nutrient loading in estuarine and coastal waters; coastal development effects to adjacent and downstream ecosystems through modification of the hydrology, chemistry, and biology of streams, lakes, bays, estuaries, and the associated wetlands; and cumulative and synergistic effects caused by association of these and other developmental and non-developmental related activities.

People are moving to the coasts in increasing numbers. A major factor in the threat posed by urban and suburban development is that of non-point source (NPS) discharges of the chemicals used in day to day activities, in operating and maintaining homes and business, for maintaining roads, and for fueling vehicles. Sustainable coastal development from a fishery habitat perspective will need to combine responsible developmental practices at the local and state levels with scientific oversight of environmental conditions in the coastal zone. This can only be accomplished through long-term ecological research and education programs that allow assessment of the combined impacts of exploiting fishery stocks and habitat degradation. The results of such investigations should be used to inform the public and elected officials of the economic and social importance of healthy and productive coastal fishery habitats.

Coastal regions can experience substantial change due to rapid population growth and urbanization. Major point source and non-point source discharges have been linked to industrial/municipal facilities, abandoned hazardous waste sites, and runoff from agriculture and urbanization. Regional monitoring studies in South Carolina that measured chemical contaminants in surface waters, sediments, and biota indicated linkage

between elevated levels of chemical contaminants including polycyclic aromatic hydrocarbons (PAHs) from roadways and marinas and chlordane from housing (Scott et al 1996). Similarly a correlation between elevated levels of coliform bacteria in coastal waters and urbanization was demonstrated (Scott et al 1996).

A consequence of increased human populations is an elevation in inorganic and organic nutrient loading in estuarine and coastal waters. This process can result in transient increased productivity and standing crop of phytoplankton, decreased levels of dissolved oxygen, and shifts in species composition. Higher phytoplankton production and biomass, although potentially beneficial as a food source, may cause decreases in light penetration needed for production by benthic algae, submerged aquatic vegetation and, subsequently, benthic animals. Increased nutrients also can lead to shifts in the species composition of the phytoplankton community where fewer and less desirable organisms may become prevalent. Significant depletion of dissolved oxygen has been shown to occur in association with large algal blooms and significant fish kills have been linked to this process. Nutrient loading has also been linked to noxious algal and dinoflagellate blooms that produce toxins which may be harmful to aquatic organisms and humans. Nutrient loading of scallop populations can cause low dissolved oxygen (hypoxic) conditions (Sindermann 1979), and an increase in bacterial infections (Liebovitz et al. 1984), or algal (Wassman and Ramus 1973) and dinoflagellate blooms (Shumway 1990), all of which can be detrimental to their population.

Urbanization and associated coastal development can effect adjacent and downstream ecosystems through modification of the hydrology, chemistry, and biology of streams, lakes, bays, estuaries, and the associated wetlands. Those aquatic features provide many essential ecological functions including flood and erosion control, diverse biological productivity, and as buffers to physicochemical changes in associated water bodies. Prior to the 1960s, most untreated organic and industrial wastes were dumped directly into streams, lakes or estuaries. Environmental damage from such uncontrolled waste discharge was evident from fish kills, oxygen depletion, massive blooms of nuisance algae, and public health problems. Pacific salmon were most evidently affected by pollution from raw sewage, pulp mill effluents, and acid and metal wastes. Strict regulation of point source discharges of municipal and industrial waste continue to improve that situation. Some toxins from previous unregulated discharges, however, remain trapped in bottom sediments and can be disturbed by current activities.

In urban areas, wetlands are easily degraded or lost by dredging, filling, diking, or draining to provide harbors and building sites. When wetlands are filled, their function of buffering physicochemical changes in adjacent and downstream water bodies is often lost. Development activities can, therefore, have severe impacts on anadromous fish, as well as other wetland-dependant species. Wetlands stabilize hydrology, improve water quality, and increase biological diversity in anadromous fish habitat. Wetlands store and control runoff, thereby decreasing flood peaks and erosion and providing greater base flows in downstream areas. With highly variable runoff, anadromous fish habitat may be eroded during floods and left dry during periods of low runoff. Salmon may be prevented from migrating due to velocity barriers or low water. Spawning areas may be scoured during high water or dry up or freeze during low water. Rearing salmon may be flushed into poor habitat during freshets or trapped in drying areas at low flows. Wetlands can improve water quality as nutrients and pollutants are removed through biological and chemical processes.

F.2.6 Point Source Pollution

Potential threats include; overburdening of bottom habitat near the location of outfall; degradation; degradation of water quality and habitat from storm water and industrial discharges; pollution effects that may be related to changes in water flow, pH, hardness, dissolved oxygen, and other parameters that affect individuals, populations, and communities; atmospheric pollution dispersal and mixing.

Point source discharges from municipal sewage treatment facilities or storm water discharges are controlled through U.S. Environmental Protection Agency mandated regulations under the Clean Water Act and by state water quality regulations. The primary concerns associated with municipal point source discharges involve treatment levels needed to attain acceptable nutrient inputs and overloading of treatment systems due to rapid development of the coastal zone. Small quantities of industrial and household pollutants have the potential to become large impacts. Storm drains are contaminated from communities with settling and storage ponds, street runoff, harbor activities, and honey buckets. Sewage outfall lines also can significantly alter pH levels of saline waters.

Industrial wastewater effluent is regulated by the U.S. Environmental Protection Agency through the National Pollutant Discharge Elimination System (NPDES) permitting program. This program provides for issuance of waste discharge permits as a means of identifying, defining, and controlling virtually all point source discharges. The complexity and the magnitude of effort required to administer the NPDES permit program limit overview of the program and federal agencies such as NMFS and the Fish and Wildlife Service generally do not provide comments on NPDES permit notices. For these same reasons, it is not possible to presently estimate the singular, combined, and synergistic effects of industrial (and domestic) discharges on aquatic ecosystems.

At certain concentrations, point source discharges can alter the following properties of ecosystems and associated communities: diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity, and species richness and evenness (Carins 1980). At certain concentrations, point source discharges may alter the following characteristics of finfish, shellfish, and related organisms: growth, visual acuity, swimming speed, equilibrium, feeding rate, response time to stimuli, predation rate, photosynthetic rate, spawning seasons, migration routes, and resistance to disease and parasites. In addition to direct effects on plant and animal physiology, pollution effects may be related to changes in water flow, pH, hardness, dissolved oxygen, and other parameters that affect individuals, populations, and communities (Carins 1980). Sewage, fertilizers, and de-icing chemicals (e.g., glycols, urea) are examples of common urban pollutants that decompose with high biological or chemical oxygen demand.

Contaminants that are emitted into the atmosphere by incinerators, fossil fueled power plants, automobiles, and industry may be transported various distances and directly and indirectly deposited into aquatic ecosystems (Baker *et al.* 1993). As such, the regulation of surface water contamination from atmospheric pollution may require local, regional, and international efforts. Atmospheric linkage of pollutants from local, regional, and remote sources is also possible and, accordingly, the types and levels of contaminants reaching surface waters may vary. Although the magnitude and effect of atmospheric pollution dispersal and mixing may be difficult to assess, it is clear that atmospheric contaminants are routinely deposited in coastal and estuarine waters.

F.2.7 Hazardous Material / General Litter

Potential impacts include: introduction of hazardous and toxic materials from at sea ocean disposal; disposal of contaminated dredged material; illegal dumping of trash, wastewater, and unwanted cargo; accidental disposal of material; "short dumping" of dredged material before permitted disposal area; introduction of general litter such as plastics, derelict fishing gear, and miscellaneous detrital matter.

Under provisions of the Marine Protection Research and Sanctuaries Act (MPRSA), ocean disposal of hazardous and toxic materials, other than dredged materials, is prohibited by U.S. flag vessels and by all vessels operating in the U.S. territorial sea and contiguous zone. The U.S. Environmental Protection Agency (EPA) may issue emergency permits for industrial waste dumping into ocean waters if an unacceptable human health risk exists and no other alternative is feasible. The MPRSA assigns responsibility for the ocean disposal of dredged material to the EPA and the U.S. Army Corps of Engineers. This involves: designating ocean sites for disposal of dredged material; issuing permits for the transportation and disposal of the dredged material; regulating times, rates, and methods of disposal and the quantity and type of dredged material that may be disposed of; developing and implementing effective monitoring programs for the sites; and evaluating the effect of dredged material disposed at the sites.

Dumping of trash, wastewater, and unwanted cargo is more likely to occur on the open seas because it is less observable here than in inshore waters. Prior to passage of the Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987 (PL 100-220), an estimated 14 billion pounds of garbage was being dumped into the ocean each year. Of this amount, more than 85 percent was believed to have come from the world's shipping fleet in the form of cargo associated wastes.

In the absence of MPRSA and MPPRCA repeal or weakening, major dumping threats to EFH within federal waters should theoretically be limited mostly to illegal dumping and accidental disposal of material in unapproved locations. In reality, the present era of reduced government action and involvement many agencies lack sufficient staff and funds to carry out mandated responsibilities and the opportunity for unobserved illegal and accidental dumping may be substantial. This includes disposal of all types of materials as well as "short dumping" of dredged material whereby dumping takes place between the dredge site and the designated dump site.

The Act to Prevent Pollution from Ships (MARPOL ANNEX V) places limitations on ships by prohibiting the discharge or deposit of any refuse matter, hazardous substance, oil, plastics and dunnage lessening impacts to EFH. Persistent plastic debris is introduced into the marine environment from offshore vessels and commercial fisheries, as well as from general shore activities. Debris includes synthetic netting, pots, longline gear, packing bands, and rope. Estimates of debris have been based on observations of debris at sea and on beaches, and occasional reports of accidental or deliberate discards of fishing gear. Studies by Merrell (1984) and others have shown that much of the observed entanglement debris consists of fragments of trawl web. Some trawl web gets discarded overboard following net repair, but most probably gets lost during normal fishing operations (e.g., fishing over rough bottoms, foul weather). Deliberate discharge at sea of all plastics are now prohibited by MARPOL Annex V.

Debris discarded at sea can entangle or be ingested by marine mammals, fish, shellfish, sea birds, and sea turtles. The persistent nature of plastics can pose a hazard to marine life for years. Other lost or discarded gear, such as crab pots continue to fish indefinitely. Neither the extent of debris-related mortality nor population effects on various species are known.

F.2.8 Mariculture and Introduction of exotic species

Potential threats include: introduction of genetic variance into juvenile and adult populations from hatchery fish stocks; transfer and introduction of exotic and harmful organisms through ballast water discharge.

Mariculture can have adverse effects on habitat because of over-enrichment of water and benthic habitat by uneaten food, feces, or other organic materials (Faris 1987). Accumulations on the bottom can create anaerobic conditions near mariculture sites and degrade foraging areas for juvenile salmon (Phillips *et al.* 1985). Additional threats include introductions of exotic species or domestic strains which might prey upon, compete with, or interbreed with wild stocks, and the spread of disease from culture facilities. Habitat can also be affected from the development of ancillary facilities, such as access roads, floating processing plants, or caretaker residences.

With recent introduction of the zebra mussel into the Great Lakes and its rapid dispersal into other waters considerable attention is being directed at the introduction of exotic species into U.S. waters via discharge of ship's ballast. According to one estimate (Carlton 1985) two million gallons of foreign ballast water are released every hour into U.S. waters – possibly representing the largest volume of foreign organisms released on a daily basis into north American ecosystems. The introduction of exotic organisms threatens native biodiversity and could lead to changes in relative abundances of species and individuals that are of ecological and economic importance. The social and economic implications of zebra mussel introduction into North American waters and the introduction of the comb jelly *Mnemiopsis* into the Sea of Azov in Russia – which has helped decimate the region's anchovy fishery – point out the seriousness of this threat.

F.2.9 Oil and Natural Gas Activities

Potential threats include: elimination or damage to bottom habitat due to drill holes and positioning of structures such as drilling platforms, pipelines, anchors, etc;, release of harmful and toxic substances from extracted muds, oil, and gas; and from materials used in oil and gas recovery; damage to organisms and habitats due to accidental spills; damage to fishing gear due to entanglement with structures and debris; and damage to fishery resources and habitats due to effects of blasting (used in platform support removal); and indirect and secondary impacts to near shore aquatic environments affected by product receiving, processing, and distribution facilities.

Information can be found in Berg (1977); Deis (1984); OCSEAP Synthesis Reports on the St. George Basin (1982), the Navarin Basin (1984), and the North Aleutian Shelf (1984); Thorsteinson and Thorsteinson (1982); and the University of Aberdeen (1978). The Alaska offshore area comprises 74 percent of the total area of the U.S. continental shelf. Because of its size, the Alaska outer continental shelf (OCS) is divided into three subregions – Arctic, Bering Sea, and Gulf of Alaska. Areas where oil and gas leases have occurred or are scheduled in the BSAI area include the Navarin Basin (1989)(Morris 1981), St. George Basin (1990)(NMFS 1979), North Aleutian Basin (1990)(NMFS 1980) and the Shumagin Basin (1992) (Morris 1987).

If a commercial quantity of petroleum is found, its production would require construction of facilities and all the necessary infrastructure from pipelines to onshore storage and shipment terminals or for building offshore loading facilities. It is believed that Bering Sea oil would be pipelined to shore and then loaded on tankers for transportation from Alaska. In the Navarin Basin, however, offshore-loading terminals may be more feasible. Unlike exploration, production would continue year-round and would have to surmount the

problems imposed by winter sea-ice in many areas. Norton Basin and perhaps Navarin Basin would require ice-breaking tanker capabilities. There are also occasional proposals for tankering oil from Arctic fields via the Bering Sea, which would also require ice-breaking capabilities.

Oil and gas related activities have the potential to cause pollution of habitats, loss of resources, and use conflicts. Physical alterations in the quality and quantity of existing local habitats may occur because of the siting and construction of offshore drilling rigs and platforms, loading platforms, or pipelines.

Accidental discharge of oil can occur during almost any stage of exploration, development, or production on the OCS or in near shore base areas. Oil spills may result from many possible causes including equipment malfunction, ship collisions, pipeline breaks, human error, or severe storms. Oil spills may also be attributed to support activities associated with product recovery and transportation. In addition to crude oil spills, chemical, diesel, and other oil-product spills can occur in association with OCS activities. Of the various potential OCS-related spill sources, the great majority are associated with product transportation activities (USDOI, MMS 1996).

The 1989 *Exxon Valdez* oil spill in Prince William Sound, the largest oil spill ever in U.S. waters, contaminated 2,000 km of coastal habitat (Spies *et al.* 1996). It spilled 42 million liters of crude oil which had immediate acute effects and longer-term impacts on fish and wildlife. Beached oil penetrated deeply into cobbled beaches and still persists in some areas beneath the surface layer of rocks and under mussel beds. Contamination of intertidal spawning areas for pink salmon caused increased embryo mortality and possible long-term developmental and genetic damage (Bue *et al.* in press). Wild pink salmon spawn in intertidal stream deltas, and therefore, are susceptible to marine oil spills. The embryo is a critical stage of salmon development and is vulnerable to pollution because of its long incubation in intertidal gravel and its large lipid-rich yolk which will accumulate petroleum hydrocarbons from low-level, intermittent exposures (Heintz et al., unpub.).

Residual oil from a spill can remain toxic for long periods because the most toxic components are the most persistent. Petroleum is a complex mixture of alkanes and aromatic hydrocarbons, of which the alkyl-substituted and multi-ring polynuclear aromatic hydrocarbons (PAH) are the most toxic and persistent. These large PAH predominate in weathered oil. Because of low solubility in water, the large PAH probably contribute little to acute toxicity of oil-water solutions. Lipophilic PAH, however, may cause physiological injury if they accumulate in tissues after lengthy exposure (Heintz *et al.* unpub.).

Chronic small oil spills are also a potential problem because residual oil can build up in sediments and affect living marine resources. Low levels of PAH from such chronic pollution can be accumulated in salmon tissues and cause lethal and sublethal effects, particularly at the embryo stage. Demonstrated effects from low-level chronic exposure include increased embryo mortality, reduced marine growth, and increased straying in returning adults.

Many factors determine the degree of damage from an oil spill. The most important variables are the type of oil, size and duration of the spill, geographic location, season, and oceanographic conditions. Habitats most sensitive to oil pollution are typically located in coastal areas with low physical energy (e.g., estuaries, tidal marshes). Exposed rocky shores and ocean surface waters are high-energy environments where physical processes more rapidly remove spilled oil. Benthic and scallop species can also be affected by oil spills, via decreased gill respiration, but the effects are considered to be sort lived (Gould and Fowler 1991). Spiny

scallops were found to be moderately sensitive to acute exposures (96 hour) to Cook Inlet crude and No. 2 oil (Rice *et al.* 1979).

After a large spill, aromatic hydrocarbons would generally be at toxic levels to some organisms within this slick. Beneath and surrounding the surface slick, there would be some oil-contaminated waters. Vertical mixing and current dispersal acts to reduce the oil concentrations with depth and distance. If the oil spill trajectory moves toward land, habitats and species could be affected by the loading of oil into contained areas of the near shore environment. In the shallower waters, an oil spill could be mixed by wave action throughout the water column and contaminate subtidal sediment. Suspended sediment can also act to carry oil to the seabed. In the *Exxon Valdez* oil spill, 13% of spilled oil was deposited in subtidal sediments where it was available to deposit-feeding organisms (Spies *et al.* 1996).

Oil mixed into bottom sediments persists for years and becomes a long term source of low level pollution. Cold temperature slows the evaporation biodegradation processes, so toxic hydrocarbons persist longer. Oil can also be trapped by ice. Toxic aromatic fractions mixed to depth under the surface slick could cause mortalities and sublethal effects on salmon.

Tainting of salmon and other fish flesh is a potential problem in areas subject to either chronic or acute oil pollution. The *Exxon Valdez* oil spill, for example, caused the closure of fisheries for black cod, shrimp, herring, and salmon. Although sockeye salmon were not directly affected by the spill, the fishery in upper Cook Inlet was closed to forestall fouling of gear and public perception of tainting. The sockeye fishery closure caused over-escapement to some freshwater spawning and rearing lakes and subsequent poor production of fry and smolts.

Large oil spills are the most serious potential source of oil and gas development-related pollution. Offshore oil and gas development will inevitably result in some oil entering the environment. Most spills are expected to be of small size, although there is a potential for large spills to occur. Chronic oil spills which build up in the sediments around rigs and facilities are also a problem. In whatever quantities, lost oil can affect habitats and living marine resources. Many factors determine the degree of damage from a spill; the most important variables are the type of oil, size and duration of the spill, geographic location of the spill, and the season. Although oil is toxic to all marine organisms at high concentrations, certain species are more sensitive than others. In general, the early life stages (eggs and larvae) are most sensitive; juveniles are less sensitive, and adults least so (Rice *et al.* 1984).

Habitats most sensitive to oil pollution are typically located in those coastal areas with the lowest physical energy because once oiled, these areas are the slowest to repurify. Examples of low energy environments include tidal marshes, lagoons, and seafloor sediments. Exposed rocky shores and ocean surface waters are higher energy environments where physical processes will more rapidly remove or actively weather spilled oil.

It is possible for a major oil spill (i.e., 50,000 bbls) to produce a slick covering up to several hundred square kilometers of surface area. Oil would generally be at toxic levels to some organisms within this slick.. Beneath and surrounding the surface slick, there would be some oil-contaminated waters. Mixing and current dispersal would act to reduce the oil concentrations with depth and distance. If the oil spill trajectory moves toward land, habitats and species could be affected by the loading of oil into contained areas of the near shore environment. In the shallower waters, an oil spill could be mixed throughout the water column and contaminate the seabed sediments. Suspended sediment can also act to carry oil to the seabed. Up to 70

percent of spilled oil may be incorporated in seafloor sediments where it is available to deposit feeding organisms (crab) and their prey items.

Toxic fractions of oil mixed to depth and under the surface slick could cause mortalities and sublethal effects to individuals and populations. However, the area contaminated would appear negligible in relation to the overall size of the area. For example, Thorsteinson and Thorsteinson (1982) calculated that a 50,000 barrel spill in the St. George Basin would impact less than 0.002 percent of the total size of this area. Even if concentrations of oil are sufficiently diluted not to be physically damaging to marine organisms or their consumers, it still could be detected by them, and alter certain behavior patterns. If an oil spill reaches near shore areas with productive nursery grounds or areas containing high densities of fish eggs and larvae, a year class of a commercially important species of fish or shellfish could possibly be reduced, and any fishery dependent on it may be affected in later years. An oil spill at an especially important habitat (e.g., a gyre where larvae are concentrated) could also result in disproportionately high losses of the resource compared to other areas. Additional concern is the unknown impact of an oil related event near and/or within ice. The water column adjacent to the ice edge is stable. This stabilization (or stratification) would allow relatively quick transport of oil to the seafloor. Additionally, oil trapped in ice could impact habitat significantly after the initial event, months or years later, and even into a different region or country.

Other sources of potential habitat degradation and pollution from oil and gas activities include the disposal of drilling muds, fluids, and cuttings to the water and seabed, and dredged materials from pipeline laying or facilities construction. Naturally occurring sediments or introduced materials may contain heavy metals or other chemical compounds that would be released to the environment, but the quantities are generally low and only local impacts would be expected to occur.

Areas that are currently and historically influenced by oil and gas production operation facilities: Arctic Ocean/ North Slope, Chukchi Sea, Bering Sea/Navarin Basin, Gulf of Alaska/Yakutat Basin, Cook Inlet, and Prince William Sound.

F.2.10 Hydroelectric Projects, Dams and Impoundments

Potential impacts include: detrimental effects on salmon and their habitat; transformation of a river from its natural free-flowing state to an impoundment fundamentally alters that environment; decline or loss of original species; change in temperature regime; change in circulation and flow patterns.

Dams are a significant barrier to upstream and downstream migrations of salmon, and have probably caused the greatest loss of salmon habitat due to human activities in the lower 48 states. Dependence on technology to provide passage around dams has seldom been successful. Fishway design and flow are important to attract and guide adult salmon into passage facilities. Poorly designed fishways can inhibit upstream movement of adults, causing migration delays, increased pre-spawning mortality, and reduced reproductive success in fish that eventually reach their spawning grounds (U.S. Bureau of Reclamation 1985; Hallock *et al.* 1982). Dams also present obstacles to downstream passage of juveniles, and passage through turbines or over spillways can result in migration delays, increase predation, and direct mortality.

Major adverse effects on salmon stocks and habitat caused by dams have been avoided or mitigated in Alaska, as managers have learned from mistakes made in the lower 48 states. A more complete discussion of effects of dams on salmon can be found in the Habitat Appendix of the Eighth Amendment to the Fishery

Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California Commencing in 1978 (PFMC 1987).

Existing Federal Energy and Regulatory Commission (FERC) hydroelectric projects within Alaska include, with project # listed in parentheses: Beaver Falls (# 01922), Black Bear Lake (#10440), Blind Slough (#00201), Blue Lake (# 02230), Bradley Lake (#08221), Burnett River Hatchery (#10773), Chignik (# 00620), Cooper Lake (#02170), Dry Spruce (# 01432), Goat Lake (# 11077), Green Lake (#02818), Humpback Creek (#08889), Jetty Lake (#03017), Ketchikan Lakes (#00420), Pelican (#10198), Power Creek (#11243), Salmon Creek (#02307), Skagway-Dewey Lakes (#01051), Solomon Gulch (# 02742), Swan Lake (#02911), Terror Lake (#02743), Tyee Lake (#03015). Recent interests for new projects include: Twin Lake and Old Harbor on Kodiak Island; Silver Lake and Power Creek in Prince William Sound.

FERC projects can have concerns regarding upstream and downstream passage; provision of adequate instream flow regimes for spawning, rearing, and migration; maintenance of water quality for anadromous fish. Each of these areas is discussed below.

Fish passage for both upstream and downstream migrating salmon, steelhead, and other anadromous fish must be provided to avoid delay, injury, and excessive stress. Required passage facilities must be installed during project construction and must be operated at all times that fish are present. In order to satisfy these objectives, it is necessary to develop a proposal for fish passage facilities. The proposal should define type, location, size, method of operation, and other pertinent facility characteristics. It should reflect state and federal fisheries agency input and design criteria.

Upstream passage facilities are generally required at any project feature which impairs natural passage conditions. At some projects this may require a fish collection system with fishway entrances correctly located and adequate attraction flows, a fish ladder, and an exit structure to return adults to the stream at an appropriate location upstream from the project. At other projects, less extensive facilities are required depending upon the degree of passage obstruction and other site-specific characteristics.

For downstream migrating juveniles, the basic need is to screen turbine intakes to prevent the fish mortalities associated with passage through the turbines by excluding fish from the intake flow. Requirements concerning screen areas and mesh sizes must be satisfied to assure acceptable operation. A bypass flow to safely carry fish from in front of the screens to an appropriate location below the project is a fundamental need. Frequently a system of ports and bypass pipes is necessary. Passage facilities must be designed and maintained to function properly through the full range of flows normally occurring during fish migration periods.

Construction impacts include: siltation of spawning gravels; timing; temperature elevation or reduction which may cause reduced fish growth or disease; gas super-saturation which may occur due to plunging water and result in fish gas-bubble disease; reservoirs which tend to be nutrient traps may cause decreased fish production downstream by reducing available food supplies; silt-laden reservoir releases which decrease invertebrate production and salmon egg survival.

Construction and operation of the project without fishery considerations could result in an interruption/diversion of water supply to and degradation of water quality. The interruption/diversion could be in terms of destruction of incubating eggs, alevins, and fry in the system. Disrupted flows and/or water quality could also result in alteration of migration and spawning habitat. Construction of the dam,

powerhouse, and penstock structures could increase turbidities downstream with potential impacts to migration, spawning and rearing of salmon. Construction of the dam, powerhouse, and penstock structures could also result in erosion and increased input of particulate matter into the creek with adverse impacts to migration, spawning, incubation, and rearing salmon.

Adequate flow regimes and water quality are critical for anadromous fish. Consequently, flow regimes and water quality sufficient for successful spawning, incubation, rearing, and migration must be established and maintained through and downstream of project area where needed. If flow reduction, diversion, or modification of flow regimes are anticipated in the operation scenario for the project, anadromous fisheries could be adversely affected not only in the immediate project area but in the entire system downstream of the facility. Examples of this include the diversion of water from the creek/river to a powerhouse which results in a decrease of water which reaches downstream spawning gravel and rearing habitat and tailrace water discharges that could attract and divert returning adult fish from creek/river, thereby decreasing egg deposition and jeopardizing future returns. To address these matters, flow studies must be performed to determine flow regimes that will conserve and protect stocks of anadromous fish in the river system.

F.2.11 Marine Traffic and Transportation

Potential threats include: potentially harmful vessel operations activities include, but are not limited to: discharge or spillage of fuel, oil, grease, paints, solvents, trash, wastes (including sanitary discharges), and cargo into coastal and tributary waters; alteration of aquatic habitats by the operation of marinas, piers, and docks; disturbance and damage to living marine resources and their habitats by waves, noise, propellers, water jets and other vessel related operations such as anchoring and grounding; exacerbation of shoreline erosion due to wakes.

Routine vessel traffic, discharges, and accidents are potential threats to EFH. The Far East Trade Route takes vessels north by northwest out of the Straits of Juan De Fuca, across the North Pacific and Gulf of Alaska, then through Unimak Pass, Alaska en route to the Far East. Cargo, bunker sea, tanker, freighter, fishing, and recreational vessels make up the vast fleet that transit these waters. In recent times, the freighter vessel Swallow, tanker vessel Exxon Valdez, and freighter vessel Kiroshima grounded and the resulting oil spills proved lethal to marine life and ecosystems. Oil tug and barge traffic is common and their route transits to the major fueling ports of Unalaska, St. Paul, and other coastal cities. In addition, summer vessel traffic increases in the offshore waters with tug and tow traffic bound for the North Slope developments. Other increased traffic seasons coincide with commercial fishery openings, which usually end with at least one vessel grounding or sinking. EFH loss from hazardous cargo is ever present. Other direct impacts from vessels include pollutants such as raw sewage, bilge oil discharge, plastics, and food wastes.

The chronic effects of vessel grounding, prop scarring, and anchor damage are generally more problematic in conjunction with recreational vessels. While grounding of ships and barges is less frequent, individual incidents can have significant localized effects.

Marinas and other sites where vessels are moored are often plagued by accumulation of anti-fouling paints in bottom sediments, by fuel spillage, and overboard disposal of trash and wastewater. A study of marinas found that they may contribute to increases in fecal coliforms, sediment oxygen demand, and chlorophyll a, and decreases in dissolved oxygen.(NC Department of Environment, Health, and Natural Resources 1990)

In the Coastal Zone Management Act of 1972, as amended, Congress declared it to be national policy that state coastal management programs provide for public access to the coasts for recreational purposes. Clearly, boating and adjunct activities (e.g., marinas) are an important means of public access. When these facilities are poorly planned or managed, however, they may pose a threat to the health of aquatic systems and may pose other environmental hazards (USEPA 1993). Since marinas are located at the water's edge, there is often no buffering of the release of pollutants to waterways. The USEPA (1993) identifies the following adverse environmental impacts as possibly being related to marinas and associated activities:

1. pollutants discharged from boats;
2. pollutants generated from boat maintenance activities on land and in the water;
3. exacerbation of existing poor water quality conditions;
4. pollutants transported in storm water runoff from parking lots, roofs, and other impervious surfaces; and
5. the physical alteration or destruction of wetlands and of shellfish and other bottom communities during the construction of marinas, ramps, and related facilities.

Marina related impacts to aquatic systems include lowered dissolved oxygen, increased temperature, bioaccumulation of pollutants by organisms, water contamination, sediment contamination, resuspension of sediments, loss of subaquatic and estuarine vegetation, change in photosynthesis activity, change in the nature and type of sediment, loss of benthic organisms, eutrophication, change in circulation patterns, shoaling and shoreline erosion. Pollutants that result from marinas include nutrients, metals, petroleum hydrocarbons, pathogens, and polychlorinated biphenyls (USEPA 1993).

Marina personnel and boat owners use a variety of boat cleaners, such as teak cleaners, fiberglass polish, and detergents and cleaning boats over the water, or on adjacent upland, creates a high probability that some cleaners and other chemicals will entering the water (USEPA 1993). Copper-based antifouling paint is released into marina waters when boat bottoms are cleaned in the water (USEPA 1993). Tributyl-tin, which was a major environmental concern, has been largely banned except for use on military vessels. Fuel and oil are often released into waters during fueling operations and through bilge pumping. Oil and grease are commonly found in bilge water, especially in vessels with inboard engines, and these products may be discharged during vessel pump out (USEPA 1993).

Boats propellers can also impact fish and fish habitat by direct damage to multiple life stages of associated organisms, including egg, larvae, juveniles, and through water column de-stratification (temperature and density), resuspending sediments, and increasing turbidity (Stolpe 1997; Goldsborough 1997).

Grounding tends to be an infrequent occurrence on fishery habitats such as seagrass beds and coral reefs. The degree of damage is related to the size of the grounded vessel. Large vessels that ground in shallow water seagrass beds may cause considerable localized damage especially when propeller force is used to break free. Crushing damage is usually minimal. Grounding on coral reefs may cause extensive damage to the reef structure because most coral is highly susceptible to breakage and crushing, and recovery is slow.

One of the most conspicuous byproducts of boating activity and human occupation of coastal environments is the presence of marine debris or trash in the coastal waters, beaches, intertidal flats, and vegetated

wetlands. The debris ranges in size from microscopic plastic particles (Carpenter *et al.* 1972), to mile-long pieces of drift net, discarded plastic bottles, bags, aluminum cans, etc.

Sewage and other wastes discharged from recreational boats may be most problematic in marinas and anchorage sites where vessels are concentrated. Despite existing federal and state regulations involving discharges of sewage and other materials, detection and control of related activities is difficult and some discharges still occur. According to the 1989 American Red Cross Boating Survey, there were approximately 19 million recreational boats in the United States (USEPA 1993). About 95 percent of these boats were less than 26 feet in length and a large number of these boats used a portable toilet, rather than a larger holding tank. Given the large percentage of smaller boats, facilities for the dumping of portable toilet waste should be provided at marinas that service significant numbers of boats under 26 feet in length (USEPA 1993).

Increased recreational boating activity may contribute significantly to pollution of coastal waters by petroleum products. All two-cycle outboard engines require that oil be mixed with gasoline, either directly in the tank or by injection. That portion of the oil that does not burn is then ejected, along with other exhaust products, into the water.

F.2.12 Natural Adverse Impacts

Potential threats include: geophysical and seismic activity such as volcanoes, earthquakes, shelf vents; natural occurring elements such as oil seeps and coal outcrops; coastal and inland storms that can cause severe acute and chronic perturbations including habitat erosion, burial by deposition of sediment on deepwater habitats and wetlands; creation of strong currents that alter habitats and remove biota; damage by wind and waves; elevation of turbidity that can cause physiological damage and disrupt feeding, spawning migration, and other vital processes; and abrupt changes in salinity and other water quality characteristics such as fecal coliform levels. Changes in marine habitat may also be the result of the activities of marine animals.

Long-term climatological changes can bring about similar changes by altering weather patterns. Large scale ecological changes may also occur where temperature changes favor or harm a particular species or group. Changes that cause relocation of frontal boundaries, weed lines, and stratification and temperature boundaries may also cause substantial and undesirable environmental change These events potentially can eliminate EFH for any species without any indication or warning. Impacts range from alteration of habitat from undersea landslides to introduction of exotic prey species following a favorable current. Events as such can be theorized but hard to foresee and manage.

The activities of some marine animals also alter benthic habitat. California grey whales “till the soil” when feeding on amphipods. In the Chirikof Basin and the area south of St. Lawrence Island, gray whales created pits averaging 2.5 meters long, 1.5 meters wide, and 10 centemeters deep. Creation of these pites are estimated to suspend 172 million metric tons of sediment a year – three times the amount of suspended sediment discharged annually by the Yukon River (Nelson and Johnson 1987). Pacific walrus make furrows (averaging 47 meters long, 0.4 meters wide, and 0.1 meters deep) in the benthic habitat while searching for clams and are estimated to disturb around 100 million metric tons of sediment per year (Nelson and Johnson 1987; Sease and Chapman 1988). Sea otters, by preying on sea urchins, allow kelp beds to increase which increases siltation rates by slowing water movement, reducing habitat for barnacles, mussels, sea stars and hermit crabs (Palmisano and Estes 1977). Sun stars *(Pycuopodia helianthoides*) using their suckers like conveyor belts are able to dig holes up to 12 inches deep in their search for clams (Mauzen *et al.* 1968).

Although the issue of global warming is controversial, all models predict some temperature increases, especially in the higher latitudes of the Northern Hemisphere (USDC 1997). According to the U.S. Department of Commerce, significant Arctic warming, particularly after 1920, may be related to increased solar radiation, increased volcanic activity, and other naturally occurring factors (USDC 1997). Human induced increases in greenhouse gas concentrations combined with natural conditions to cause unprecedented warming in the Arctic in the 20th century and between 1840 and the mid-20th century the Arctic warmed to the highest level in the past four centuries.

Global temperature increases of a degree or two can cause sea level rise if melting of permafrost and ice cap follow. Possible effects include: significant loss of coral reefs, salt marshes, and mangrove swamps that are unable to keep up with sea level rise; loss of species whose temperature tolerance ranges are exceeded (this could be especially problematic for corals); elevated nutrient and sediment loading due to Tundra run-off; saltwater intrusion into freshwater ecosystems such as freshwater marshes and forested wetlands; invasion of warmer water species into areas occupied by cooler habitat species; and physical changes in the Arctic Seas that could have much broader implications by altering flows, food chains, and climate (USDC 1997). The severity of impact on natural resources, including certain EFH will be determined by natural and human obstruction to inland habitat shifts, resilience of species and populations to withstand changes in environmental conditions, and the rate of environmental change (USDC 1997).

F.2.13 Summary

Table F-3 summarizes the non-fishing adverse impacts to essential fish habitat.

Table F-3a Summary of non-fishing adverse impacts to habitat (excavation, recreation use, fish waste processing, petroleum production, and hydrological threats).

	THREATS														
	Excavation				Recreational Uses		Fish Waste Processing			Petroleum Production			Hydrological		
	Dredging	Dredge Material Disposal	Marine Mining	Nearshore Mining	Boating	Stream Bank Over-usage	Shoreside Discarge	Vessel Discharge	Aquaculture	Production Facility	Exploration	Oil Spill	Hydroelectric Dams	Impoundments	Flood Erosion/ Control
Habitat Alteration															
Alteration of original or normal habitat	X	X	X	X		X	X			X	X	X		X	X
Loss of offshore habitat		X	X							X	X	X			
Loss of pelagic habitat					X			X							
Loss of nearshore habitat	X	X		X	X		X		X	X	X	X			X
Loss of benthic habitat	X	X	X	X	X		X	X		X	X	X			
Loss of aquatic vegetation	X	X		X	X		X		X	X	X	X		X	X
Loss of wetland value	X	X				X				X	X	X		X	X
Loss of original sediment type	X	X	X	X		X	X			X		X	X	X	X
Detrimental Matter Introduction		X	X	X	X	X	X	X	X	X		X			
Topographic Alteration															
Change in original feature or structure	X	X	X	X		X	X			X	X			X	X
Accretion/overburden of original feature	X	X	X	X		X	X			X	X			X	X
Erosion/despersal of features	X		X	X		X				X	X			X	X
Organism Alteration															
Physical damage to organism	X	X	X	X	X	X					X	X		X	X
Mortality	X	X	X	X	X	X				X	X	X	X	X	X
Spatial alteration		X							X	X					
Gene pool deterioration									X			X			
Introduction of exotic species					X				X						
Introduction of pathogens/disease		X	X	X	X	X	X	X	X	X	X	X	X	X	
Change in photosynthetic regime	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Oceanographic Alteration															
Change in temperature regime	^	^	X	^	^		X		X	X					
Change in salinity	^	^	X	^	^		X		X	X		^			
Change in circulation pattern	^	^	X	^	^				X	X	X				
Water Quality Alteration															
Change in dissolved oxygen content	^	^	^	^	^		^	^	^			X	X	X	X
Eutrophication, nutrient loading	X	X	X	X	^	X	X	X	X					X	X
Water contamination	X	X	X	X	X	X	X		X	X	X	X			
Suspended sediments, turbidity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Atmospheric deposition					X					X	X	X			

^ - short term impact

Table F-3b Summary of non-fishing adverse impacts to habitat (agricultural, harbors/ports/ marinas, municipal and industrial, environmental, and marine transportation threats).

	THREATS																
	Agricultural				Harbors/Ports/ Marinas			Municipal and Industrial				Environmental			Marine Transportation		
	Agricultural/ Farming	Insect Control	Forestry	Water Diversion	Port Construction	Port Development	Artifical Reefs	Non-point Source	Coastal Urbanization	Sewage Treatment	Storm Water Runoff	Climatic Changes/ Shifts	Toxic Algal Bloom	Intro. of Exotic Species	Vessel Groundings	Ballast Water	Marine Debris
Habitat Alteration																	
Alteration of original or normal habitat	X		X	X	X	X	X		X	X					X		X
Loss of offshore habitat																	
Loss of pelagic habitat								X				X				X	X
Loss of nearshore habitat	X	X	X	X	X	X	X	X	X	X	X	X			X		X
Loss of benthic habitat					X	X	X	X	X	X					X	X	X
Loss of aquatic vegetation	X	X	X	X	X	X		X	X			X			X		X
Loss of wetland value	X	X	X	X	X	X		X	X								
Loss of original sediment type	X		X		X	X		X	X						X		X
Detrimental Matter Introduction	X		X		X	X		X	X	X	X				X		X
Topographic Alteration																	
Change in original feature or structure	X		X	X	X	X	X		X						X		
Accretion/overburden of original feature	X		X	X	X	X	X	X	X	X		X					X
Erosion/despersal of features	X		X	X	X	X	X		X			X			X		
Organism Alteration																	
Physical damage to organism		X	X		X	X		X	X	X	X		X	X	X	X	X
Mortality		X			X	X		X	X	X	X		X	X	X	X	X
Spatial alteration	X		X		X	X	X	X	X					X			X
Gene pool deterioration								X	X	X	X		X	X		X	
Introduction of exotic species									X	X	X			X	X	X	
Introduction of pathogens/disease	X	X				X		X	X	X	X		X	X	X	X	X
Change in photosynthetic regime		X	X	X	X	X	X	X	X	X	X	X	X			X	X
Oceanographic Alteration																	
Change in temperature regime	^		X	^	^		X	X	X	X	X	X				X	
Change in salinity	^		^		^		X	X	X	X	X	X	^			X	
Change in circulation pattern				X	X	^	X		X			X					
Water Quality Alteration																	
Change in dissolved oxygen content	X			X	^	^		X	X	X	X		X				
Eutrophication, nutrient loading	X			X					X	X	X			X			
Water contamination	X	X	X	X	X	X		X	X	X	X				X	X	X
Suspended sediments, turbidity	X		X	X	X	X			X		X						
Atmospheric deposition		X						X	X			X					

^ - short term impact

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F.3 Cumulative Effects from Fishing and Non-Fishing Activities

The Council and the Secretary of Commerce have taken appropriate actions when threats to fish habitat have been identified. These include cumulative effects from fishing activities and non-fishing activities. Cumulative effects have been examined in the Stock Assessment and Fishery Evaluation (SAFE) reports and NEPA analyses, which are produced annually for the GOA groundfish fisheries. In addition, an Ecosystem Considerations section to the SAFE reports is prepared which identifies specific ecosystem concerns that are considered by fishery managers in maintaining sustainable marine ecosystems.

Cumulative effects from non-fishing activities relate to the amount of habitat loss from human interaction and alteration or natural disturbances. Non-fishing activities are widespread and can have localized impacts to groundfish habitats such as accretion of sediments from at-sea disposal areas, oil and gas exploration, sea floor mining, ice scouring and significant storm events. In addition to EFH consultation guidelines mandated by the Magnuson-Stevens Act, NMFS reviews these types of effects during the review process required by Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for certain activities that are regulated by Federal, state, tribal or local authority. The jurisdiction of these activities is in "waters of the United States" and includes both riverine and marine habitats. To assist in understanding these widespread impacts, the development of a habitat and effect baseline database would accelerate the review process and outline areas of increased disturbance. Inter-agency coordination would prove beneficial to all.

Appendix G Fishery Impact Statement

The Magnuson-Stevens Fishery and Conservation Management Act (Magnuson-Stevens Act) requires that a fishery management plan (FMP) include a fishery impact statement that assesses, specifies, and describes the likely effects of the FMP measures on participants in the fisheries and fishing communities affected by the FMP. A detailed analysis of the effects of the FMP on the human environment, including fishery participants and fishing communities, was conducted in the *Alaska Groundfish Fisheries Programmatic Supplemental Enivonmental Impact Statement* (NMFS 2004). The following is a brief summary from this analysis.

The FMP has instituted privilege-based management programs in the sablefish fishery, and fishery managers, under the guidance of the FMP management policy, are moving towards extending privilege-based allocations to other groundfish fisheries.

- The FMP promotes increased social and economic benefits through the promotion of privilege-based allocations to individuals, sectors and communities. For this reason, it is likely to increase the commercial value generated from the groundfish fisheries.
- As the race-for-fish is eliminated, the FMP could result in positive effects in terms of producer net revenue, consumer benefits, and participant health and safety.
- The elimination of the race-for-fish will likely result in a decrease in overall participation levels. In the long-run, communities are likely to see fewer persons employed in jobs related to the fishing industry (fishing, processing, or support sectors), but the jobs that remain could be more stable and provide higher pay.
- The FMP's promotion of privilege-based allocations is also expected to increase consumer benefits and health and safety of participants.

The FMP has adopted a variety of management measures to promote the sustainability of the groundfish fisheries and dependent fishing communities.

- Management measures to account for uncertainty ensure the sustainability of the managed species by maintaining a spawning stock biomass for the target species with the potential to produce sustained yields.
- The transition to privilege-based management in the short-term could disrupt stability, however in the long-term, the stability of fisheries would be increased in comparison to a derby-style fishery.
- Communities would also tend to experience an increase in stability as a result of built-in community protections to the privilege-based management programs.

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Appendix H Research Needs

Although research needs are expressed in this appendix to the Fishery Management Plan (FMP), ongoing research and research needs are constantly being updated. It may therefore be useful to the reader to access other sources in order to obtain the North Pacific Fishery Management Council (Council)'s most current description of research and research needs on the Gulf of Alaska (GOA) groundfish fisheries. A complete discussion of up-to-date sources is included in Chapter 6 of the FMP. In particular, the Council's Science and Statistical Committee regularly updates the Council research needs, and these can be found on the Council's website. Additionally, ongoing research by National Marine Fisheries Service (NMFS)'s Alaska Fisheries Science Center is also accessible through their website. Website addresses are in Chapter 6.

The FMP management policy identifies several research programs that the Council would like to encourage. These are listed in Section H.1. The Council relies on its Scientific and Statistical Committee (SSC) to assist the Council in interpreting biological, sociological, and economic information. The SSC also plays an important role in providing the Council with recommendations regarding research direction and priorities based on identified data gaps and research needs. The SSC and Council's research priorities are listed in Section H.2. Additionally, NMFS regularly develops a five-year strategy for fisheries research which is described in Section H.3. Research needs specific to essential fish habitat are described in Section H.4.

H.1 Management Policy Research Programs

The management objectives of the FMP (see Section 2.2.1) include several objectives that provide overarching guidance as to research programs that the Council would like to encourage.

- Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits as information becomes available.
- Encourage programs to review status of endangered or threatened marine mammal stocks and fishing interactions and develop fishery management measures as appropriate.
- Encourage development of a research program to identify regional baseline habitat information and mapping, subject to funding and staff availability.
- Encourage a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives, subject to funding and staff availability.

Other objectives in the management policy also contain research elements without which they cannot be achieved. Research initiatives that would support other FMP management objectives are discussed in Section H.1.2 below.

H.2 Council Research Priorities

At its March 2003 meeting, the SSC reviewed the list of research priorities as developed by the Council's BSAI and GOA groundfish plan teams, and developed the following short list of research topics:

A. Critical Assessment Problems

For rockfish stocks there is a general need for better assessment data, particularly investigation of stock structure and biological variables.

- Supplement triennial trawl survey biomass estimates with estimates of biomass or indices of biomass obtained from alternative survey designs.
- Obtain age and length samples from the commercial fishery, especially for Pacific ocean perch, northern rockfish, and dusky rockfish.
- Increase capacity for production ageing of rockfish so that age information from surveys and the fishery can be included in stock assessments in a timely manner.
- Further research is needed on model performance in terms of bias and variability. In particular, computer simulations, sensitivity studies, and retrospective analyses are needed. As models become more complex in terms of parameters, error structure, and data sources, there is a greater need to understand how well they perform.

There is a need for life history information for groundfish stocks, e.g., growth and maturity data, especially for rockfish.

- There is a need for information about stock structure and movement of all FMP groundfish species, especially temporal and spatial distributions of spawning aggregations.

B. Stock Survey Concerns

- There is a need to explore ways for inaugurating or improving surveys to assess rockfish, including nearshore pelagics.
- There is a need to develop methods to measure fish density in habitats typically inaccessible to NMFS survey gear, i.e., untrawlable habitats.

C. Expanded Ecosystem Studies

- Research effort is required to develop methods for incorporating the influence of environmental and climate variability, and there influence on processes such as recruitment and growth into population models, especially for crab stocks.
- Forage fish are an important part of the ecosystem, yet little is known about these stocks. Effort is needed on stock status and distribution for forage fishes such as capelin, eulachon, and sand lance.
- Studies are needed to identify essential habitat for groundfish and forage fish. Mapping of nearshore and shelf habitat should be continued for FMP species.

D. Social and Economic Research

- Development of time series and cross-sectional databases on fixed and variable costs of fishing and fish processing.

- Pre- and post-implementation economic analyses of crab and GOA groundfish rationalization.
- Identification of data needed to support analyses of community level consequences of management actions.
- Development of integrated multispecies/multifishery models for use in analyses of large scale management actions, such as Programmatic SEIS and EFH.

E. Bycatch

- Identify sources of variability in actual and estimated bycatch rates.

F. Monitoring

- Promote advance in video monitoring of other wised unobserved catch for improved estimation of species composition of total catch and discrimination of retained and discarded catch

G. Research Priorities Identified by the NRC Steller Sea Lion Committee

The SSC held a brief discussion on the research and monitoring recommendations of the NRC Steller Sea Lion Committee, as presented in the Executive Summary of their report. The SSC noted that their recommendations are consistent with recognized needs, but also that there is considerable ongoing Steller sea lion research. Among the NRC's recommendations, the SSC wishes to particularly identify their recommendation for a spatially-explicit, adaptive management experiment to definitively conclude whether fishing is playing a role in the current lack of Steller sea lion recovery. As noted in the SSC's February 2003 minutes, there are a number of scientific, economic, and Endangered Species Act (ESA) regulatory considerations that must be addressed before such a plan can be seriously considered for implementation. However, the SSC supports further exploration of the merits of this adaptive management approach.

H.3 National Marine Fisheries Service

NMFS is responsible for ensuring that management decisions are based on the best available scientific information relevant to the biological, social, and economic status of the fisheries. As required by the Magnuson-Stevens Act, NMFS published the *NMFS Strategic Plan for Fisheries Research* in December 2001, outlining proposed research efforts for fiscal years 2001-2006. The Strategic Plan outlines the following broad goals and objectives for NMFS: 1) to improve scientific capability; 2) to increase science quality assurance; 3) to improve fishery research capability; 4) to improve data collection; 5) to increase outreach/information dissemination; and 6) to support international fishery science. The document also outlines the NMFS Alaska Fisheries Science Center (AFSC)'s research priorities for this time period. Summarized below are the AFSC's research priorities grouped into four major research areas: research to support fishery conservation and management; conservation engineering research; research on the fisheries themselves; and information management research.

1. Research to Support Fishery Conservation and Management

- Biological research concerning the abundance and life history parameters of fish stocks

- Conduct periodic (annual, biennial, triennial) bottom trawl, midwater trawl-acoustic, hydroacoustic bottom trawl, longline surveys on groundfish in the Bering Sea and GOA.
- Conduct field operations to study marine mammal-fish interactions, with particular emphasis on sea lion-pollock/cod/Atka mackerel interactions in the GOA and the BSAI areas.
- Observer programs for groundfish fisheries that occur off Alaska.
- Assessments of the status of stocks, including their biological production potentials (maximum sustainable yield, acceptable biological catch, overfishing levels), bycatch requirements, and other parameters required for their management.
- Assessments of the population dynamics, ecosystem interactions, and abundance of marine mammal stocks and their incidental take requirements.

b. Social and economic factors affecting abundance levels

c. Interdependence of fisheries or stocks of fish

d. Identifying, restoring, and mapping of EFH

e. Assessment of effects of fishing on EFH and development of ways to minimize adverse impacts.

2. Conservation Engineering Research

- Continue to conduct research to measure direct effects of bottom trawling on seafloor habitat according to a five-year research plan.
- Conduct fishing gear performance and fish behavioral studies to reduce bycatch and bycatch mortality of prohibited, undersized, or unmarketable species, and to understand performance of survey gear.
- Work with industry and the Council to develop bycatch reduction techniques.

3. Research on the Fisheries

a. Social and economic research

b. Seafood safety research

c. Marine aquaculture

4. Information Management Research

- Continue to build data infrastructure and resources for easy access and data processing. The AFSC's key data bases are its survey data bases from the 1950s (or earlier) and the scientific observer data base that extends back to the foreign fishing days of the 1960s.
- Continue to provide information products based on experts and technical data that support NMFS, the Council, international scientific commissions, and the overall research and management community.

H.4 Essential Fish Habitat Research and Information Needs

Alaska leads the Nation in fish habitat area and in the value of fish harvested, yet the most basic information on distribution and habitat utilization for most early life stages of commercially valuable groundfish and shellfish is lacking. Systematic sampling exists only for targeted adults. A program is required to generate distributional data on which to determine EFH for the juvenile and larval stages of most of our marine fish. Additionally, Alaska fisheries are affected by anthropogenic impacts, including anthropogenic development that impacts watersheds, wetlands, estuaries, and nearshore benthic environment. Priority needs to be given to identifying, assessing and mapping habitat types such as offshore larval concentration areas (i.e. gyres), near shore nursery areas such as eel grass beds, rocky outcroppings, fine/mixed sediments, and productive bottom types for juveniles and adults. Functional value of high-priority habitats need to be established, and the linkages between fishery productivity and habitats need to be understood. Fishing impact studies are in their infancy in Alaska. Increased emphasis needs to be placed on fish ecology, and marine benthic habitat typing in conjunction with impact assessments of trawls, dredges, longlines, pot gear, and other fishing gear used in Alaska fisheries. Development of a standardized marine benthic habitat typing technology is a required precursor.

Specific research needs for the Gulf of Alaska are:

1. Surveys and studies of nearshore pelagic and benthic areas are needed to determine their use by a variety of species, including Atka mackerel, Pacific cod, pollock, rockfish, sablefish, octopus and flatfishes and juveniles and larvae of all species and forage species considered in Council FMPs.

2. Information on habitat distribution, in conjunction with fish distribution, is needed to determine species' habitat requirements and utilization. Information on the extent and distribution of complex habitat types susceptible to bottom fishing will greatly improve the ability to evaluate the potential of a fishery to physically alter bottom habitat and evaluate proposed measures to minimize impacts on EFH. To attain this information, increased use of remote bottom typing technology is necessary, as well as, increased application of currently available technology such as multi-beam sonar, that can provide detailed topographic maps of the continental shelf and slope.

3. Research is necessary to raise the level of information known on a species life stage from Level 0 or 1 to Level 2 or higher. To increase EFH tier levels and obtain valid measures of habitat utilization, systematic surveys must be conducted throughout the full-depth habitat range of each species.

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Appendix I Information on Marine Mammal and Seabird Populations

This appendix contains information on the marine mammal and seabird populations in the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI) management areas. Much of the information in this appendix is from the *Programmatic Supplemental Environmental Impact Statement for Alaska Groundfish Fisheries* (PSEIS), published by National Marine Fisheries Service (NMFS) in 2004.

I.1 Marine Mammal Populations

Marine mammals occur in diverse habitats, including deep oceanic waters, the continental slope, and the continental shelf (Lowry *et al.* 1982). In the areas fished by the federally managed groundfish fleets, twenty-six species of marine mammals are present from the orders Pinnipedia (seals, sea lion, and walrus), Carnivora (sea otter and polar bear), and Cetacea (whales, dolphins, and porpoises) (Lowry and Frost 1985). Most species are resident throughout the year, while others seasonally migrate into and out of Alaskan waters.

I.1.1 Potential impacts of fisheries on marine mammals

Direct Mortality from Intentional Take

Commercial harvests of marine mammals have occurred at various times and places, sometimes with devastating impacts on the populations of particular species. In some cases, such as the northern right whale, the species have not recovered to pre-exploitation population levels even though commercial whaling was halted decades ago.

Direct Mortality from Incidental Take in Fisheries

Some types of fisheries are much more likely to catch marine mammals incidentally than others. High seas driftnet fishing killed thousands of mammals before it was prohibited in 1991. Longline and pot fisheries very rarely catch marine mammals directly.

Indirect Effects through Entanglement

The following effects are classified as indirect because the impacts are removed in time and/or space from the initial action although in the analysis, these effects are considered together with the direct effect of incidental take. In some cases, individual marine mammals may be killed outright by the effect. In other cases, individuals are affected in ways that may decrease their chances of surviving natural phenomenon or reproducing successfully. These sub-lethal impacts may reduce their overall “fitness” as individuals and may have population-level implications if enough individuals are impacted.

Although some fisheries have no recorded incidental take of marine mammals, all of them probably contribute to the effects of entanglement in lost fishing gear. Evidence of entanglement comes from observations of animals trailing ropes, buoys, or nets or bearing scars from such gear. Sometimes stranded marine mammals also have evidence of entanglement but it my not be possible to ascertain whether the entanglement caused the injury or whether the corpse picked up gear as it floated around after death. Sometimes an animal is observed to become entangled in specific fishing gear, in which case an incidental take or minor injury may be recorded for that particular fishery, but many times the contributions of individual fisheries to the overall effects of entanglement are difficult to document and quantify.

The Marine Plastic Pollution Research and Control Act of 1987 (33 USC §§ 1901 *et seq.*), implements the provisions relating to garbage and plastics of the MARPOL. These regulations apply to all vessels, regardless of flag, on the navigable waters of the U.S. and in the exclusive economic zone of the U.S. It applies to U.S. flag vessels wherever they are located. The discharge of plastics into the water is prohibited, including synthetic ropes, fishing nets, plastic bags, and biodegradable plastics.

Indirect Effects through Changes in Prey Availability

The availability of prey to marine mammals depends on a large number of factors and differs among species and seasons. Among these factors are oceanographic processes such as upwellings, thermal stratification, ice edges, fronts, gyres, and tidal currents that concentrate prey at particular times and places. Prey availability also depends on the abundance of competing predators and the ecology of prey species, including their natural rates of reproduction, seasonal migration, and movements within the water column. The relative contributions of factors that influence prey availability for particular species and areas are rarely known. Most critical is the lack of information on how events outside an animal's foraging range or in a different season may influence the availability of prey to animals in a particular place and time.

Marine mammal species differ greatly from one another in their prey requirements and feeding behaviors, leading to substantial differences in their responses to changes in the environment. For some species, such as the baleen whales, diets consist largely of planktonic crustaceans or small squid and have no overlap of prey with species that are targeted or taken as bycatch in the groundfish fisheries. For other species, notably Steller sea lions, there is a high degree of overlap between their preferred size and species of prey and the groundfish catch. Many other species are in between, perhaps feeding on the same species but smaller sizes of fish than what is typically taken in the fisheries. Although they may take a wide variety of prey species during the year, many species may depend on only one or a few prey species in a given area and season. In addition, the prey requirements and foraging capabilities of nursing females and subadult animals may be much more restricted than for non-breeding adults, with implications for reproductive success and survival.

The question of whether different types of commercial fisheries have had an effect on the availability of prey to marine mammals has been addressed by examining the degree of direct competition (harvest) of prey and by looking for potential indirect or cascading effects of the fisheries on the food web of the mammals. For marine mammals whose diets overlap to some extent with the target or bycatch species of the fisheries, fishery removals could potentially decrease the density of prey fields or cause changes in the distribution of prey such that the foraging success of the marine mammals is affected. If alternate prey is not available or is of poorer nutritional quality than the preferred species, or if the animal must spend more time and energy searching for prey, reproductive success and/or survival can be compromised. In the case of marine mammals that do not feed on fish or feed on different species than are taken in the fisheries, the removal of a large number of target fish from the ecosystem may alter the predator/prey dynamics and thus the abundance of

another species that is eaten by marine mammals. The mechanisms and causal pathways for many potential food web effects are poorly documented because they are very difficult to study scientifically at sea.

Although reductions in the availability of forage fish to marine mammals have been attributed to both climatic cycles and commercial fisheries, a National Research Council study on the Bering Sea ecosystem (NRC 1996) concluded that both factors probably are significant. Regime shifts are major changes in atmospheric conditions and ocean climate that take place on multi-decade time scales and trigger community-level reorganizations of the marine biota (Anderson and Piatt 1999). Two cycles of warm and cold regimes have been documented in the GOA in the past 100 years, with the latest shift being from a cold regime to a warm regime in 1977. The consequences of this shift on fish and crustacean populations have been documented, including major improvements in groundfish recruitment and the collapse of some high-value forage species such as shrimp, capelin, and Pacific sand lance (Anderson and Piatt 1999). Directed fisheries on forage fish can deepen and prolong their natural low population cycles (Duffy 1983, Steele 1991), with potential effects on marine mammal foraging success. There is some evidence that another regime shift may have begun in 1998 with colder water temperatures and increases in certain forage populations (NPFMC 2002), but the implications for marine mammals are still unclear. Climate change may also affect the dynamics of the ice pack, with serious consequences for the marine mammals associated with the ice pack, such as bowhead whales, the ice seals, and walrus.

Direct Effects through Disturbance by Fishing Vessels

The effects of disturbance caused by vessel traffic, fishing operations, engine noise, and sonar pulses on marine mammals are largely unknown. With regard to vessel traffic, many baleen and toothed whales appear tolerant, at least as suggested by their reactions at the surface. Observed behavior ranges from attraction to the vessel to course modification or maintenance of distance from the vessel. Dall's porpoise, Pacific white-sided dolphins, and even beaked whales have been observed adjacent to vessels for extended periods of time. Conversely, harbor porpoise tend to avoid vessels. However, a small number of fatal collisions with various vessels have been recorded in California and Alaska in the past decade and others likely go unreported or undetected (Angliss *et al.* 2001).

Reactions to some fishing gear, such as pelagic trawls, are poorly documented, although the rarity of incidental takes suggests either partitioning of foraging and fishing areas or avoidance. Given their distribution throughout the fishing grounds, at least some individuals may be expected to occasionally avoid contact with vessels or fishing gear, which would constitute a reaction to a disturbance. Assuming these instances occur, the effects are likely temporary. Sonar devices are used routinely during fishing activity as well as during vessel transit. The sounds produced by these devices may be audible to marine mammals and may thus constitute disturbance sources. Wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other cases of reaction have been documented.

Indirect Effects through Contamination by Oil Spills

For species such as the pinnipeds and sea otters that spend a substantial amount of time on the surface of the water or hauled out on shore, oil spills pose a significant environmental hazzard, even in small amounts. The toxicological effects of ingested oil, ranging from potential organ damage to weakening of the immune system, are poorly known for most species, especially in regard to chronic low doses. Sea otters are particularly susceptible to oil spills because they depend on their thick fur to protect them from cold water, rather than layers of fat, and oil destroys the insulative properties of their fur. Thousands of sea otters died

over a large expanse of the GOA as a result of the EVOS in 1989 (Garshelis 1997, Garrot *et al.* 1993, DeGange *et al.* 1994). There is very little data on the mortality of marine mammals from the much smaller volumes of oil that are more typical of marine vessel spills, resulting from fuel transfer accidents and bilge operations.

I.1.2 Statutory protection for marine mammals

There are two major laws that protect marine mammals and require the North Pacific Fishery Management Council (Council) to address their conservation in the FMPs . The first is the Marine Mammal Protection Act of 1972 (amended 1994) (MMPA). Management responsibility for cetaceans and pinnipeds other than walrus is vested with NMFS Protected Resources Division (PRD). The USFWS is responsible for management of walrus and sea otters. The goal of the MMPA is to provide protection for marine mammals so that their populations are maintained as a significant, functioning element of the ecosystem. The MMPA established a moratorium on the taking of all marine mammals in the United States with the exception of subsistence use by Alaska Natives. Under the authority of this Act, NMFS PRD monitors populations of marine mammals to determine if a species or population stock is below its optimum sustainable population. Species that fall below this level are designated as "depleted." Populations or stocks (e.g., the western stock of Steller sea lions) listed as threatened or endangered under the ESA, are automatically designated as depleted under the MMPA.

The ESA was enacted in 1973 and reauthorized in 1988. This law provides broad protection for species that are listed as threatened or endangered under the Act. The species listed under the ESA that spend all or part of their time in the BSAI/GOA and that may be affected by the groundfish fisheries are included in the table below. There are eight whale species, and two distinct population segments of Steller sea lions.

Listed Species	Population or Distinct Population Segment (DPS)	Latin Name	Status
Blue whale	North Pacific	*Balaenoptera musculus*	Endangered
Bowhead whale	Western Arctic	*Balaena mysticetus*	Endangered
Fin whale	Northeast Pacific	*Balaenoptera physalus*	Endangered
Humpback whale	Western and Central North Pacific	*Megaptera novaeangliae*	Endangered
Right whale	North Pacific	*Eubalaena japonica*	Endangered
Sei whale	North Pacific	*Balaenoptera borealis*	Endangered
Sperm whale	North Pacific	*Physeter macrocephalus*	Endangered
Gray whale	Eastern Pacific	*Eschrichtius robustus*	Delisted
Steller sea lion	Western Alaska DPS	*Eumetopias jubatus*	Endangered
Steller sea lion	Eastern Alaska DPS	*Eumetopias jubatus*	Threatened

The mandatory protection provisions of the ESA have led to numerous administrative and judicial actions and has brought the issue of fisheries/sea lion interactions under intense scrutiny. Section 7(a)(2) of the ESA requires federal agencies to ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of its designated critical habitat. For federal fishery management actions, the action agency, NMFS Sustainable Fisheries Division, is required under Section7(a)(2) to consult with the Steller sea lion expert agency, NMFS PRD, to determine if the proposed action may affect Steller sea lions or their critical habitat. If the proposed action may affect Steller sea lions or its designated critical habitat, formal consultation is required. Formal consultation is a process between the action and expert

agency that determines whether a proposed action is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. The process begins with the action agency's assessment of the effects of their proposed action on listed species and concludes with the issuance of a "Biological Opinion" (BiOp) by the expert agency. A biological opinion is a document which includes: a) the opinion of NMFS PRD as to whether or not a federal action (such as federally authorized fisheries) is likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat; b) a summary of the information on which the opinion is based; and c) a detailed discussion of the effects of the action on listed species or designated critical habitat. If the BiOp concludes that the proposed action is likely to jeopardize the continued existence of threatened or endangered species or adversely modify critical habitat, then the expert agency recommends. Reasonable and Prudent Alternatives (RPAs) to avoid the likelihood of "jeopardy" or "adverse modification" of critical habitat. The resulting legal requirements limit the Council from adopting FMP policies that result in a jeopardy finding for the Steller sea lions.

I.1.3 Consideration of marine mammals in groundfish fishery management

In order to fulfill their oversight responsibilities under the MMPA, NMFS PRD and USFWS have developed appropriate survey methodologies to census the various species of marine mammals. The results of these surveys, and other factors that affect the status of each species, are published in an annual "Marine Mammal Stock Assessment" report that is available on the NMFS national website (www.nmfs.noaa.gov).

Some species are much more difficult to census accurately than others, so there is a great deal of variation in the uncertainty of various population estimates. In addition, the huge expanses over which many species traverse and the remoteness of their habitats make surveys logistically difficult and expensive. For budgetary and logistical reasons, surveys of most species are not carried out every year and survey effort is prioritized for species of management concern. As a result, population estimates for some species may be outdated and trend information may not exist.

NMFS PRD requires all commercial fisheries in the U.S. EEZ to report the incidental take and injury of marine mammals that occur during their operations (50 CFR 229.6). In addition to self-reported records, which NMFS PRD considers to be negatively biased and under representing actual take levels, certified observers are required in some fisheries to provide independent monitoring of incidental take as well as other fishery data.

Management measures are in place in the BSAI and GOA groundfish fisheries to protect Steller sea lions. These protection measures were deemed necessary based on the hypothesis that the continued decline of the western stock of the Steller sea lion is due to nutritional stress and that groundfish fisheries contribute to this stress by competing with sea lions for their key prey species. Management measures were specifically developed to reduce competitive interaction between Steller sea lions and the groundfish fisheries (NMFS 2001a). Mitigation efforts have focused on protecting the integrity of food supplies near rookeries and haulouts. Competitive interactions with the fishery may have the greatest effect on juvenile Steller sea lions between the time they are weaned and the time they reach adult size and foraging capability as the diving capacity of juveniles (and thus available foraging space) is less than that of adults. Adult females may also be susceptible to nutritional stress due to reduced prey availability in the vicinity of rookeries because of the limited foraging distribution and increased energetic demands when caring for pups. Specifically, the intent of the protection measures was to avoid competition around rookeries and important haulouts with extra precaution in the winter, and to disperse the fisheries outside of those time periods and areas.

Section 118 of the MMPA (50 CFR 229.2) requires all commercial fisheries to be placed into one of three categories, based on the frequency of incidental take (serious injuries and mortalities) relative to the value of potential biological removal (PBR) for each stock of marine mammal. PBR is defined as the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. In order to categorize each fishery, NMFS PRD first looks at the level of incidental take from all fisheries that interact with a given marine mammal stock. If the combined take of all fisheries is less than or equal to 10 percent of PBR, each fishery in that combined total is assigned to Category III, the minimal impact category. If the combined take is greater than 10 percent of PBR, NMFS PRD then looks at the individual fisheries to assign them to a category. Category I designates fisheries with frequent incidental take, defined as those with takes greater than or equal to 50 percent of PBR for a particular stock; Category II designates fisheries with occasional serious injuries and mortalities, defined as those with takes between one percent and 50 percent of PBR; Category III designates fisheries with a remote likelihood or no known serious injuries or mortalities, defined as those with take less than or equal to one percent of PBR. Owners of vessels or gear engaging in Category I or II fisheries are required to register with NMFS PRD to obtain a marine mammal authorization in order to lawfully take a marine mammal incidentally in their fishing operation (50 CFR 229.4). In Alaska, this registration process has been integrated into other state and federal permitting programs to reduce fees and paperwork. Owners of vessels or gear engaging in Category III fisheries are not required to register with NMFS PRD for this purpose. Every year, NMFS PRD reviews and revises its list of Category I, II, and III fisheries based on new information and publishes the list in the Federal Register.

Under provisions of the MMPA, NMFS PRD is required to establish take reduction teams with the purpose of developing take reduction plans to assist in the recovery or to prevent the depletion of strategic stocks that interact with Category I and II fisheries. A “strategic” stock is one which: 1) is listed as endangered or threatened under the ESA, 2) is declining and likely to be listed as threatened under the ESA, 3) is listed as depleted under the MMPA, or 4) has direct human-caused mortality which exceeds the stock’s PBR.

The immediate goal of a take reduction plan is to reduce, within six months of its implementation, the incidental serious injury or mortality of marine mammals from commercial fishing to levels less than PBR. The long-term goal is to reduce, within five years of its implementation, the incidental serious injury and mortality of marine mammals from commercial fishing operations to insignificant levels approaching a zero serious injury and mortality rate, taking into account the economics of the fishery, the availability of existing technology, and existing state or regional FMPs. Take reduction teams are to consist of a balance of representatives from the fishing industry, fishery management councils, state and federal resource management agencies, the scientific community, and conservation organizations. Fishers participating in Category I or II fisheries must comply with any applicable take reduction plan and may be required to carry an observer onboard during fishing operations.

In 2002, all of the Alaska groundfish fisheries (trawl, longline, and pot gear in the BSAI and GOA) were listed as Category III fisheries (67 FR 2410). However, NMFS PRD has recently proposed that the BSAI groundfish trawl fishery be elevated to Category II status based on a review of Observer Program records of marine mammal incidental take from 1990-2000 (68 FR 1414). According to the records, total incidental take of all fisheries is greater than 10 percent of PBR for the Alaska stocks of western and central North Pacific humpback whales, resident killer whales, transient killer whales, and the western stock of Steller sea lions. Based on the incidental take of these species relative to their respective PBRs, and some other considerations in the case of humpback whales, NMFS PRD determined in their “Tier 2” analysis that the BSA groundfish trawl fishery posed a modest risk to these species. In addition, a number of state-managed

salmon drift and set gillnet fisheries are listed in Category II, including those in Bristol Bay, Aleutian Islands, Alaska Peninsula, Kodiak, Cook Inlet, PWS, and Southeast Alaska. NMFS PRD has recently proposed reclassifying the Cook Inlet drift and set gillnet fisheries from Category II to Category III (68 FR 1414).

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I.2 Seabird Populations

Over 70 species of seabirds occur over waters off Alaska and could potentially be affected by direct and indirect interactions with the Bering Sea Aleutian Islands and Gulf of Alaska (BSAI and GOA) groundfish fisheries. Thirty-eight of these species regularly breed in Alaska and waters of the Exclusive Economic Zone (EEZ). More than 1,600 seabird colonies have been documented, ranging in size from a few pairs to 3.5 million birds (USFWS 2000). Breeding populations of seabirds are estimated at approximately 48 million birds and non-breeding migrant birds probably account for an additional 30 million birds (USFWS 2000). Most of the migrant birds are present only during the summer months (May through September) although some non-breeding albatross have been sighted at all months of the year (USFWS 1999). The distributions of species that breed in Alaska are well known in summer but for some species winter distributions are poorly documented or completely unknown.

I.2.1 Potential impacts of fisheries on seabird species

Potential fisheries impacts on a given seabird species could theoretically be measured by changes in survival or reproductive rates and ultimately by changes in the population. For all of these biological parameters, one would expect fluctuations in time and space as part of "normal" or natural conditions. The ability to

distinguish these natural fluctuations from potential human-caused fluctuations requires reasonably accurate measurements of several parameters over a long time period and in many different areas. Although the United States Fish and Wildlife Service (USFWS) surveys a number of large seabird colonies every year, present population estimates for most species are not precise enough to detect anything but the largest fluctuations in numbers. This is especially true for species that do not nest in dense concentrations. For some species, like the burrow and crevice-nesting alcids and storm-petrels, field methods for censussing populations are not available and require additional budgetary support for development (Dragoo *et al.* 2001).

Seabirds can interact with fisheries in a number of direct and indirect ways. Direct effects occur at the same time and place as the fishery action. Seabirds are attracted to fishing vessels to feed on prey churned up in the boat's wake, escaping fish from trawl nets, baited hooks of longline vessels, and offal discharged from trawl, pot, and longline vessels. In the process of feeding, seabirds sometimes come into contact with fishing gear and are caught incidentally. A direct interaction is usually recorded as the injury or killing of a seabird and is referred to as an "incidental take". Information on the numbers of birds caught incidentally in the various gear types comes from the North Pacific Groundfish Observer Program (Observer Program) and is summarized in the seabird section of "Ecosystem Considerations for 2003" report (NPFMC 2002, Tables 8, 9, 11, and 12).

Another direct fishery effect is the striking of vessels and fishing gear by birds in flight. Some birds fly away without injury but others are injured or killed and are thus considered incidental take. The Observer Program does not collect data on vessel strikes in a systematic way but there are some records of bird-strikes that have been collected on an opportunistic basis. These sporadic observations of vessel strikes from 1993-2000 have been entered into the Observer Notes Database, which is maintained by the USFWS, but have only received preliminary statistical analysis (seabird section of "Ecosystem Considerations for 2003", NPFMC 2002). Indirect effects refer to either positive or negative impacts on the reproductive success or survival of seabirds that may be caused by the fishery action but are separated in time or geographic location. The indirect effect which has received the most attention is the potential impact of fisheries competition or disturbance on the abundance and distribution of prey species that seabirds depend on, thus affecting seabird foraging success. Of particular note would be those effects on breeding piscivorous (fish-eating) seabirds that must meet the food demands of growing chicks at the nest colony. Reproductive success in Alaskan seabirds is strongly linked to the availability of appropriate fish (Piatt and Roseneau 1998, Suryan *et al.* 1998a, Suryan *et al.* 2000, Golet *et al.* 2000). Although seabird populations remain relatively stable during occasional years of poor food and reproduction, a long-term scarcity of forage fish leads to population declines. Other potential indirect effects on seabirds include physical disruption of benthic foraging habitat by bottom trawls, consumption of processing wastes and discarded offal, contamination by oil spills, introductions of nest predators (i.e., rats) to nesting islands, and ingestion of plastics released intentionally or accidentally from fishing vessels. Some of these potential impacts are related more to the presence of fishing vessels rather than the process of catching fish.

1.2.2 Statutory protection for seabirds

There are two major laws that protect seabirds and require the Council to address seabird conservation in their Fishery Management Plans (FMPs). The first is the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712), as amended over the years. This law pertains to all of the seabird species found in the BSAI/GOA area (66 FR 52282) and governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. The definition of "take" in the Migratory Bird Treaty Act (MBTA) is "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture,

or collect" (50 CFR 10.12). In a fishery context, "take" refers to birds killed or injured during commercial fishing operations, whether in fishing gear or by striking some part of a vessel. Under the MBTA, take of migratory birds is illegal, even if it is accidental or inadvertent, unless permitted through regulations (such as hunting regulations or permit exemptions). Thus far, only certain forms of intentional take have been legalized in these ways. There are currently no regulations to allow unintentional take. The USFWS and Department of Justice are vested with enforcement discretion, which has been used in lieu of a permitting program. Enforcement has focused on those who take birds with disregard for the law and the impact of their actions on the resource, particularly where effective conservation measures are available but have not been applied ("Fact sheet" on MBTA, K. Laing, USFWS). Executive Order 13186 (66 FR 3853-3856), "Responsibilities of Federal Agencies to Protect Migratory Birds," which was signed by the President on January 10, 2001, directs federal agencies to develop and implement a "Memorandum of Understanding" with the USFWS to promote the conservation of migratory birds affected by their actions, including mitigation of activities that cause unintentional take. National Marine Fisheries Service (NMFS) and USFWS are currently developing this framework document which will incorporate seabird protection measures designed for specific fisheries (K. Rivera, NMFS National Seabird Coordinator, personal communication).

The second law is the Endangered Species Act (ESA) which provides broad protection for species that are listed as threatened or endangered. Presently there are three species listed under the ESA that spend all or part of their time in the BSAI/GOA and that may be affected by the groundfish fisheries: short-tailed albatross (endangered), Steller's eider (threatened), and spectacled eider (threatened). Section 7(a)(2) of the ESA requires federal agencies to ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of the species or result in the destruction or adverse modification of habitat important to the continued existence of the species (Critical Habitat). For ESA listed seabirds, the USFWS is the agency responsible for conducting an assessment of the proposed action and preparing the appropriate Section 7 document, a "Biological Opinion" (BiOp). If the BiOp concludes that the proposed action is likely to jeopardize the continued existence of threatened or endangered species or adversely modify its Critical Habitat, then the agency must develop Reasonable and Prudent Alternatives (RPAs) to minimize or mitigate the effect of the action. Even if a "no jeopardy" determination is made, as has been done for all three listed species in the BSAI/GOA, the agency may require and/or recommend that certain mitigation measures be adopted. In addition, the agency may establish a threshold number of incidental takes that would trigger a new Section 7 consultation to reexamine the required mitigation measures. In the case of the short-tailed albatross, the number of incidental takes that could be reasonably expected, given the designated mitigation measures, has been adopted as a threshold value and is described in the Incidental Take Statement attached to the BiOp (USFWS 1999). These provisions of the ESA, as applied to the short-tailed albatross, have played a major role in the development of seabird protection measures for the longline sector of the BSAI/GOA groundfish fishery.

USFWS may designate Critical Habitat areas for each species under the ESA if it can determine that those areas are important to the continued existence of the species. Critical Habitat may only be designated in U.S. territory, including waters of the EEZ. Short-tailed albatross do not nest in U.S. waters but have been sighted throughout the BSAI/GOA area. No Critical Habitat has been designated for this species. Spectacled and Steller's eiders each have designated Critical Habitats in the BSAI where they concentrate in winter and during flightless molting periods (66 FR 9146 and 66 FR 8850 respectively; February 2001). Critical Habitat designations do not automatically restrict human activities like fishing. They do require the lead agency, in this case the USFWS, to monitor activities that may degrade the value of the habitat for the listed species.

I.2.3 Consideration of seabirds in groundfish fishery management

Seabird protection measures in the BSAI/GOA groundfish fisheries were initiated in the 1990s and have focused primarily on collecting seabird/fishery interaction data and on requiring longliners to use specific types of gear and fishing techniques to avoid seabird incidental take. This emphasis on longline gear restrictions has been driven by conservation concerns for the endangered short-tailed albatross as well as other species. Longline vessels over 26 ft LOA are required to use either single or paired streamer lines (or in some cases for smaller vessels, a buoy bag line) to reduce incidental take of seabirds.

Observers collect incidental take data in the trawl and pot sectors of the fishery. USFWS and the trawl sector of the fishing industry are collaborating on research into minimizing the effects of the trawl "third wire" (a cable from the vessel to the trawl net monitoring device) on incidental take of seabirds. However, there have been no regulatory or FMP-level efforts to mitigate seabird incidental take in the trawl and pot sectors.

For species listed as threatened or endangered under the ESA, the USFWS may establish a threshold number of incidental takes that are allowed before mitigation measures are reviewed and perhaps changed. Although this is sometimes viewed as a "limit" on the number of birds (e.g., short-tailed albatross) that can be taken, the result of exceeding this threshold number is a formal consultation process between NMFS and USFWS, not an immediate shutdown of the fishery.

Another management tool that may affect incidental take of seabirds is the regulation of who is allowed to fish. Limited entry and rationalization programs such as Individual Fishing Quota (IFQ) and Community Development Quota (CDQ) may impact seabird incidental take if the number or size of fishing vessels changes because regulations on protective measures are based on the size of the vessel. Since different types of fishing gear are more prone to take different kinds and numbers of seabirds, allocation of TAC among the different gear sectors can also have a substantial impact on incidental take.

Food web impacts can be addressed with several management tools. The Council has designated particular species and size classes of fish as being important prey for seabirds and marine mammals and has prohibited directed fisheries on these forage fish (BSAI FMP Amendment 36 and GOA Amendment 39). The Council may also manage the allocation, biomass, and species of fish targeted by the industry through the total allowable catch (TAC)-setting process. These factors impact the food web and could thus alter the availability of food to seabirds. While more information is available for the dynamics of fish populations than of invertebrate prey, food web interactions are very complicated and there is a great deal of scientific uncertainty regarding the specific effects of different management options.

Each of the management tools listed above requires reliable data to monitor the extent of fishery interactions and the effectiveness of mitigation efforts in accordance with management policy objectives. The Council established the Observer Program in order to collect fishery information. Beginning in 1993, the Observer Program was modified to provide information on seabird/fishery interactions. Observers are presently required on vessels 125 feet (ft) or more in length overall (LOA) for 100 percent of their fishing days and aboard vessels 60-124 ft LOA for 30 percent of their fishing days. Vessels less than 60 ft LOA do not have to carry observers.

Observers receive training in seabird identification, at least to the level of being able to place birds into the categories requested by the USFWS. Some of these categories identify individual species and others lump species under generalized groups, e.g., "unidentified alcids." In many cases, birds that were caught as the

gear was being deployed have soaked at depth for hours and have been eaten by invertebrates. By the time they are retrieved on board they may be identifiable only to a generalized group level. NMFS is currently working to improve the training of its observers in identifying birds from their feet and bills, which are often the only parts of the bird that are recognizable (S. Fitzgerald, Observer Program, personal communication). When the Observer Program data is analyzed and reported (as in the Ecosystem Considerations reports in *Stock Assessment and Fishery Evaluation* documents), individual species with relatively few records are often lumped into larger categories. For example, the "gull" category contains many "unidentified gulls" but also various numbers of five different gull species that observers have identified to species. Similarly, the "alcid" group contains separate records of seven different alcid species.

For those vessels operating without observers, regulations require captains to report the taking of any ESA-listed species and to retain and deliver the body to USFWS for positive identification. Unfortunately, such self-reporting is unreliable due to the inability or unwillingness of some crews to identify and retain species of concern. Other existing fishery record-keeping and reporting requirements provide data on the distribution of fishing effort which could potentially be used in conjunction with directed research to analyze potential food web and seabird population impacts.

I.2.4 Bibliography

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