# FISHERY MANAGEMENT PLAN

# FOR

# GROUNDFISH OF THE GULF OF ALASKA

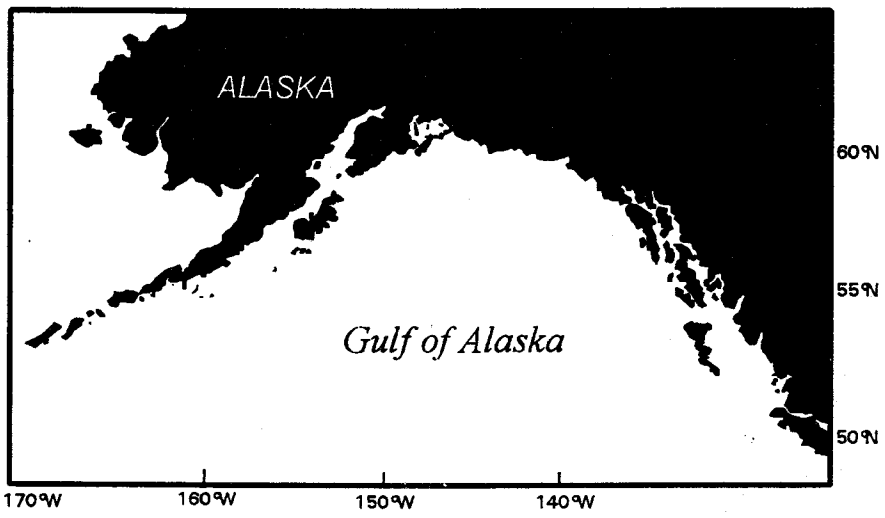


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TABLE OF CONTENTS


1.0 INTRODUCTION . . . . . 1

2.0 GOALS AND OBJECTIVES . . . . . 2
2.1 Goals and Objectives for Management of Gulf Groundfish Fisheries . . . . . 2
2.2 Operational Definition of Terms . . . . . 3

3.0 AREAS AND STOCKS INVOLVED . . . . . 7

4.0 MANAGEMENT MEASURES . . . . . 14
4.1 General Information . . . . . 14
4.2 Framework Measures . . . . . 14
4.2.1 Setting harvest levels . . . . . 14
4.2.1.1 Procedure for setting total allowable catch levels . . . . . 15
4.2.1.2 The OY range . . . . . 16
4.2.1.3 Procedure for setting joint venture and foreign prohibited species catch limits of fully utilized species . . . . . 20
4.2.1.4 The Stock Assessment and Fishery Evaluation Report . . . . . 20
4.2.1.5 Reserves . . . . . 21
4.2.2 Apportionment of harvest within DAH and TALFF . . . . . 21
4.2.3 Prohibited species catch limits and adjustments to control Pacific halibut bycatch . . . . . 22
4.2.3.1 Procedure for establishing prohibited species catch mortality limits for halibut, and seasonal allocations thereof. . . . . 23
4.2.4 Incentive programs to reduce bycatch rates of halibut. . . . . 25
4.2.5 In-season adjustment of time and area . . . . . 25
4.2.6 Time/area closure authority . . . . . 26
4.3 Conventional Measures . . . . . 27
4.3.1 Domestic . . . . . 27
4.3.1.1 Permit Requirements . . . . . 27
4.3.1.2 General Restrictions . . . . . 27
4.3.1.2.1 Catch restrictions . . . . . 27
4.3.1.2.2 Processing Restrictions . . . . . 27
4.3.1.2.3 Gear restrictions . . . . . 27
4.3.1.3 Recordkeeping and Reporting Requirements . . . . . 31
4.3.1.4 Gear allocations . . . . . 31
4.3.1.5 Experimental fishing permits. . . . . 32
4.3.1.6 Inshore/offshore allocations of pollock and Pacific cod . . . . . 33
4.3.1.6.1 Definitions . . . . . 33
4.3.1.6.2 Declarations and operating restrictions . . . . . 33
4.3.1.6.3 Allocations . . . . . 34
4.3.1.6.4 Reapportionment of unused allocations . . . . . 34
4.3.1.6.5 Duration . . . . . 34
4.3.2 Foreign . . . . . 34
4.3.2.1 Permits . . . . . 34
4.3.2.2 Catch and gear restrictions . . . . . 35
4.3.2.2.1 Total allowable level of foreign fishing (TALFF) . . . . . 35

4.3.2.2.2 Prohibited species . . . 35
4.3.2.2.3 Time/area closures and gear restrictions . . . 35
4.3.3 Fishing Seasons . . . 35
4.3.4 Generic . . . 36
4.3.4.1 Observers . . . 36
4.3.4.2 Habitat protection . . . 36
4.3.4.3 Vessel safety considerations . . . 36
4.4 Other Measures . . . 36
4.4.1 Access limitation . . . 36
4.4.1.1 Management of Fixed Gear Sablefish Fisheries . . . 40
4.4.1.1.1 Definitions . . . 40
4.4.1.1.2 Management Areas . . . 41
4.4.1.1.3 Initial Allocation of Quota . . . 41
4.4.1.1.4 Transfer Provisions . . . 42
4.4.1.1.5 Use and Ownership Provisions . . . 43
4.4.1.1.6 Annual Allocation of QS/IFQ . . . 45
4.4.1.1.7 General Provisions . . . 45
4.4.1.1.8 Community Development Quotas . . . 45
4.4.1.2 Moratorium on Vessels Entering the Fisheries . . . 45
4.4.1.2.1 Elements of the Moratorium . . . 45
4.4.1.2 Groundfish License Limitation Program . . . 47
4.4.1.2.1 Elements of the License Limitation Program . . . 47
4.4.2 Size limits . . . 49
4.4.3 Gear Testing . . . 49
4.4.4 Marine Mammal Conservation Measures . . . 50
4.4.5 Improved Retention/Improved Utilization (IR/IU) Program . . . 50
4.4.5.1 Minimum retention requirements . . . 50
4.4.5.2 Minimum utilization requirements . . . 50

5.0 INFORMATION ON THE FISHERY AND RESOURCES . . . 51
5.1 Biological and Environmental Characteristics of the Resource . . . 51
5.1.1 Habitat Requirements by Life History Stage . . . 51
5.1.1.1 Walleye pollock . . . 51
5.1.1.2 Pacific cod . . . 58
5.1.1.3 Deep Water Flatfish . . . 62
5.1.1.4 Shallow Water Flatfish . . . 65
5.1.1.5 Rex sole . . . 69
5.1.1.6 Flathead sole . . . 72
5.1.1.7 Arrowtooth Flounder . . . 75
5.1.1.8 Sablefish . . . 78
5.1.1.9 Pacific ocean perch . . . 82
5.1.1.10 Shortraker Rockfish and Rougheye Rockfish . . . 87
5.1.1.11 Northern Rockfish . . . 90
5.1.1.12 Dusky Rockfish . . . 94
5.1.1.13 Demersal Shelf Rockfish . . . 98
5.1.1.14 Thornyhead Rockfish . . . 102
5.1.1.15 Atka mackerel . . . 105
5.1.1.16 Capelin . . . 109
5.1.1.17 Eulachon . . . 113

5.1.1.18 Sculpins . . . 116
5.1.1.19 Sharks . . . 120
5.1.1.20 Skates . . . 123
5.1.1.21 Squid . . . 126
5.1.1.22 Octopus . . . 130
5.1.2 Status of Stocks . . . 133
5.1.2.1 Pollock . . . 133
5.1.2.2 Pacific cod . . . 133
5.1.2.3 Flounders . . . 134
5.1.2.4 Rockfish . . . 134
5.1.2.5 Sablefish . . . 135
5.1.2.6 Pacific halibut . . . 135
5.1.3 Description of habitat types in the Gulf of Alaska . . . 136
5.2 Description of the Fishery . . . 137
5.2.1 Domestic Fisheries . . . 142
5.2.1.1 North American Halibut Fishery . . . 142
5.2.1.1.1 Vessels and Gear . . . 146
5.2.1.1.2 Catch and Effort . . . 146
5.2.1.2 Sablefish Fishery . . . 147
5.2.1.2.1 Vessels and Gear . . . 147
5.2.1.2.2 Catch and Effort . . . 147
5.2.1.3 Bait Fishery . . . 148
5.2.1.3.1 Vessels and Gear . . . 148
5.2.1.3.2 Catch and Effort . . . 148
5.2.1.4 Trawl Fishery . . . 148
5.2.1.5 Joint Ventures . . . 148
5.2.1.5.1 Vessels and Gear . . . 149
5.2.1.5.2 Catch and Effort . . . 149
5.2.2 Foreign Fisheries . . . 149
5.2.2.1 Canada . . . 149
5.2.2.1.1 Vessels and Gear . . . 151
5.2.2.1.2 Catch and Effort Trends . . . 151
5.2.2.2 U.S.S.R. . . . 151
5.2.2.2.1 Vessels and Gear . . . 151
5.2.2.2.2 Catch and Effort Trends . . . 162
5.2.2.3 Japan . . . 164
5.2.2.3.1 North Pacific Trawl Fishery . . . 164
5.2.2.3.1.1 Vessels and Gear . . . 164
5.2.2.3.1.2 Catch and Effort Trends . . . 165
5.2.2.3.2 Sablefish Setline Fishery . . . 165
5.2.2.3.2.1 Vessels and Gear . . . 165
5.2.2.3.2.2 Catch and Effort Trends . . . 165
5.2.2.4 Republic of Korea (ROK) . . . 166
5.2.2.4.1 Vessels and Gear . . . 166
5.2.2.4.2 Catch and Effort Trends . . . 166
5.2.2.5 Poland . . . 166
5.2.2.5.1 Vessels and Gear . . . 166
5.2.2.6 Other Nations . . . 167

5.3 Socioeconomic Characteristics of the Resource ... 167
5.3.1 Output Characteristics of the Subject Domestic Fishery ... 174
5.3.1.1 Description and Value of Product (wholesale) ... 175
5.3.1.2 Markets ... 175
5.3.1.3 Impact on Domestic Groundfish Fishery Development ... 177
5.3.2 Domestic Commercial Fleet Characteristics ... 178
5.3.3 Recreational Fishing Characteristics ... 182
5.3.4 Subsistence Fishing Characteristics ... 182
5.3.5 Native Treaty Fishing Characteristics ... 182
5.3.6 Area Community Characteristics ... 183
5.4.1 Domestic Fisheries ... 183
5.4.1.1. Regulatory Measures ... 183
5.4.1.2 Purpose of Regulatory Measures ... 183
5.4.2 Foreign Fisheries ... 184
5.4.2.1 Regulatory Measures ... 184
5.4.2.2 Purpose of Regulatory Measures ... 184
5.4.3 Effectiveness of Management Measures (Foreign and Domestic) ... 184
5.4.4 History of Research ... 185
5.4.4.1 United States (see also 5.4.4.5) ... 185
5.4.4.2 Canada ... 186
5.4.4.3 Japan ... 187
5.4.4.4 U.S.S.R. ... 187
5.4.4.5 International Pacific Halibut Commission (IPHC) ... 187
5.5 Interaction Between and Among User Groups ... 188
5.5.1 Domestics ... 188
5.5.2 Impacts on halibut from other Fisheries ... 189
5.5.3 Trawl vs. Salmon Fisheries ... 191
5.5.4 Trawl vs. Crab Fisheries ... 193
5.6 Relationship of this Management Plan to Existing Laws and Policies ... 193
5.6.1 Other Fishery Management Plans Proposed by a Council or the Secretary ... 193
5.6.2 Federal Law and Policies ... 193
5.6.2.1 Treaties and Conventions ... 193
5.6.2.2 Federal Programs Addressing Habitat of Gulf of Alaska Groundfish Stocks ... 193
5.6.3 State Laws and Policies ... 196
5.6.4 Other ... 197
5.7 Enforcement Requirements ... 198
5.8 Financing Requirements ... 198
5.8.1 Management and Enforcement Costs ... 198
5.8.2 Federal and State Revenues Derived From Fishery ... 199
5.8.2.1 Federal Revenues ... 199
5.8.2.2 State Revenues ... 199
5.8.3 Expected State and Federal Revenues, Taxes, Fees ... 199
5.9 References ... 200
5.10 Essential Fish Habitat for GOA Groundfish ... 204
5.10.1 EFH Determination ... 215
5.10.2 EFH Maps ... 227
5.10.3 Fishing Activities that may adversely affect EFH ... 248
5.10.3.1 The indirect effects of fishing: An executive summary ... 248

5.10.3.2 The Effects of Fishing Gear on Benthic Communities ..... 249
5.10.3.3 Literature of Scientific Studies on Fishing Threats to Habitat ..... 258
5.10.4 Non-fishing activities that may adversely affect EFH ..... 262
5.10.4.1 Identification of non-fishing adverse impacts to EFH in Alaska .... 262
5.10.4.2 References ..... 279
5.10.5 Cumulative Effects on EFH from Fishing and Non-fishing Activities ..... 282
5.10.6 Habitat Conservation and Enhancement Recommendations for Non-fishing Threats to EFH ..... 283
5.10.7 Habitat Conservation and Enhancement Recommendations for Fishing Threats to EFH ..... 285
5.10.8 Prey species as a component of EFH ..... 285
5.10.9 Habitat Areas of Particular Concern ..... 285
5.10.9.1 Living Substrates in Shallow Waters ..... 285
5.10.9.2 Living Substrates in Deep Waters ..... 286
5.10.9.3 Freshwater Areas Used by Anadromous Fish ..... 287
5.10.10 Essential Fish Habitat Research and Information Needs ..... 287
5.10.11 Review and Revision of EFH Components of FMPs ..... 288
5.11 Information on Important Habitat for Non-FMP Species Pacific halibut and GOA crab species ..... 288

## 1.0 INTRODUCTION

This Fishery Management Plan (FMP) has been developed by the North Pacific Fishery Management Council and is for the groundfish fishery (excluding halibut) of the Gulf of Alaska. In 1978 it replaced the Preliminary Fishery Management Plan for the management of groundfish in the Gulf of Alaska. Since then the FMP has been amended fifty-two times. Amendments are frequently required in response to stock fluctuations or changes in allocations. A number of amendments modified the sablefish Individual Fishing Quota program. Since 1997, the FMP has been amended to respond to new requirements on essential fish habitat and overfishing in the Sustainable Fisheries Act of 1996, and to avoid seabirds in hook-and-line fisheries.

In terms of the fisheries and the groundfish resource, the Gulf of Alaska (excluding halibut) forms a distinct management unit. The history of fishery development, target species and species composition of the commercial catch, bathemetry, and oceanography are all much different in the Gulf from the adjacent Bering Sea/Aleutian Islands or British Columbia to California regions. Although many species occur over a broader range than the Gulf of Alaska, stocks of common species in the Gulf are believed different from those in adjacent regions.

Even though the International Pacific Halibut Commission is responsible for management of the North American halibut fishery, the potential adverse impact on halibut of a fishery for other groundfish species is so great 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 terms "groundfish" and "bottomfish" exclude Pacific halibut unless otherwise noted. This FMP follows the plan outline adopted by the North Pacific Fishery Management Council and forms the major component of an Environmental Impact Statement which assesses the effect that implementation of this plan is expected to have on the environment of the region which encompasses the Gulf of Alaska.

## 2.0 GOALS AND OBJECTIVES

### 2.1 Goals and Objectives for Management of Gulf Groundfish Fisheries

The North Pacific Fishery Management Council (NPFMC or the Council) is committed to develop long-range plans for managing the Gulf of Alaska groundfish fisheries that will promote a stable planning environment for the seafood industry and will maintain the health of the resource and environment for the seafood industry and will maintain the health of the resource and environment. In developing allocations and harvesting systems, the Council will give overriding considerations to maximizing economic benefits to the United States. Such management will:

(1) Conform to the National Standards and to NPFMC Comprehensive Fishery Management Goals.

(2) Be designed to assure that to the extent possible:

- (a) Commercial, recreational, and subsistence benefits may be obtained on a continuing basis.
- (b) Minimize the chances of irreversible or long-term adverse effects on fishery resources and the marine environment.
- (c) A multiplicity of options will be available with respect to future use of the resources.
- (d) Regulations will be long-term and stable with changes kept to a minimum.

Principal Management Goal. Groundfish resources of the Gulf of Alaska will be managed to maximize positive economic benefits to the United States, consistent with resource stewardship responsibilities for the continuing welfare of the Gulf of Alaska living marine resources. Economic benefits include, but are not limited to, profits, benefits to consumers, income and employment.

To accomplish this goal, a number of objectives will be considered:

Objective 1: The Council will establish annual harvest guidelines, within biological constraints, for each groundfish fishery and mix of species taken in that fishery.

Objective 2: In its management process, including the setting of annual harvest guidelines, the Council will account for all fishery-related removals by all gear types for each groundfish species, sport fishery and subsistence catches, as well as by directed fisheries.

Objective 3: The Council will manage the fisheries to minimize waste by:

- (a) Developing approaches to treating bycatches other than as a prohibited species. Any system adopted must address the problems of covert targeting and enforcement.
- (b) Developing management measures that encourage the use of gear and fishing techniques that minimize discards.

Objective 4: The Council will manage groundfish resources of the Gulf of Alaska to stimulate development of fully domestic fishery operations.

Objective 5: The Council will develop measures to control effort in a fishery, including systems to convert the common property resource to private property, but only when requested to do so by industry.

Objective 6: Rebuilding stocks to commercial or historic levels will be undertaken only if benefits to the United States can be predicted after evaluating the associated costs and benefits and the impacts on related fisheries.

Objective 7: Population thresholds will be established for economically viable species complexes under Council management on the basis of the best scientific information, and acceptable biological catches (ABCs) will be established as defined in this document. If population estimates drop below these thresholds ABC will be set to reflect necessary rebuilding as determined in Objective 6.

## 2.2 Operational Definition of Terms

The following terms are used extensively throughout this fishery management plan.

Acceptable Biological Catch is a preliminary description of the acceptable harvest (or range of harvests) for a given stock or stock complex. Its derivation focuses on the status and dynamics of the stock, environmental conditions, other ecological factors, and prevailing technological characteristics of the fishery. The fishing mortality rate used to calculate ABC is capped as described under "overfishing" below.

Domestic annual harvest (DAH) is the estimated portion of the U.S. groundfish harvest which will be utilized by domestic processors (DAP) and the estimated portions, if any, delivered to foreign processors (JVP) which are permitted to receive U.S. harvested groundfish in the fishery conservation zone.

Domestic annual processed catch (DAP) is the estimated portion of DAH that is expected to be processed by U.S. processors. It is also includes estimates of the quantities and species of groundfish that enter nonprocessed fish markets such as those for bait in crab and longline fisheries. It includes catches by U.S. factory trawlers.

Fishing year is defined as January 1 through December 31.

Forage fish are all species of the following families: Osmeridae (eulachon, capelin and other smelts); Myctophidae (lantern fishes); Bathylagidae (deep-sea smelts); Ammodytidae (Pacific sand lance); Trichodontidae (Pacific sand fish); Pholidae (gunnels); Stichaeidae (pricklebacks, warbonnets, eelblennys; cockscombs and shannys); Gonostomatidae (bristlemouths, lightfishes, and anglemouths); and the Order Euphausiacea (krill))

Joint venture processed catch (JVP) is the estimated portion of DAH that exceeds the capacity and intent of U.S. processors to utilize, or for which domestic markets are not available, that is expected to be delivered to foreign processors in the Fishery Conservation Zone.

Maximum sustainable yield (MSY) is an average over a reasonable length of time of the largest catch which can be taken continuously from a stock under current environmental conditions. It should normally be presented with a range of values around its point estimate.

Where sufficient scientific data as to the biological characteristics of the stock do not exist or the period of exploitation or investigation has not been long enough for adequate understanding of stock dynamics, a preliminary MSY will be estimated from the best information available.

Nonspecified species are species and/or species groups of no current or foreseeable economic value and which are taken by the groundfish fishery only as an incidental catch in target fisheries. Virtually no data exist to conduct population assessments. No record of catch is necessary.

Optimum yield (OY) is the amount of fish (a) which will provide the greatest overall benefit to the nation; (b) which is prescribed as such on the basis of the MSY from such fishery, as modified by any relevant economic, social, or ecological factor; specifically, for Gulf of Alaska groundfish resources as a whole, the OY is specified as a range established from historical fishery performance and estimates of MSY for each species.

Other species are groundfish species and/or species groups which currently are of only slight economic importance or contain economically valuable species but insufficient data exist to allow separate management. Records of catch of this category as a whole must be maintained.

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 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 (1-2), 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 (1-5), if a reliable pdf of $B$ is available, the preferred point estimate is the geometric mean of its pdf. For tiers (1-3), the coefficient $a$ is set at a default value of 0.05, with the understanding that the SSC may establish a different value for a specific stock or stock complex as merited by the best available scientific information. For tiers (2-4), a designation of the form "$F_{X\%}$" refers to the $F$ associated with an equilibrium level of spawning per recruit (SPR) 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 SPR 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

$F_{ABC} \le m_H$, the harmonic mean of the pdf

*1b) Stock status:* $a < B/B_{MSY} \le 1$

$F_{OFL} = m_A \times (B/B_{MSY} - a)/(1 - a)$

$F_{ABC} \le m_H \times (B/B_{MSY} - a)/(1 - a)$

*1c) Stock status:* $B/B_{MSY} \le a$

$F_{OFL} = 0$

$F_{ABC} = 0$

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

*2a) Stock status:* $B/B_{MSY} > 1$

$F_{OFL} = F_{MSY}$

$F_{ABC} \le F_{MSY} \times (F_{40\%}/F_{35\%})$

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:* $B/B_{MSY} \leq a$

$F_{OFL} = 0$

$F_{ABC} = 0$

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:* $B/B_{40\%} \leq a$

$F_{OFL} = 0$

$F_{ABC} = 0$

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

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

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

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

$F_{OFL} = M$

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

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 $\leq 0.75 \times$ OFL

Prohibited Species are those species and species groups the catching of which must be avoided while fishing for groundfish and which must be immediately returned to sea with minimum of injury when caught and brought aboard except when their retention is authorized by other applicable law (see Prohibited Species Donation Program defined in this section).

Prohibited Species Catch (PSC) is nonretainable catch. It can take the form of a prohibited or nongroundfish species and/or as a fully utilized groundfish species captured incidentally in groundfish fisheries. Such catch must be recorded and returned to sea with a minimum of injury except as provided in the Prohibited Species Donation Program. A PSC limit is an apportioned, nonretainable amount of fish provided to a fishery for bycatch purposes. PSC limits of groundfish may be provided to JVP and TALFF when the species is fully utilized by the wholly domestic fishery (i.e., DAP=TAC).

Prohibited Species Donation Program The Prohibited Species Donation Program authorizes the distribution of 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 Federal regulations that may be implemented under the FMP. The Prohibited Species Donation Program applies to the following species:

(1) Pacific salmon
(2) Pacific halibut

Stock Assessment and Fishery Evaluation (SAFE) is an annually prepared document that presents both biological and economic fishery information.

Target species are groundfish species which support either 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, socioeconomic, and ecological merits. Records of catch of this category must be maintained.

Total allowable catch (TAC) is the harvest quota for a species or species group; the retainable catch. TAC will be apportioned to DAP, JVP, and possibly TALFF, by area.

Total allowable level of foreign fishing (TALFF) is determined by deducting the DAH and RESERVE from TAC and is the amount surplus to domestic requirements.

## 3.0 AREAS AND STOCKS INVOLVED

This Fishery Management Plan (FMP) and its management regime applies:

(1) To the U.S. Exclusive Economic Zone 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 and includes the following regulatory areas: Western, Central, and Eastern (Figure 3.1).

(2) To all foreign and domestic fisheries for all finfish except salmon, steelhead, halibut, herring, and tuna. Harvest allocations and management are based on the calendar year.

For purposes of managing pollock, the Western and Central areas are combined to allow improved management and better conservation of the pollock resource. To provide for regulating the harvest of pollock in Shelikof Strait, an important spawning area and the location of a concentrated fishing effort during late winter and early spring, a Shelikof District is specified within the Central Regulatory Area. For purposes of managing sablefish and rockfish stocks, the Eastern Regulatory Area has been divided into two districts: West Yakutat (140° W. longitude - 147° W. longitude) and Southeast Outside (132°40' - 140° W. longitude and north of 54°30' N. latitude). 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. Some of these districts may be managed together to improve management of these fisheries. For purposes of managing rockfish, the Southeast Outside district, as described above, is specified. This district is to protect localized rockfish stocks from overharvest and delineates the primary rockfish fishing ground in this region.

Figure 3.1 indicates regulatory areas as defined by the FMP consisting of Western, Central, and Eastern areas. Total area of the continental shelf in the Gulf of Alaska is about 160,000 square km, which is more than the shelf area in the Washington-California region but less than 25% of the eastern Bering Sea Shelf. Between Canada and Cape Spencer in the Gulf of Alaska 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. Figure 3.2 illustrates the Shelikof District of the Central Regulatory Area.

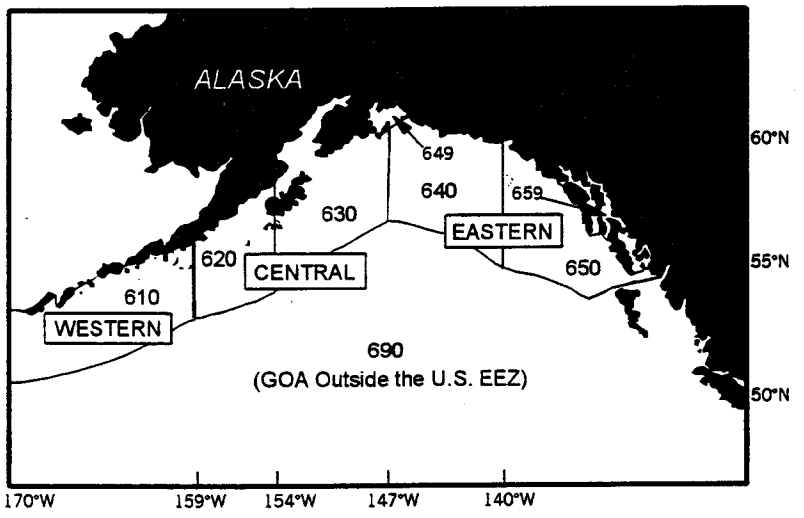
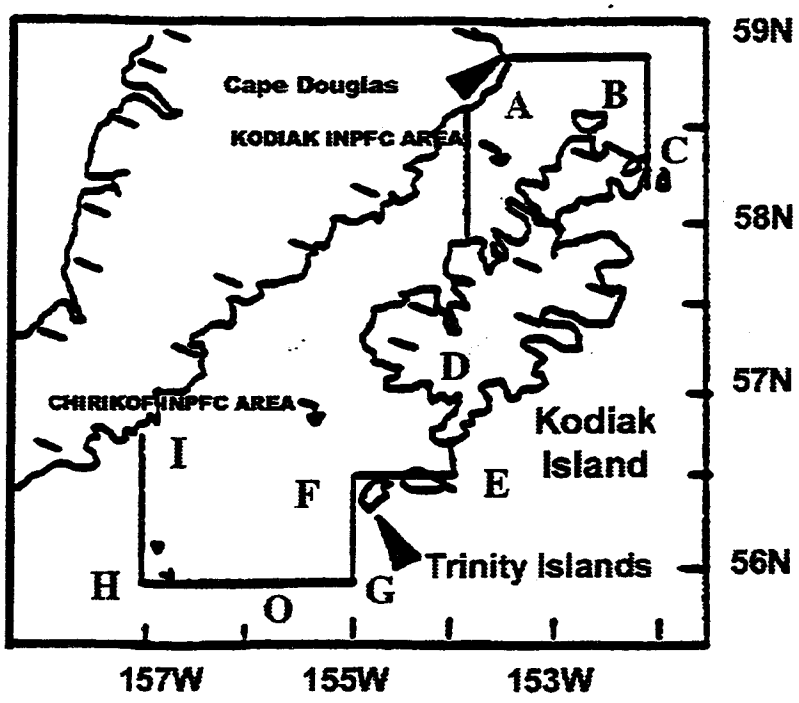



Figure 3.1. Regulatory areas of the Gulf of Alaska.

Figure 3.2 Shelikof District of the Central Regulatory Area in the Gulf of Alaska.




**Boundaries of the Shelikof Strait District in the Gulf of Alaska.**

**The Shelikof Strait District means all waters of the EEZ enclosed by a line connecting the following points in the order listed:**

| Reference point | N. Lat. | W. Long. | Description |
|---|---|---|---|
| A | 58°51' N. | 153°15' W. | Cape Douglas then |
| B | 58°51' N. | 152°00' W. | south to the intersection |
| C | | | of 152°00'W. with Afognak Island, then counter clockwise around the western shorelines of Afognak, Kodiak, and Raspberry Islands to |
| D | 57°00' N. | 154°00' W. | Alitak Bay then south to |
| E | 56°30' N. | 154°00' W. | then west through Trinity Islands to |
| F | 56°30' N. | 155°00' W. | then south to |
| G | 56°00' N. | 155°00' W. | then west to |
| H | 56°00' N. | 157°00' W. | then north to |
| I | | | Intersection of 157°00'W. with the Alaska Peninsula. |

Diversity of commercial bottomfish species in the Gulf of Alaska is intermediate between the Bering Sea, where fewer species occur, and the Washington-California region, where more species are present. The most diverse species in the Gulf of Alaska is the rockfish group (genus *Sebastes*), of which 30 species have been identified in this area. Several species of rockfish have been 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 trawl fishery from the 1960's through mid-1980's, and of a domestic fishery at that time. Although Pacific ocean perch is found throughout the Gulf, the biomass and fishery have been concentrated in the eastern area. For management purposes rockfish are classified into three distinct assemblages that are based on their habitat and distribution. These assemblages are:

Slope Assemblage

Aurora rockfish (*S. aurora*)
Blackgill rockfish (*S. melanostomus*)
Boccacio (*S. paucispinus*)
Chilipepper rockfish (*S. goodei*)
Darkblotch rockfish (*S. crameri*)
Greenstriped rockfish (*S. elongatus*)
Harlequin rockfish (*S. variegatus*)
Northern rockfish (*S. polyspinus*)
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*)

Demersal Shelf Assemblage

Canary Rockfish (*S. pinniger*)
China Rockfish (*S. nebulosus*)
Copper rockfish (*S. caurinus*)
Quillback rockfish (*S. maliger*)
Redbanded rockfish (*S. babcocki*)
Rosethorn rockfish (*S. helvomaculatus*)
Tiger Rockfish (*S. nigrocinctus*)
Yelloweye rockfish (*S. ruberrimus*)

Pelagic Shelf Assemblage

Dusky rockfish (*S. ciliatus*)
Widow rockfish (*S. entomelas*)
Yellowtail rockfish (*S. flavidus*)

Harvest of groundfish in the Gulf of Alaska began in the 1950's. Conservative quotas have allowed for sustained yields, with catches averaging 215,000 mt for the last ten year period. Consequently, most groundfish stocks are at levels considered to be healthy. Some stocks are currently above their long term average, and some below. In general, stock size increases and decreases with variable recruitment strengths. Catches are closely monitored, and kept within ABC limits. For all stocks, ABCs are less than overfishing levels.

The four most valuable slope species, Pacific ocean perch (POP), shortraker, rougheye, and northern rockfish, have been managed separately since 1988, and 1993 for northern rockfish, from the remainder of the slope assemblage to prevent possible overfishing. A rebuilding plan for POP was implemented in 1994 and modified in 1996. The POP stock was considered rebuilt in 1996. Slope and demersal shelf rockfish are considered at medium relative abundance. Pelagic shelf rockfish, principally dusky rockfish, are considered at high relative abundance. Shortspine and, to a lesser extent, longspine thornyhead rockfish taken incidentally in the trawl and longline fisheries (primarily sablefish) are one of the most valuable rockfish species. Catches declined markedly in 1984 and 1985 due primarily to restrictions on foreign fisheries. U.S. catches reached a peak in 1989. Thornyhead abundance has remained relatively stable since the 1970s and is considered at low relative abundance.

The relative abundance of fishes in the cod family (Gadidae) is different in the Gulf of Alaska 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 Gulf and generally not in commercial quantities. Pollock (*Theragra chalcogramma*), the dominant "cod" and largest element in the bottomfish biomass of the Bering Sea, is much less abundant in the Gulf of Alaska and becomes progressively scarce to the south until it is practically absent off Oregon. The abundance of pollock in the Gulf of Alaska peaked in the early 1980s and declined to its lowest level in 1995. Biomass rose through 1999, but is projected to decline through 2003. Strong year classes in 1988 and 1994 comprise a large component of the current population. Pollock currently comprise the largest exploitable biomass within the gadoid community in the Gulf. Pacific cod *(Gadus macrocephalus)* may reach its greatest coastwide abundance in the Gulf. A series of below average and average recruitment has resulted in declining annual abundances since a peak in 1988. Above average recruitment in 1995 has begun to reverse that trend, however, and the population is projected to decline through 2003.

Other groundfishes which are the target of fisheries in the Gulf include sablefish (*Anoplopoma fimbria*) and Atka mackerel, a member of the greenling family (Hexagrammidae). 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 Gulf of Alaska and Bering Sea, but this species reaches its greatest abundance in the Gulf of Alaska. Atka mackerel stocks 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. Due to its low availability the domestic groundfish industry showed little interest in targeting on this species, and Atka mackerel in the Western Regulatory area resulted in establishment of that species as a target species category beginning with the 1994 fishing year.

Many of the flounders present in the Gulf of Alaska 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 Gulf 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 Gulf of Alaska. Other abundant flounders in the Gulf include Pacific halibut (*Hippoglossus stenolepis*), which reaches its greatest abundance there and off British Columbia; rocksole (*Lepidopsette bilineata*); starry flounder (*Platichthys stellatus*); flathead sole (*Hippoglossoides elassodon*); rex sole (*Glyptocephalus zachirus*); and, in deep water, the Dover sole (*Microstomus pacificus*). These flatfish are considered to be at medium relative abundance.

Along the slope of the continental shelf, rattails (*Coryphaenoides sp.*) are a frequent component of the groundfish community and are taken incidentally in the sablefish longline fisheries.

Elasmobranchs are represented in the Gulf by several species of sharks and skates. The spiny dogfish shark (*Squalus acanthias*), is much less abundant in the Gulf than in waters off British Columbia and the Pacific Northwest where it is an important element within the groundfish community. Skates (Rajidae) are widely distributed throughout the Gulf and are most abundant on the inner shelf. Ratfish (*Hydrolagus collei*) are present in the Gulf 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 Gulf toward the Alaska Peninsula.

## 3.1 Species Managed by this Plan

Five categories of species or species groups are likely to be taken by the groundfish fishery. Species may be split or combined with the Target Species category according to procedures set forth in Section 4.2.1.1 without amendments to this FMP, notwithstanding the designation listed below under Target Species. The optimum yield concept is applied to the "target species," other species," and "forage species" categories. The five categories are described as follows:

| Target Species | Other Species | Forage Fish | Prohibited Species | |
|---|---|---|---|---|
| | | | Domestic | Foreign |
| Pollock | Squid | Osmeridae family (eulachon, capelin, and other smelts) | - Pacific halibut | All of the above and other unallocated species |
| Pacific cod | Sculpins | Myctophidae family (lanternfishes) | - Pacific herring | |
| Atka mackerel | Sharks | Bathylagidae family (deep-sea smelts) | - Pacific salmon | |
| Rockfish | Skates | Ammodytidae family (Pacific sand lance) | - Steelhead trout | |
| - Other slope | Octopus | Trichodontidae family (Pacific sand fish) | - King crab | |
| - Demersal shelf | | Pholidae family (gunnels) | - Tanner crab | |
| - Pelagic shelf | | Stichaeidae family (pricklebacks, warbonnets, eelblennys, cockscombs and shannys) | | |
| - Northern rockfish | | | | |
| - Thornyhead rockfish | | | | |
| - Shortraker/rougheye | | | | |
| - Pacific ocean perch | | | | |
| Flatfish | | Gonostomatidae family (bristlemouths, lightfishes, and anglemouths) | | |
| - Deep water | | Order Euphausiacea (krill) | | |
| - Shallow water | | | | |
| - Flathead sole | | | | |
| - Rex sole | | | | |
| - Arrowtooth | | | | |
| Sablefish | | | | |

Forage Fish Species Category. 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 which are a critical food source for many marine mammal, seabird and fish species. 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.

Non-specified species. All other species of fish and invertebrates taken incidentally that are not managed by other FMPs and are associated with groundfish fisheries are not designated as "non-specified species" and catch records need not be kept.

State Regulations of 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 NOAA 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:

> The 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.

## 4.0 MANAGEMENT MEASURES

### 4.1 General Information

The Council may control fisheries by quotas, for target and bycatch species, seasons, gear restrictions, reporting requirements and permits. The measures authorized for management of groundfish in the Gulf of Alaska fall into two categories: framework measures and conventional measures. Framework measures often require adjustment on an annual basis, for example, the setting of the annual yield to fall within the OY range. They are administratively designed to let the Council rapidly respond to biological and socioeconomic changes within a fishery without amending the plan. Often framework measures have a range of management options which are implemented according to specified criteria.

Conventional measures are specific in their application and can only be changed by formal amendment to the FMP. Conventional measures include permits, reporting requirements, gear restrictions, and allocations of target quotas among user groups. Changes to these measures require extensive analysis and public input and at least one year to implement. Fishery regulations must be consistent with the management measures. Management decisions outside of the implemented regulations, but within the measures authorized in the FMP, will require a regulatory amendment.

### 4.2 Framework Measures

#### 4.2.1 Setting harvest levels

A procedure has been developed whereby the Council can set annual harvest levels by specifying a total allowable catch (TAC) for each groundfish fishery on an annual basis. The procedure consists of five steps:

(1) Determine the ABC for each managed species or species group.

(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. Conversely, the TAC may be higher than ABC if the Council believes that socioeconomic considerations warrant a harvest in excess of ABC.

The Council has examined biological and socioeconomic information and has adopted a rebuilding plan for Pacific ocean perch. Rebuilding is determined to have occurred when the current total biomass of mature females is equal to, or greater than, $B_{MSY}$. Other procedures notwithstanding, this rebuilding plan establishes the annual TAC of Pacific ocean perch as follows:

(a) determine the current and target biomass and optimal fishing mortality rate. For purposes of this rebuilding plan, the target biomass is $B_{MSY}$, the total biomass of mature females that would produce the maximum sustainable yield, on average. The optimal fishing mortality rate is the rate that maximizes expected biological and economic yields over a range of plausible stock-recruitment relationships.

(b) determine the fishing mortality rate halfway between the optimal fishing mortality rate and the fishing mortality rate estimated to be sufficient to supply unavoidable bycatch of Pacific ocean perch in the Gulf based on 1992 bycatch.

(c) when the current biomass of mature females is less than $B_{MSY}$, adjust the resultant fishing mortality rate in (b) by the ratio of current biomass to $B_{MSY}$. When $B_{MSY}$ is attained, the fishing mortality rate will be the optimal fishing mortality.

(d) the TAC of Pacific ocean perch is the amount of fish resulting from the adjusted fishing mortality rate.

(e) the TAC is apportioned among regulatory areas in proportion to POP biomass distribution.

(f) the TAC, once calculated and apportioned as outlined in the above paragraphs (a-e), may be further adjusted downward in one or more Gulf of Alaska regulatory areas or districts to accommodate the following:

(1) Biological or resource conservation concerns about the Pacific ocean perch resource or associated with the Pacific ocean perch fishery that are not accounted for in the Rebuilding Plan or the annual Stock Assessment and Fishery Evaluation reports, or

(2) To maintain the TAC within the bounds of the ABC, in cases where the calculated TAC results in an amount that is higher than the ABC.

(3) 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 4.3.3 when recommending changes in seasonal allowances. Shortfalls or overages in one seasonal allowance shall be proportionately added to, or subtracted from, subsequent seasonal allowances.

(4) Identify which groundfish species will be fully utilized by the wholly domestic fishery (DAP = TAC). Then, in these fully utilized fisheries set a PSC limit based on biological and socioeconomic information for joint venture and foreign fisheries. The sum of TAC and PSC for any groundfish species cannot result in overfishing.

(5) Sum TAC for all groundfish species, excluding nonspecified species to assure that the sum is within the OY range specified in the FMP. If the sum falls outside this range the TACs must be adjusted or the plan amended.

It should be noted that 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 nonretainable bycatch of the closed species is found to be nondetrimental to that stock. Similarly, the attainment of a PSC limit of a fully utilized species will result in the closure of the appropriate fishery.

With the exception of the "other species" management category, the framework procedure described above is used to determine TACs for every groundfish species and species group managed by the plan. The other species category will be managed by a single TAC equal to 5% of the combined TACs for target species.

4.2.1.1 Procedure for setting total allowable catch levels

The Secretary, after receiving recommendations from the Council, will determine TACs and apportionments thereof among DAP, JVP, TALFF, and reserves for each target species and the "other species" category by January 1 of the new fishing year, or as soon as practicable thereafter, by means of regulations implementing the FMP. Notwithstanding designated target species and species groups listed in Section 3.1, the Council may recommend splitting or combining species in the target species category for purposes of establishing a new TAC if such action is desirable based on commercial importance of a species or species group and whether sufficient biological information is available to manage a species or species group on its own merits.

Prior to making recommendations to the Secretary, the Council will make available to the public for comment as soon as practicable after its October meeting, a preliminary Stock Assessment and Fishery Evaluation (SAFE) and preliminary specifications of ABC and TAC for each target species and the "other species" category, and apportionments thereof among DAP, JVP, TALFF, and reserves. At a minimum the SAFE will contain information listed in Section 4.2.1.4.

At its December meeting, the Council will review the final SAFE and comments received. The Council will then make final recommendations to the Secretary. The Secretary will implement one-fourth of the preliminary TACs and apportionments thereof on or about January 1 of each year on an interim basis. They will be replaced by final TACs as approved by the Secretary following the Council's December meeting.

4.2.1.2 The OY range

The range of OY specified in the FMP is 116,000-800,000 mt of groundfish. This range was established by examining historical and recent catches, recent determinations of ABC, and the current and past estimates of MSY for each major groundfish species (Tables 4.1 and 4.2).

In particular, the end points of the range were derived as described below: For the minimum value, 116,000 mt is approximately equal to the lowest historical groundfish catch during the 21-year period 1965-1985 (116,053 mt in 1971). In that year catches of pollock, Pacific cod and Atka mackerel were all at very low levels. Given the current status of the groundfish resources and the present management regime, it is considered extremely unlikely that future total harvest will fall below this level. Thus, the TACs will 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) has ranged from 804,950 mt in 1983 to 1,018,750 mt for the 1987 fishing year. The average MSY over the five-year period is 825,470 mt. Therefore, the upper end of the range is approximately equal to 97% of the mean MSY for this five-year period. The ABC summed for all species has ranged from 457,082 mt in 1985 to 814,752 mt in 1987. More recent estimates of MSY are not available, as the emphasis in stock assessment research has focused on estimation of ABC rather than MSY. Most of the variation in the ABC and catch over the five-year interval results from changes in the status of two species: pollock and flounder. Pollock ABC has ranged from 112,000 mt in 1987 to 516,600 mt in 1984; while flounder ABC changed 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.

Table 4.1 Groundfish landings (metric tons) in the Gulf of Alaska, 1956-1998.

| Year | Pollock | Pacific Cod | Flat Fish | Arrowtooth Flounder | Sable Fish | Slope Rock Fish[a] |
|---|---|---|---|---|---|---|
| 1956 | | | | | 1,391 | |
| 1957 | | | | | 2,759 | |
| 1958 | | | | | 797 | |
| 1959 | | | | | 1,101 | |
| 1960 | | | | | 2,142 | |
| 1961 | | | | | 897 | 16,000 |
| 1962 | | | | | 731 | 65,000 |
| 1963 | | | | | 2,809 | 136,300 |
| 1964 | 1,126 | 196 | 1,028 | | 2,457 | 243,385 |
| 1965 | 2,749 | 599 | 4,727 | | 3,458 | 348,598 |
| 1966 | 8,932 | 1,376 | 4,937 | | 5,178 | 200,749 |
| 1967 | 6,276 | 2,225 | 4,552 | | 6,143 | 120,010 |
| 1968 | 6,164 | 1,046 | 3,393 | | 15,049 | 100,170 |
| 1969 | 17,553 | 1,335 | 2,630 | | 19,376 | 72,439 |
| 1970 | 9,343 | 1,805 | 3,772 | | 25,145 | 44,918 |
| 1971 | 9,458 | 523 | 2,370 | | 25,630 | 77,777 |
| 1972 | 34,081 | 3,513 | 8,954 | | 37,502 | 74,718 |
| 1973 | 36,836 | 5,963 | 20,013 | | 28,693 | 52,973 |
| 1974 | 61,880 | 5,182 | 9,766 | | 28,335 | 47,980 |
| 1975 | 59,512 | 6,745 | 5,532 | | 26,095 | 44,131 |
| 1976 | 86,527 | 6,764 | 6,089 | | 27,733 | 46,968 |
| 1977 | 112,089 | 2,267 | 16,722 | | 17,140 | 23,453 |
| 1978 | 90,822 | 12,190 | 15,198 | | 8,866 | 8,176 |
| 1979 | 98,508 | 14,904 | 13,928 | | 10,350 | 9,921 |
| 1980 | 110,100 | 35,345 | 15,846 | | 8,543 | 12,471 |
| 1981 | 139,168 | 36,131 | 14,864 | | 9,917 | 12,184 |
| 1982 | 168,693 | 29,465 | 9,278 | | 8,556 | 7,991 |
| 1983 | 215,567 | 36,540 | 12,662 | | 9,002 | 7,405 |
| 1984 | 307,400 | 23,896 | 6,914 | | 10,230 | 4,452 |
| 1985 | 284,823 | 14,428 | 3,078 | | 12,479 | 1,087 |
| 1986 | 93,567 | 25,012 | 2,551 | | 21,614 | 2,981 |
| 1987 | 69,536 | 32,939 | 9,925 | | 26,325 | 4,981 |
| 1988 | 65,625 | 33,802 | 10,275 | | 29,903 | 13,779 |
| 1989 | 78,220 | 43,293 | 11,111 | | 29,842 | 19,002 |
| 1990 | 90,490 | 72,517 | 15,411 | | 25,701 | 21,114 |
| 1991 | 107,500 | 76,997 | 20,068 | | 19,580 | 13,994 |
| 1992 | 93,904 | 80,100 | 28,009 | | 20,451 | 16,910 |
| 1993 | 108,591 | 55,994 | 37,853 | | 22,671 | 14,240 |
| 1994 | 110,891 | 47,985 | 29,958 | | 21,338 | 11,266 |
| 1995 | 73,248 | 69,053 | 32,273 | | 18,631 | 15,023 |
| 1996 | 50,206 | 67,966 | 19,838 | 22,183 | 15,826 | 14,288 |
| 1997 | 89,892 | 68,474 | 17,179 | 16,319 | 14,129 | 15,304 |
| 1998[b] | 123,853 | 62,327 | 10,430 | 13,063 | 12,501 | 14,562 |

Table 4.1 (continued)

| Year | Pelagic Shelf Rockfish | Demersal Shelf Rockfish[b] | Thorny Heads[c] | Atka Mackerel[e] | Other Species[d] | Total All Species |
|---|---|---|---|---|---|---|
| 1956 | | | | | | 1,391 |
| 1957 | | | | | | 2,759 |
| 1958 | | | | | | 797 |
| 1959 | | | | | | 1,101 |
| 1960 | | | | | | 2,142 |
| 1961 | | | | | | 16,897 |
| 1962 | | | | | | 65,731 |
| 1963 | | | | | | 139,109 |
| 1964 | | | | | | 248,192 |
| 1965 | | | | | | 360,131 |
| 1966 | | | | | | 221,172 |
| 1967 | | | | | | 139,206 |
| 1968 | | | | | | 125,822 |
| 1969 | | | | | | 113,333 |
| 1970 | | | | | | 84,983 |
| 1971 | | | | | | 115,758 |
| 1972 | | | | | | 158,768 |
| 1973 | | | | | | 144,478 |
| 1974 | | | | | | 153,143 |
| 1975 | | | | | | 142,015 |
| 1976 | | | | | | 174,081 |
| 1977 | | | 0 | 19,455 | 4,642 | 195,768 |
| 1978 | | | 0 | 19,588 | 5,990 | 160,830 |
| 1979 | | | 0 | 10,949 | 4,115 | 162,675 |
| 1980 | | | 1,351 | 13,166 | 5,604 | 202,426 |
| 1981 | | | 1,340 | 18,727 | 7,145 | 239,476 |
| 1982 | | 120 | 788 | 6,760 | 2,350 | 234,001 |
| 1983 | | 176 | 730 | 12,260 | 2,646 | 296,988 |
| 1984 | | 563 | 207 | 1,153 | 1,844 | 356,659 |
| 1985 | | 489 | 81 | 1,848 | 2,343 | 320,656 |
| 1986 | | 491 | 862 | 4 | 401 | 147,483 |
| 1987 | | 778 | 1,965 | 1 | 253 | 146,703 |
| 1988 | 1,086 | 508 | 2,786 | - | 647 | 158,411 |
| 1989 | 1,739 | 431 | 3,055 | - | 1,560 | 188,253 |
| 1990 | 1,647 | 360 | 1,646 | 1,416 | 6,289 | 236,591 |
| 1991 | 2,342 | 323 | 2,018 | 3,258 | 1,577 | 247,657 |
| 1992 | 3,440 | 511 | 2,020 | 13,834 | 2,515 | 261,694 |
| 1993 | 3,193 | 558 | 1,369 | 5,146 | 6,867 | 256,482 |
| 1994 | 2,990 [f] | 540 | 1,320 | 3,538 | 2,752 | 232,578 |
| 1995 | 2,891 | 219 [g] | 1,113 | 701 | 3,433 | 216,585 |
| 1996 | 2,302 | 401 | 1,100 | 1,580 | 4,302 | 199,992 |
| 1997 | 2,629 | 406 | 1,240 | 331 | 5,409 | 230,448 |
| 1998 | 3,109 | 306 | 1,130 | 316 | 3,698 | 245,295 |

a/ Catch defined as follows: (1) 1961-78, Pacific ocean perch (S. alutus) only; (2) 1979-1987, the 5 species of the Pacific ocean perch complex; 1988-90, the 18 species of the slope rock assemblage; 1991-1995, the 20 species of the slope rockfish assemblage.

b/ Catch from Southeast Outside District.

c/ Thornyheads were included in the other species category, and are foreign catches only.

d/ After numerous changes, the other species category was stablized in 1981 to include sharks, skates, sculpins, eulachon, capelin (and other smelts in the family Osmeridae and octopus. Atka mackerel and squid were added in 1989. Catch of Atka Mackerel is reported separately for 1990-1992; thereafter Atka mackerel was assigned a seperate target species.

e/ Atka mackerel was added to the Other Species category in 1988.

f/ PSR includes light dusky rockfish, black rockfish, yellowtail rockfish, widow rockfish, dark dusky rockfish, and blue rockfish.

g/ Does not include at-sea discards.

h/ Catch data reported through November 7, 1998.

i/ Includes all species except arrowtooth.

Table 4.2 Gulf of Alaska MSYs, ABCs, and catches for the period 1983-87.

| YEAR | | Pollock | Pacific Cod | Flounders | Pacific Ocean Perch | Sablefish | Atka Mackerel | Rockfish | Thornyhead | Squid | Totals, All Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MSY | 334,000 | 177,000 | 67,000 | 150,000 | 25,000 | 33,000 | 10,200 | 3,750 | 5,000 | 804,950 |
| 1983 | ABC | 256,000 | 60,000 | 67,000 | 25,000 | 13,000 | 28,700 | 7,600 | 3,750 | 5,000 | 466,050 |
| | Catch | 215,608 | 36,401 | 12,661 | 7,406 | 9,002 | 12,260 | 2,001 | 730 | 271 | 296,340 |
| | MSY | 334,000 | 177,000 | 67,000 | 150,000 | 25,000 | 33,000 | 10,200 | 3,750 | 5,000 | 804,950 |
| 1984 | ABC | 516,600 | 60,000 | 67,000 | 21,875 | 9,480 | 28,700 | 7,600 | 3,750 | 5,000 | 720,005 |
| | Catch | 306,693 | 23,219 | 6,878 | 4,325 | 10,229 | 1,152 | 1,278 | 183 | 95 | 354,052 |
| | MSY | 334,000 | 177,000 | 67,000 | 150,000 | 25,000 | 33,000 | 10,200 | 3,750 | 5,000 | 804,950 |
| 1985 | ABC | 321,600 | 60,000 | 33,500 | 11,474 | 9,480 | 4,678 | 7,600 | 3,750 | 5,000 | 457,082 |
| | Catch | 291,489 | 14,442 | 3,369 | 925 | 11,887 | 1,848 | 442 | 38 | 12 | 324,452 |
| | MSY | 334,000 | 136,000 | 141,000 | 150,000 | 25,000 | 7,800 | 10,200 | 3,750 | 5,000 | 812,750 |
| 1986 | ABC | 116,600 | 136,000 | 141,000 | 10,500 | 18,800 | 4,700 | N/A | N/A | N/A | N/A |
| | Catch | 72,790 | 21,918 | 2,309 | 2,857 | 20,794 | 4 | 3,022 | 714 | 7 | 124,415 |
| | MSY | 334,000 | 125,000 | 477,000 | 150,000 | 25,000 | 7,800 | 10,200 | 3,750 | 5,000 | 1,137,750 |
| 1987 | ABC | 112,000 | 125,000 | 537,000 | 3,702 | 25,000 | 600 | 2,700 | 3,750 | 5,000 | 814,752 |
| STATISTICS | | | | | | | | | | | |
| | MSY, min. | 334,000 | 125,000 | 67,000 | 150,000 | 25,000 | 7,800 | 10,200 | 3,750 | 5,000 | 804,950 |
| Range | MSY, max. | 334,000 | 177,000 | 477,000 | 150,000 | 25,000 | 33,000 | 10,200 | 3,750 | 5,000 | 1,137,750 |
| | ABC, min. | 112,000 | 60,000 | 33,500 | 3,702 | 9,480 | 600 | 2,700 | 3,750 | 5,000 | 457,082 |
| | ABC, max. | 516,600 | 136,000 | 537,000 | 25,000 | 25,000 | 28,700 | 7,600 | 3,750 | 5,000 | 814,752 |
| | Catch, min. | 72,790 | 14,422 | 2,309 | 925 | 9,002 | 4 | 442 | 38 | 7 | 124,415 |
| | Catch, max. | 306,693 | 36,401 | 12,661 | 7,406 | 20,794 | 12,260 | 3,022 | 730 | 271 | 354,052 |
| | MSY | 334,000 | 158,400 | 163,800 | 150,000 | 25,000 | 22,920 | 10,200 | 3,750 | 5,000 | 873,070 |
| Mean | ABC | 264,560 | 88,200 | 16[illegible],100 | 14,510 | 15,152 | 13,476 | 6,375 | 3,750 | 5,000 | 614,472 |
| | Catch (83-85) | 271,263 | 24,687 | [illegible],636 | 4,219 | 10,373 | 5,087 | 1,240 | 317 | 126 | 324,948 |
| | MSY | 0 | 10,306 | 71,197 | 0 | 0 | 5,521 | 0 | 0 | 0 | 59,200 |
| Std. Error | ABC | 66,938 | 15,524 | 83,756 | 3,501 | 2,678 | 5,599 | 1,061 | 0 | 0 | 78,282 |
| | Catch (83-85) | 23,002 | 5,210 | 2,212 | 1,528 | 683 | 2,933 | 368 | 172 | 62 | 13,604 |

Source: PacFIN and Gulf of Alaska Groundfish Plan Team Reports, 1982-86.

4.2.1.3 Procedure for setting joint venture and foreign prohibited species catch limits of fully utilized species

The timing of actions and procedure to be taken in establishing prohibited species catch limits (PSCs) of fully utilized species is as follows, although the commercial groundfish fisheries have been fully Americanized since 1990:

(1) September. Following the initial determination of TACs for all managed groundfish species as described in Section 3.1, the plan team will identify those groundfish species that are fully utilized by the wholly domestic fishery. For those species, initial PSC limits will be calculated for joint venture and foreign fisheries using the best available bycatch rates obtained by NMFS observers from the respective fisheries and applying it to initial joint venture (JVP) and foreign (TALFF) TAC apportionments. Each PSC may be apportioned among the regulatory areas and districts of the Gulf of Alaska.

(2) September Council meeting. Council will review and approve preliminary PSCs and release the SAFE for 30-day public review.

(3) October 1. As soon as practicable after October 1 the Secretary, after consultation with the Council, will publish a rule-related notice in the Federal Register specifying the proposed PSCs for JVP and TALFF. Public comments on the proposed PSCs will be accepted by the Secretary for 30 days after the notice is published.

(4) November. Plan Team prepares final SAFE.

(5) December Council meeting. Council reviews public comments, takes public testimony and makes final decisions on annual PSC limits.

(6) By January 1 the Secretary will publish a notice of final PSC limits in the Federal Register.

(7) January 1. Annual PSC Limits take effect for the current fishing year.

4.2.1.4 The Stock Assessment and Fishery Evaluation Report

For purposes of supplying scientific information to the Council for setting annual harvest levels, a Stock Assessment and Fishery Evaluation Report (SAFE) is prepared annually. The (SAFE) will at a minimum contain or refer to the following:

(1) Current status of Gulf of Alaska Groundfish resources, by major species or species groups.

(2) Estimates of maximum sustainable yield (MSY) and acceptable biological catch (ABC).

(3) Estimates of groundfish species mortality from nongroundfish fisheries, subsistence fisheries, and recreational fisheries, and the 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 (PSCs) for Pacific halibut and fully utilized species in joint venture and foreign fisheries with supporting justification and rationale.

(8) Any other biological, social, or economic information which 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 SSC and information presented by the PT and SSC in support of these recommendations; (2) information presented by the AP and the public; and (3) other relevant information.

4.2.1.5 Reserves

Reserves are set at 20% of the TAC of pollock, Pacific cod, flounders, and other species. At any time, the Regional Director may assess the DAP or JVP and apportion to them any amounts from the reserves that is determined will be harvested by U.S. vessels. As soon as practicable after April 1, June 1, and August 1, and on any such dates as is determined appropriate, the Regional Director may apportion to TALFF any portion of the reserves that is determined will not be harvested by U.S. fishing vessels during the remainder of the fishing year.

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

4.2.2 Apportionment of harvest within DAH and TALFF

Prior to 1990 when the commercial groundfish fisheries became fully Americanized, the procedure was that the estimate of DAP shall equal the amount of those species harvested by domestic fishermen during the previous year plus any additional amounts the Regional Director finds will be harvested by the growing domestic fishery. The supplemental amounts will reflect, as accurately as possible, the probable increase in U.S. harvesting and processing capacity and the extent to which that capacity will be used. JVP is the U.S. harvested portion of the total allowable catch (TAC) in excess of the estimated amount to be utilized by U.S. processors or for which actual domestic markets are not available, that will be delivered to authorized foreign processors. Estimates of domestic utilization in this category are updated annually based upon the previous year's catch and projected increases in catch anticipated by the various joint venture companies. The projected increases in DAP and JVP will be based on surveys conducted by the National Marine Fisheries Service, recommendations from the Council, information provided by the domestic fishing industry, other agencies, and knowledgeable people. TALFF is the foreign portion of TAC determined by deducting DAH and Reserves from TAC. The Regional Director, upon recommendation of the Council, will publish a notice in the Federal Register of proposed apportionments of each TAC among DAP, JVP and TALFF as soon as practicable after October 1. Based on comments received he will publish a final notice of DAP, JVP and TALFF apportionments on or about January 1 of each new year.

Estimates of future production by processors are difficult, if not impossible, to make accurately. It is generally recognized by those processors making the estimates that their figures are optimal and based on assumptions that sometimes do not materialize. Machinery or installation delays, changes in markets, better than normal alternative fisheries for the fishing fleets (or processors) may all affect their actual production. Therefore, a DAH reassessment system and release mechanism is established through this FMP and by regulation to allow adjustments in DAH during the fishing year.

Production by U.S. fishermen and processors shall be reassessed periodically based on:

(1) Catch and production to date during the year.
(2) Current fishing and production activity.
(3) Projections for additional catch and production during the remainder of the year based on demonstrated capacity.

The Regional Director may reassess the DAP and JVP at any time and apportion to them any amounts from the reserve that he finds will be taken by each category. As the fishing season progresses, should the initial DAP exceed timely expectations of actual harvest, the Regional Director shall reapportion the excess to JVP, if needed, or to TALFF.

If the initial JVP exceeds timely expectations of actual harvest, the Regional Director shall reapportion the excess to DAP, if needed, or to TALFF.

The Regional Director shall apportion to TALFF as soon as practicable after April 1, June 1, and August 1, and on such other dates as he determines appropriate any portion of JVP and/or DAP that he determines will not be harvested by U.S. fishing vessels during the remainder of the fishing year. When the Regional Director determines that apportionment is required and that immediate action is necessary to increase DAP, JVP or TALFF, he may decide that such an adjustment is to be made without affording a prior opportunity for public comment. Public comments on the necessity for, and the extent of the apportionment shall then be submitted to the Regional Director for a number of days after the effective date that will be specified in a notice announcing such action.

4.2.3 Prohibited species catch limits and adjustments to control Pacific halibut bycatch

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 fishermen 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 domestic halibut fishermen and groundfish fishermen 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.

Notwithstanding framework procedures for setting prohibited species catch (PSC) limits in Section 4.2.3.1, specific interim PSC limits of 2,000 mt and 750 mt are established for trawl and fixed gear, respectively to control halibut bycatch during the 1990 fishing year only (Amendment 18 to the Gulf FMP). If the 2,000 mt PSC limit established for trawl gear is reached, further fishing with bottom trawl gear may be prohibited in the Gulf of Alaska management area for the remainder of the 1990 fishing year. If the 750 mt PSC limit established for fixed gear is reached, further fishing with hook-and-line or pot gear may be prohibited in the Gulf of Alaska for the remainder of the 1990 fishing year.

PSC limits are currently set in the annual specification process. Fixed gear limits have been reduced to 300 mt since the sablefish fishery was exempted from halibut PSC limits after implementation of the Individual Fishing Quota Program in 1995.

When a PSC limit is reached, further fishing with specific types of gear or modes of operation during the year (i.e., DAP, JVP, TALFF) 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 DAP, JVP, or TALFF vessels to which a PSC limit applies have caught an amount of prohibited species equal to that PSC, 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.

Separate PSC limits may be established for the wholly domestic fishery and the joint venture fishery for each area, although the commercial groundfish fisheries have been fully Americanized since 1990. Separate PSC limits may be established for specific gear.

4.2.3.1 Procedure for establishing prohibited species catch mortality limits for halibut, and seasonal allocations thereof.

Except for the provisions set forth in Section 4.2.3 for the 1990 halibut PSC limit, PSC limits will be determined annually by the Secretary in consultation with the Council using the following framework procedures:

(1) Prior to the October Council meeting. The Plan Team will prepare for the Council a preliminary Stock Assessment and Evaluation Report under Section 4.2.1 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 for DAP, JVP, and TALFF by target fisheries and gear types and also an economic analysis of the effects of the apportionments.

(2) October Council meeting. While setting preliminary groundfish harvest levels under Section 4.2.1, the Council will also review the need to control the bycatch of halibut and will, if necessary, recommend preliminary halibut PSC mortality limits (PSCs) and apportionments thereof among DAP, JVP, and TALFF. The Council will also review the need for seasonal allocations of the halibut PSCs.

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

(1) The regulatory areas and districts for which PSCs might be established;
(2) PSCs for particular target fisheries and gear types;
(3) Seasonal allocations by target fisheries, gear types, and/or regulatory areas and district;
(4) PSC allocations to individual operations; and
(5) Types of gear or modes of fishing operations that might be prohibited once a PSC 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 PSCs and which may be found in the SAFE report, include:

(1) Estimated change in biomass and stock condition of halibut;
(2) Potential impact on halibut stocks;
(3) Potential impacts on the halibut fisheries;

(4) Estimated bycatch in years prior to that for which the halibut PSC is being established;
(5) Expected change in target groundfish catch;
(6) Estimated change in target groundfish biomass;
(7) Methods available to reduce halibut bycatch;
(8) The cost of reducing halibut bycatch; and
(9) 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:

(1) Seasonal distribution of halibut;
(2) Seasonal distribution of target groundfish species relative to halibut distribution;
(3) Expected halibut bycatch needs on a seasonal basis relevant to changes in halibut biomass and expected catches of target groundfish species;
(4) Expected bycatch rates on a seasonal basis;
(5) Expected changes in directed groundfish fishing seasons;
(6) Expected actual start of fishing effort; and
(7) Economic effects of establishing seasonal halibut allocations on segments of the target groundfish industry.

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

(3) As soon as practicable after the Council's September 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 Stock Assessment and Evaluation Report under Section 4.2.1 which provides the best available information on estimated halibut bycatch rates in the target groundfish fisheries, recommendations for halibut PSCs and apportionments thereof among DAP, JVP, and TALFF by target fisheries and gear types and also an economic analysis of the effects of the apportionments.

(5) December Council meeting. While setting final groundfish harvest levels, the Council reviews public comments, takes public testimony, and makes final decisions on annual halibut PSC limits and seasonal allocations, using the same factors, (a) through (i), concerning PSC limits, and the same factors, (a) through (e), concerning seasonal allocations of the PSC limits. The Council will recommend its decisions, including no change for the new fishing year, to the Secretary of Commerce for implementation.

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

4.2.4 Incentive programs to reduce bycatch rates of halibut.

The Secretary of Commerce, after consultation with the Council, may implement by regulation measures that provide incentives to individual vessels to reduce halibut bycatch rates of halibut for which PSC limits are established under Section 4.2.3.1. 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.

4.2.5 In-season adjustment of time and area

Harvest levels or total allowable catches (TACs) 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 Director and/or the Council during the course of a fishing year that warrants in-season adjustments in 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 Director to protect the resource from biological harm by instituting gear modifications or adjustments through closures or restrictions. Other changes warrant action by the Regional Director 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 adjustment may be related to several circumstances. For instance, certain target or bycatch species may have decreased in abundance. When current 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. Likewise, current information relating to prohibited species, i.e., those species that must be returned to the sea, might become available that indicates their abundance has decreased. Conservation measures limited to establishing prohibited species catch (PSC) 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 was more abundant than was anticipated when PSC 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 utilizes the prohibited species. However, adjustments to TAC or PSC limits which are not initially specified on the basis of biological stock status are not appropriate.

The Council finds that in-season 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 delegation to the Regional Director, to make in-season 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 any or part of a regulatory area, or restrict the use of any type of fishing gear as a means of conserving the resource, and 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 on biological stock status. Such in-season adjustments must be necessary to prevent one of the following occurrences:

(1) The overfishing of any species or stock of fish, including those for which PSC limits have been set.

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

The types of information which the Regional Director must consider in determining whether stock conditions exist that require an in-season management response are described, as follows, although he or she is not precluded from using information not described but determined to be relevant to the issue:

(1) The effect of overall fishing effort within a regulatory area;
(2) Catch per unit of effort and rate of harvest;
(3) Relative abundance of stocks within the area;
(4) The condition of the stock within all or part of a regulatory area; and
(5) Any other factors relevant to the conservation and management of groundfish species or any incidentally caught species which are designated as a prohibited species or for which a PSC limit has been specified.

The Regional Director 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 Director must consider in-season adjustments to prevent over-fishing are specified as: (1) any gear modification that would protect the species in need of conservation protection, but which would still allow fisheries to continue for other species; (2) a time/area closure which 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 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 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 Director must coordinate in-season adjustments, when appropriate, with the State of Alaska to assure uniformity of management in both State and Federal waters.

Any in-season time/area adjustments made by the Regional Director 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 Fisheries Conservation and Management Act. Any adjustments will be made by the Regional Director by such procedures provided under existing law. Any in-season 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 Act.

### 4.2.6 Time/area closure authority

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 PSC 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 PSC limits or bycatch allowances and associated foregone opportunity for vessels to harvest available groundfish.

4.3 Conventional Measures

4.3.1 Domestic

4.3.1.1 Permit Requirements

Certain permits are required of participants in the GOA groundfish fisheries. Specific requirements are found in regulations implementing the FMP.

4.3.1.2 General Restrictions

4.3.1.2.1 Catch restrictions

This FMP authorizes the commercial harvest of species listed in Chapter 3.1 of this plan. 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 (see Prohibited Species Donation Program). Prohibited species are Pacific halibut, Pacific herring, Pacific salmon, steelhead trout, king crab and Tanner crab. Commercial fishing is authorized during the fishing year unless otherwise specified in the FMP.

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.

4.3.1.2.2 Processing Restrictions

Roe-stripping of pollock is prohibited, and the Regional Director 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.

4.3.1.2.3 Gear restrictions

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 672. In addition, the following gear or area limitations apply as follows:

Eastern Area

Legal gear. Legal gears for the taking of sablefish are trawls and hook and longlines.

Central Area

Legal gear. In 1986, legal gears for the taking of sablefish were trawls, hooks and longlines, and pot longlines. Beginning in 1987 and thereafter, legal gears are defined as trawls and hooks and longlines.

Time/area closures and gear restrictions to control king crab bycatch. 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 are at historically low levels. 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. During this same period a developing domestic groundfish fishery using a variety of gear has displaced all foreign fisheries. 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.

These area designations have been established for purposes of protecting king crab stocks and are described in Figure 4.1 and Table 4.3.

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 crabs drops below the threshold level established for that district. Implementation of the Type III area closures would be accomplished by regulatory amendment. See Table 4.3.1 for geographic coordinates defining Type I, II, and III areas.

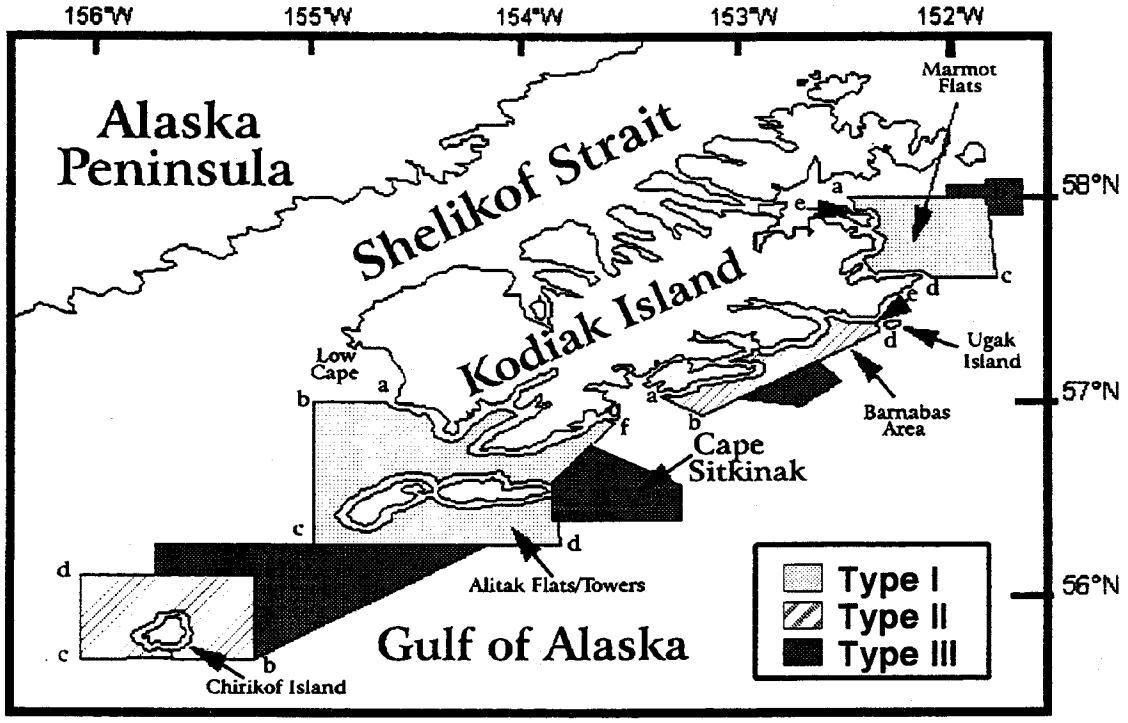



Figure 4.1 Kodiak Islands areas closed to non-pelagic trawl gear

Table 4.3 Definitions of king crab bycatch areas.

| Area Type | Name and Definition |
|---|---|
| I | 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 | Type II areas are those areas 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 | Type III areas are those geographic areas adjacent to a Type I or Type II area 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" has occurred. The NMFS Regional Director will classify the expanded area as either Type I or II depending on the information available. |

# Table 4.3.1. Kodiak Island Areas Closed to Non-pelagic Trawl Gear
## b. Coordinates

| Name and Description of Reference Area | North Latitude / West Longitude | Reference Point |
|---|---|---|
| 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" 154° 31' 1" | Low Cape |
| b | 57° 00' 0" 155° 00' 0" | |
| c | 56° 17' 0" 155° 00' 0" | |
| d | 56° 17' 0" 153° 52' 0" | |
| e | 56° 33' 5" 153° 52' 0" | Cape Sitkinak |
| f | 56° 54' 5" 153° 32' 5" | East point of Twoheaded Island |
| g | 56° 56' 0" 153° 35' 5" | Kodiak Island, thence, along the coastline of Kodiak Island until intersection of Low Cape. |
| a | 56° 59' 4" 154° 31' 1" | 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" 152° 30' 0" | |
| b | 58° 00' 0" 151° 47' 0" | |
| c | 57° 37' 0" 151° 47' 0" | |
| d | 57° 37' 0" 152° 10' 1" | Cape Chiniak, then along the coastline of Kodiak Island to |
| e | 57° 54' 5" 152° 30' 0" | North Cape. |
| a | 58° 00' 0" 152° 30' 0" | |
| Chirikof Island Area -- All waters surrounding Chirikof Island enclosed by a line connecting the following four points in the counter-clockwise order listed: | | |
| a | 56° 07' 0" 155° 13' 0" | |
| b | 56° 07' 0" 156° 00' 0" | |
| c | 55° 41' 0" 156° 00' 0" | |
| d | 55° 41' 0" 155° 13' 0" | |
| a | 56° 07' 0" 155° 13' 0" | |
| Barnabas Area -- All waters enclosed by a line connecting the following six points in the counter clockwise order listed: | | |
| a | 57° 00' 0" 153° 18' 0" | Black Point. |
| b | 56° 56' 0" 153° 0[illegible]' 0" | |
| c | 57° 22' 0" 152° 18' 5" | South Tip of Ugak Island |
| d | 57° 23' 5" 152° 17' 5" | North Tip of Ugak Island |
| e | 57° 25' 3" 152° 20' 0" | Narrow Cape, thence, along the coastline of Kodiak Island |
| f | 57° 04' 2" 153° 30' 0" | Cape Kasick to |
| a | 57° 00' 0" 153° 18' 0" | Black Point, including inshore waters |

Western Area

Legal gear. In 1986, 1987, and 1988, legal gears for the taking of sablefish are hooks and longlines, pot longlines, and trawls. In 1989 and thereafter, legal gears shall be trawls and hooks and longlines.

4.3.1.3 Recordkeeping and Reporting Requirements

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 in-season 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 Act, Executive Order 12291, 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 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 processing expectations. In consultation with the Council, the Secretary may require U.S. processors and persons delivering U.S.-caught fish to foreign processing vessels to submit information to the Regional Director that is necessary and appropriate to reassess the adequacy of DAP and JVP specifications. Such information may be collected by means of written or telephone surveys. 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 Territorial Sea adjacent to the Federal statistical area. Such requirements will be contained in regulations implementing this FMP.

4.3.1.4 Gear allocations

The following gear allocations are specified by this plan.

Eastern Area

Allocation of sablefish among gears. 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.

Central Area

Allocation of sablefish among gears. In 1986, vessels using hook and longline gear shall be permitted to take up to 55% of the sablefish TAC; vessels using pot-longline gear shall be permitted to take up to 25% of the TAC; and trawl vessels shall be permitted to take up to 20% of the TAC. In 1987 and thereafter, 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.

Western Area

Allocation of sablefish among gears. In 1986, 1987, and 1988, vessels using hook and longline gear shall be permitted to take up to 55% of the TAC for sablefish; vessels using pot longline gear shall be permitted to take up to 25% of the TAC; and vessels using trawls may take up to 20% the TAC. In 1989 and thereafter, vessels using hooks and longlines may take up to 80% of the TAC; and vessels using trawls may take up to 20% the TAC.

4.3.1.5 Experimental fishing permits.

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

As well as other information required by regulations, each application for an experimental 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 Director may deny an experimental fishing permit for reasons contained in regulations, including a finding that:

(1) 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;
(2) Issuance of the experimental fishing permit would inequitably allocate fishing privileges among domestic fishermen or would have economic allocation as its sole purpose;
(3) Activities to be conducted under the experimental fishing permit would be inconsistent with the intent of the management objectives of the FMP;
(4) The applicant has failed to demonstrate a valid justification for the permit;
(5) The activity proposed under the experimental fishing permit could create a significant enforcement problem; or

(6) The applicant failed to make available to the public information that had been obtained under a previously issued experimental fishing permit.

4.3.1.6 Inshore/offshore allocations of pollock and Pacific cod

The allowed harvests of Gulf of Alaska pollock and Pacific cod 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.

Amendment 51 implemented on January 25, 1999 replaced the three year Inshore/Offshore allocation established with Amendment 40. One hundred percent of the pollock TAC is allocated to harvesting vessels which deliver their catch to the inshore component. Trawl catcher processors will be able to take pollock incidentally as bycatch. Ninety percent of the Pacific cod TAC is allocated to harvesting vessels which deliver to the inshore component and the inshore catcher processors; the remaining ten percent is allocated to offshore catcher/processors and harvesting vessels which deliver to the offshore component. These allocations will remain in effect until December 31, 2001, unless replaced by another management regime approved by the Secretary.

4.3.1.6.1 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 which meet length requirements defined in federal regulations and which have declared themselves to be "Inshore."
3) All motherships or floating processors which have declared themselves to be "Inshore."

Offshore is defined to consist of two components the of industry:

1) All catcher/processors not included in the inshore processing category, or which have declared themselves to be "Offshore."
2) All motherships and floating processing vessels not included in the inshore processing category, or which have declared themselves to be "Offshore."

4.3.1.6.2 Declarations and operating restrictions

Annually before operations commence, each mothership, floating processing vessel and catcher/processor vessel must declare on its Federal Permit application whether it will operate in the inshore or offshore component of industry. This declaration must be the same for both the BSAI and the GOA if applications for both are made. All shoreside processors will be in the inshore component. Once declared, a vessel cannot switch to the other component, and will be subject to restrictions on processing amounts or locations for pollock and Pacific cod for the rest of the fishing year. Harvesting vessels can choose to deliver their catch to either or both components.

Catcher Processors which have declared themselves to be inshore have the following restrictions:

1) The vessel must be less than 125' LOA.

2) The vessel may not catch or process more than 126 mt (round weight) of pollock or GOA Pacific cod in combination in a given week of operations.

Motherships and floating processors which have declared themselves to be inshore have the following restriction:

Processing from a directed pollock fishery or a directed GOA Pacific cod fishery must occur in a single location within the waters of the State of Alaska.

4.3.1.6.3 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.

4.3.1.6.4 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 component for that year. This shall have no impact upon the allocation formula.

4.3.1.6.5 Duration

Inshore-offshore allocation of Pacific cod and pollock shall cease to be a part of this FMP either (1) at midnight on December 31, 2001; or (2) earlier if replaced with another management regime approved by the Secretary.

4.3.2 Foreign

The commercial groundfish fisheries have been fully Americanized since 1990.

4.3.2.1 Permits

All foreign vessels require an annual permit from the Secretary of Commerce.

4.3.2.2 Catch and gear restrictions

4.3.2.2.1 Total allowable level of foreign fishing (TALFF)

Groundfish apportionments from total allowable catch (TAC) to TALFF, if made, will be specified by regulatory area or parts thereof.

4.3.2.2.2 Prohibited species

Pacific halibut, Pacific herring, salmonids, king crab, and Tanner crab are prohibited species and must be treated as described in Section 2.2. Records of catches of these species must be kept. Any groundfish species not allocated to foreign fishermen must be treated as described in Section 2.2. Records of catches of these species must be kept. Catches of "nonspecified" species as described in Section 2.2 must be treated as prohibited species, except that catch records are not required.

4.3.2.2.3 Time/area closures and gear restrictions

Time/area closures and gear restrictions are used in managing the foreign fisheries to prevent conflicts with domestic fisheries and minimize bycatch. A summary of time/area and gear restrictions are provided in Table 4.4 and Figures 4.2 and 4.3.

4.3.2.2.4 Other regulations

Once a nation's allocation of any species or species group in a regulatory area is reached, that area shall be closed to all fishermen of that nation for the remainder of the fishing year. This provision does not apply to foreign longline fishermen which may target only Pacific cod. If the allocation species which is not targeted by longliners is exhausted, longliners must treat that species as "prohibited". Strict limits are set on the foreign bycatch of U.S. fully utilized species (described in Section 4.2.1). The foreign fisheries close upon reaching those limits.

4.3.3 Fishing Seasons

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 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:

(1) Biological: spawning periods, migration, and other biological factors;
(2) Bycatch: biological and allocative effects of season changes;
(3) Exvessel and wholesale prices: effects of season changes on prices;
(4) Product quality: producing the highest quality product to the consumer;
(5) Safety: potential adverse effects on people, vessels, fishing time, and equipment;
(6) Cost: effects on operating costs incurred by the industry as a result of season changes;
(7) Other fisheries: possible demands on the same harvesting, processing, and transportation systems needed in the groundfish fishery;

(8) 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;
(9) Enforcement and management costs: potential benefits of seasons changes relative to agency resources available to enforce and manage new seasons; and
(10) Allocation: potential allocation effects among users and indirect effects on coastal communities.

4.3.4 Generic

4.3.4.1 Observers

The Council and NOAA Fisheries 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 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.

4.3.4.2 Habitat protection

The Secretary, upon the recommendation of the Council, may adopt the following types of regulations:

(1) Propose regulations establishing gear, time, or area restrictions to protect particular habitats or life stages of species in the Gulf of Alaska groundfish fishery;
(2) Propose regulations establishing area or time restrictions to prevent the harvest of fish in contaminated areas; and
(3) Propose regulations restricting disposal of fishing gear by domestic vessels.

4.3.4.3 Vessel safety considerations

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

4.4 Other Measures

4.4.1 Access limitation

The Council may wish to limit access in the fisheries in the Gulf of Alaska in order to maintain an orderly fishery and prevent overcapitalization in the harvesting sector. An objective for fisheries management as stated in the Magnuson 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.

Table 4.4 Gulf of Alaska Groundfish Plan foreign fishery restrictions by area.

| Area | Foreign Trawl | | Foreign Longline |
|---|---|---|---|
| East 140°W | Closed all year. | | |
| 140-147°W | Foreign trawlers must use off-bottom trawls. | | (see below) |
| | Open beyond 12 miles | | |
| 140-169°W | Foreign trawlers must use off-bottom trawls 12/1 to 5/31. Area between 147° and 157°W closed 2/16 to 5/31. | 140-169°W: | Foreign lonliners may not target on Pacific cod between 140-169°W landward of the 400-meter contour during halibut seasons. West of 157°W only longline may be used to target on Pacific cod landward of the 500-meter contour. Only longline gear may be used to target on sablefish and targeting is prohibited landward of the 400-meter contour 5/1 to 10/1 and landward of the 500-meter contour 10/1 to 5/1. |
| 169-170°W | Same as above but open beyond 3 miles. | | |
| Kodiak Gear (Lechner) Area | Closed 2 days before king crab seasons through 2/15. | | Same as for 140-169°W. |
| Three Kodiak Halibut Areas | Closed from 5 days before to 5 days after halibut season opening, if it occurs after May 26. | | Same as for 140-169°W. |
| Davidson Bank | Closed all year. | | |

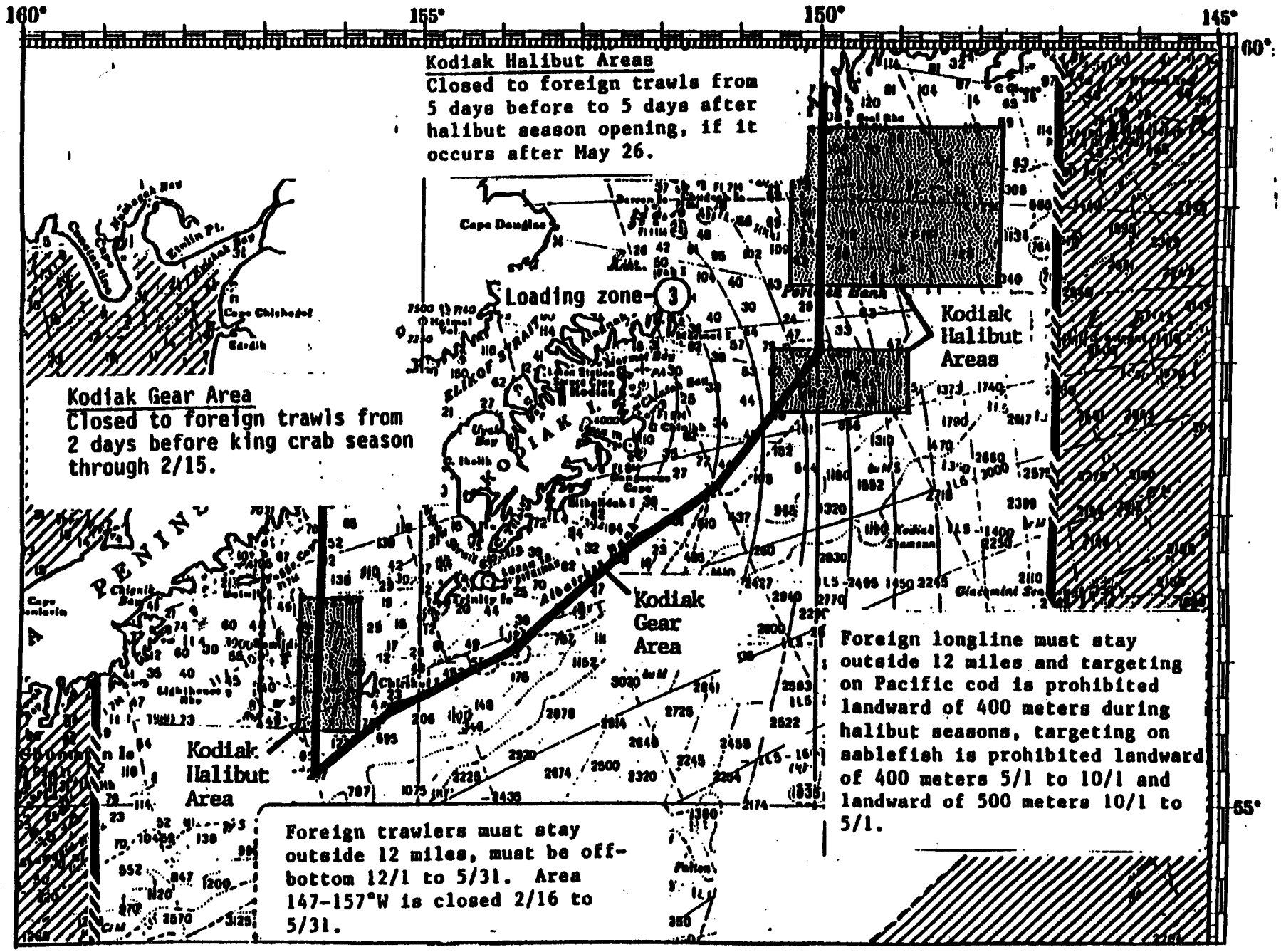



Figure 4.2 Central Regulatory Area of the Gulf of Alaska Groundfish FMP, showing foreign fisheries restrictions and loading zones.

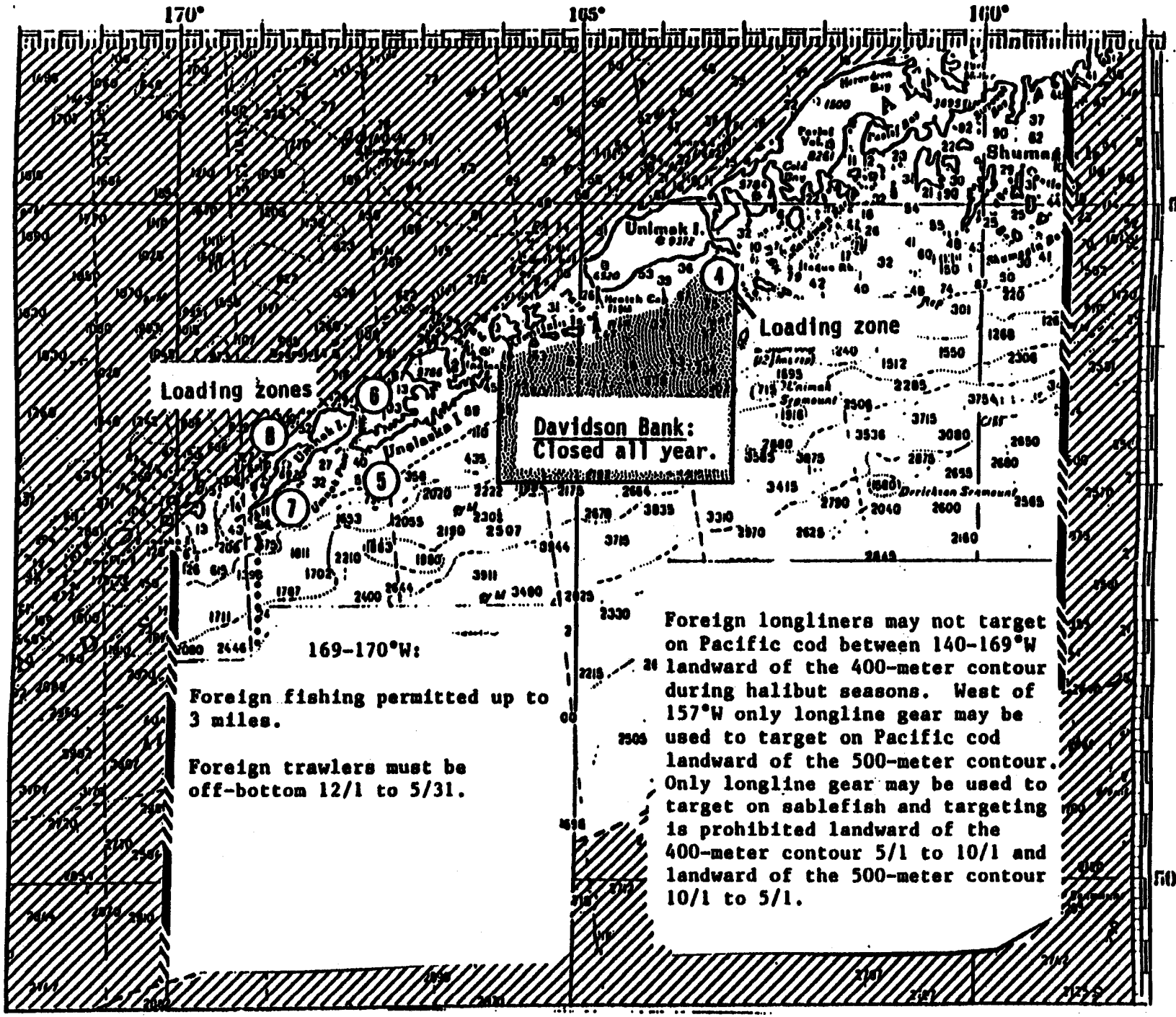



Figure 4.3 Western Regulatory Area of the Gulf of Alaska Groundfish FMP, showing foreign fisheries restrictions and loading zones.

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 plan will require amendment providing the supporting rationale and specific details of the measure.

Any limited entry program must be designed specifically for the fishery to which it will be applied, taking into consideration the unique characteristics of that fishery.

The fishery should be monitored and data collection started so that conditions such as those described above can be identified and measured. The data base could also indicate the character and level of participation in the fishery, including: (1) investment in vessel and gear; (2) the number and type of units of gear; (3) the distribution of catch; (4) the value of catch; (5) the economic returns to the participants; (6) mobility between fisheries; and (7) various social and community considerations.

The current condition of the groundfish fisheries of the Gulf of Alaska is such that limited entry programs for the domestic groundfish fleet may be required in the near future. Research and monitoring programs need to be developed and implemented for the fishery so that information required in a limited entry program is available.

In Alaska, where groundfish fisheries may occur completely or partly in waters under State jurisdiction, some fisheries may eventually be included in a State limited entry program. Coordination between the Council and the State will be necessary in order to develop a comprehensive program that recognizes unique local or regional conditions as well as the national standards of the Magnuson Act.

4.4.1.1 Management of Fixed Gear Sablefish Fisheries

Beginning with the 1995 fishing season, the directed fixed gear sablefish fisheries will be managed under an Individual Fishing Quota (IFQ) program. This form of limited entry will replace the current open access fisheries for sablefish in the Gulf of Alaska and is described in this section.

4.4.1.1.1 Definitions

For purposes of Section 4.4.1.1, 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) which meets the requirements set forth in 46 CFR Part 67.03, as applicable.

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 QS in each management area. The QS 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 QS into the QS 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, etc.). For purposes of initial allocation, legal pot gear landings will be counted.

Catcher boat or catcher vessel means any vessel which 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 crew member is defined as any person that has acquired commercial fish harvesting time at sea (i.e., fish harvesting crew), that is equal to five 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 QS will be considered a bona fide crew member.

4.4.1.1.2 Management Areas

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

4.4.1.1.3 Initial Allocation of Quota Shares

(A) INITIAL RECIPIENTS

(1) Initial assignments of Quota Shares shall be made to:
(i) a qualified person who is a vessel owner who meets the requirements in this section; or
(ii) 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 will be assigned only to persons who meet all other requirements of this section and who have landed that 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 shall be assigned initially for each management area to qualified persons based on recorded landings, as documented through fish tickets or other documentation for fixed gear landings. Historical catch of sablefish will be counted from 1985 through 1990. This historical period shall be known as the quota share base period. For each management area, 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 QS in any area shall be added together to form the "Quota Share Pool" for that area.

(B) 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:
(i) All landings made during the QS 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.

(ii) There shall be two categories of catcher boat shares for the sablefish QS/IFQ fishery;
(a) vessels less than or equal to 60 feet in length overall; and
(b) vessels greater than 60 feet in length overall.

(iii) For initial allocation of catcher boat Quota Shares:
(a) if, during the last year of participation in a fixed gear fishery through September 25, 1991, a QS recipient simultaneously owned or leased two or more vessels on which sablefish were landed, and those vessels were in different vessel categories, then the QS allocation shall be for each vessel category and may not be combined into a single category; and
(b) if a QS recipient bought or sold vessels in succession during the qualifying period, and to the extent the QS recipient operations were in one vessel category during one year and the next vessel owned was in another vessel category, the QS will be combined and applied to the latest vessel category of ownership as of September 25, 1991.

(C) QUOTA SHARE BLOCKS

(1) All initial allocations of sablefish QS and all CDQ compensation QS initially issued to a person in an IFQ regulatory area in less than 20,000 pounds of IFQ based on the 1994 TAC for the fixed gear sablefish fishery in that area will be issued as a QS block.

(2) All initial allocations of sablefish QS that would result in at least 20,000 pound of IFQ based on the 1994 TAC for the fixed gear sablefish fishery in that area, and all CDQ compensation QS initially issued to a persons in an IFQ regulatory area in which that person does not hold QS, will be issues as unblocked QS.

4.4.11.4 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) In order to purchase or lease QS, 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 QS may purchase catcher boat QS and/or IFQs.

(4) 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 QS equivalent to less than 5,000 lb IFQ (based on 1996 quotas) may be used on Category C vessels.

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

(6) QS designated as a "block" may only be traded in its entirety and may not be divided into smaller QS units. Blocks of QS representing IFQs of less than 5,000 pounds 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 pounds.

4.4.1.1.5 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 QS; 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 this Section, who receive initial catcher vessel QS may utilize a hired skipper to fish their quota providing the person owns the vessel upon which the QS will be used. These initial recipients may purchase up to the total share allowed for the area. There shall be no leasing of such catcher vessel QS other than provided for in Section 4.4.1.1.4 (1) 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 and partnerships. (*Additional shares purchased by these corporations or partnerships for the area east of 140 °W 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.*)

This provision will cease upon the sale or transfer of QS or upon any change in the identity of the corporation or partnership 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 members. 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 changes, 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 changes, nor is a partnership deemed to have changed if a partner leaves the partnership.

c) **Individual**: Any individual as defined in Section 4.4.1.1.1.

(6) For sablefish each qualified person or individual may own, hold, or otherwise control, individually or collectively, but may not exceed, 1% of the combined QS for the Gulf of Alaska and Bering Sea/Aleutian Islands; additionally QS holdings in the area east of 140°W. (East Yakutat and Southeast Outside) shall not exceed 1% of the QS or IFQs for that management area.

(7) Any person who receives an initial assignment of quota shares in excess of the limits set forth in (6) above 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 Gulf of Alaska and Bering Sea/Aleutian Island quota may be taken on any one vessel, and no more than 1% of the TAC east of 140°W. (EY/SO), may be landed on the same vessel, except that persons who received an initial allocation of more than the 1% overall ownership level (or 1% in the area east of 140°W.) may continue to fish their QS 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 IPHC.

(10) QS Block Provisions:

(i) A person may own and use up to two blocks in each management area;

(ii) Persons owning two blocks in a given management area may not use normal QS in that area; and

(iii) Persons who own less than two blocks in an area may own and use normal QS up to the limits specified under this program, noting that the limit applies to both normal QS and QS embedded in blocks.

4.4.1.1.6 Annual Allocation of QS/IFQ

Individual fishing quotas are determined for each calendar year for each person by applying the ratio of a person's QS to the QS pool for an area to the annual fixed gear Total Allowable Catch for each management area, after adjusting for the Community Development Quota (CDQ) program. In mathematical terms, IFQs = (QS / QS pool) x fixed gear TAC.

4.4.1.1.7 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) QS owners wishing to transport their catch outside of the jurisdiction of the Council must first check in their catch at a NMFS specified site and have the load sealed; and
  (d) 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 utilizing pots in the Gulf of Alaska.

(3) QS are a harvest privilege, and are valid 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 IPHC on an annual basis.

4.4.1.1.8 Community Development Quotas *(reserved)*

4.4.1.2 Moratorium on Vessels Entering the Fisheries

Beginning on January 1, 1996, a moratorium on harvesting vessels (including harvester/processors) entering the GOA groundfish fisheries, other than fixed gear sablefish, is in effect. Vessels fishing in State waters will be exempt. The vessel moratorium will last until the Council replaces or rescinds the action, but in any case will end on December 31, 1999. The Council may however extend the moratorium up to 2 additional years, if a permanent limited access program is imminent.

4.4.1.2.1 Elements of the Moratorium

1. Qualifying Period. In order to qualify, a harvesting vessel must have made a reported landing in one of the designated moratorium fisheries during the period beginning January 1, 1988, and ending February 9, 1992, including landings of moratorium species from State waters. Moratorium species are those managed under Council FMPs and include groundfish (other than fixed gear sablefish) in the BSAI and GOA and BSAI king and Tanner crab. A moratorium qualification for which a vessel moratorium permit has not been issued prior to December 31, 1998, or for which a vessel moratorium

permit is not applied for applied for on or before December 31, 1998, will not be eligible for a vessel moratorium permit after that date.

2. Eligible Fisheries. If a vessel qualifies based on Item 1 above, the following provisions apply:
   a. A vessel that made a qualifying landing in the BSAI or GOA groundfish fisheries would be eligible to participate in the GOA groundfish fisheries under the moratorium.
   b. A vessel that made a qualifying landing in the BSAI crab fisheries would be eligible to participate in the BSAI crab fisheries **AND** the GOA groundfish fisheries under the moratorium providing:
      (1) it uses only the same fishing gear in the groundfish fisheries that it used in the BSAI crab fisheries to qualify for the moratorium, and
      (2) it does not use any fishing gear prohibited in the BSAI or GOA groundfish fisheries.
   c. A vessel that made a qualifying landing in the BSAI crab fisheries, and during the period February 9, 1992, through December 11, 1994, made a landing in the BSAI or GOA groundfish fisheries would be eligible to continue to participate in the GOA groundfish fisheries under the moratorium using the gear with which the groundfish landing was made.
3. Length Increases During the Moratorium: The 20% Rule. Moratorium qualified vessels will be limited to a 20% increase in length overall (LOA) as long as the increase does not result in a vessel greater than 125 ft LOA. The 20% increase will be based on the LOA of the original qualified vessel. Vessels over 125 ft LOA may not be lengthened under any circumstance.
4. Reconstruction of Vessels During the Moratorium. An eligible vessel that is reconstructed during the moratorium retains its privilege to participate in all fisheries under the Council's jurisdiction subject to the following provisions: (1) If reconstruction is completed prior to June 24, 1992, the new size is unrestricted and length increases subject to the 20% Rule discussed above are allowed between June 24, 1992 and the end of the moratorium. (2) If reconstruction began prior to June 24, 1992 but was not completed until after that date, the new size would be unrestricted but no more length increases would be allowed. (3) If reconstruction commences on or after June 24, 1992, increases in length may not exceed the 20% Rule. (4) Other types of vessel reconstructions or upgrades may occur as long as they do not result in the lengthening of a vessel.
5. Replacement of Vessels During the Moratorium. During the moratorium, qualifying vessels can be replaced with non-qualifying vessels so long as the replaced vessel leaves the fishery. Though multiple or sequential replacements are allowed, vessel length can only be increased subject to the 20% Rule. In the case of existing qualified vessels over 125 ft LOA, the replacement vessel cannot exceed the length of the original vessel. In the event of a combined replacement/reconstruction, increases in LOA may not exceed the 20% Rule.
6. Replacement of Vessels Lost or Destroyed On or After January 1, 1989 But Before January 1, 1996. Vessels lost or destroyed on or after January 1, 1989 may be replaced provided the following conditions are met. (1) The LOA of the replacement vessel does not exceed the 20% Rule. (2) The replacement vessel must make a landing in a moratorium fishery prior to January 1, 1998 to remain a qualified vessel. The replaced vessel would no longer be a moratorium qualified vessel.
7. Replacement of Vessels Lost or Destroyed After January 1, 1996. Vessels lost or destroyed after January 1, 1996 may be replaced subject to the 20% Rule and the replaced vessel would no longer be a moratorium qualified vessel.
8. Salvage of Vessels Lost or Destroyed On or After January 1, 1989. A moratorium qualified vessel lost or destroyed between January 1, 1989 and the end of the moratorium may be salvaged and will be considered a moratorium qualified vessel, as long as it has not already been replaced, as per item 5 above.

9. Salvage of Vessels Lost or Destroyed Before January 1, 1989. A moratorium qualified vessel lost or destroyed before January 1, 1989 may not be replaced. The lost or destroyed vessel may be salvaged and become moratorium qualified if it meets the following two conditions: (1) Salvage operations must have been ongoing as of June 24, 1992. (2) The salvaged vessel must make a landing in a moratorium fishery prior to January 1, 1998.
10. Small Vessel Exemptions. Vessels 26 ft or less LOA would be exempted from the moratorium in the Gulf of Alaska.
11. Disadvantaged Communities. New vessels constructed after implementation of Community Development Quota (CDQ) programs, pursuant to an approved CDQ project, will be exempt from the moratorium. In order to qualify for such exemption the vessel must: (1) be constructed solely for the purpose of furthering the goals of a community CDQ project, and (2) be a specialized vessel designed and equipped to meet the needs of a community or group of communities that have specific and unique operating requirements. Such exemptions would be limited to vessels 125 ft LOA and under. These vessels may fish in both CDQ and non-CDQ fisheries. Vessels built pursuant to a CDQ project under this exemption that are transferred to a non-CDQ entity during the life of the moratorium may not be considered eligible under the moratorium.
12. Halibut and Sablefish Fixed Gear Vessels. Halibut and sablefish fixed gear vessels operating under the provisions of the proposed IFQ Amendment will be exempted from the vessel moratorium as it affects directed halibut and sablefish operations. Such an exemption becomes effective at the time of implementation of the IFQ program. Non-qualifying vessels entering the halibut and sablefish fisheries under this exemption may not participate in any other directed fisheries under the Council's authority. If the total retained catch of species other than halibut and sablefish exceeds 20% of the total weight of sablefish and halibut on board, then the vessel must be a moratorium-qualified vessel.
13. Transfer of Moratorium Rights. It shall be assumed that any transfer of vessel ownership includes a transfer of moratorium fishing rights. Moratorium rights may however be transferred without a transfer of ownership of the original qualifying vessel or any subsequently qualified vessel. The recipient of such transfers of rights will bear the burden of proof for moratorium qualification. Transfers of moratorium rights may not be used to circumvent the 20% Rule. Moratorium permits may be transferred only in their entirety; i.e, species or gear endorsements may not be separated and transferred independently.

4.4.1.2 Groundfish License Limitation Program *(will replace 4.4.1.2 Moratorium on Vessels Entering the Fisheries upon implementation of final rulemaking)*

Beginning on (*insert the effective date of the LLP*) a license will be 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°). Vessels fishing in State waters 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. The vessel license limitation program will replace the vessel moratorium and will last until the Council replaces or rescinds the action.

4.4.1.2.1 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 Bering Sea / Aleutian Island 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). Southeast Outside endorsements will be designated for use by legal fixed gear only.

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% 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.

6. Separability of General Licenses and Endorsements. General licenses may be issued for the Bering Sea /Aleutian Islands groundfish, Gulf of Alaska groundfish, and Bering Sea /Aleutian Islands 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 length over all (MLOA) 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 MLOA of a vessel with license qualification will be determined by the Regional Director 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', which ever 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) which 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 which 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' 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. 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 which 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.

4.4.2 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 plan will require an amendment specifying a specific length and the supporting rationale for the limit.

4.4.3 Gear Testing

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 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.

4.4.4 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. For example, Steller sea lions are so reduced in abundance that they have been listed as threatened within the meaning of the Endangered Species Act. Even absent such a listing, 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.

4.4.5 Improved Retention/Improved Utilization (IR/IU) Program

4.4.5.1 Minimum retention requirements

All vessels participating in the groundfish fisheries of the GOA are required to retain all catch of all IR/IU species (pollock and Pacific cod beginning January 1, 1998 and shallow water flatfish beginning January 1, 2003) when directed fishing for those species are open, regardless of gear type employed and target fishery. When directed fishing for an IR/IU species is prohibited, retention of that species is required only up to any maximum retainable bycatch amount in effect for that species, and these retention requirements are superseded if retention of an IR/IU species 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 any IR/IU species is also prohibited, unless required by other regulations.

4.4.5.2 Minimum utilization requirements

Beginning January 1, 1998, all IR/IU species 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 this amendment, or (2) delivered in their entirety to onshore processing plants for which similar processing requirements are implemented by State regulations.

# 5.0 INFORMATION ON THE FISHERY AND RESOURCES

## 5.1 Biological and Environmental Characteristics of the Resource

### 5.1.1 Habitat Requirements by Life History Stage

This section summarizes habitat requirements and life histories of the groundfish managed by this FMP.

#### 5.1.1.1 Walleye pollock

Management Plan and Area Eastern Bering Sea-Aleutian Islands (BSAI) and Gulf of Alaska (GOA)

The Gulf of Alaska are managed under the Gulf of Alaska Groundfish Fisheries Management Plan and the Eastern Bering Sea and Aleutian Islands pollock stocks are managed under the Eastern Bering Sea and Aleutian Islands Groundfish Fisheries Management Plan. Pollock occur throughout the area covered by the FMP and straddle into the Canadian and Russian EEZ, international waters of the central Bering Sea, and into the Chukchi Sea.

Life History and General Distribution

Pollock is the most abundant species within the eastern Bering Sea comprising 75-80% of the catch and 60% of the biomass. In the Gulf of Alaska, pollock is the second most abundant groundfish stock comprising 25-50% of the catch and 20% of the biomass.

Four stocks of pollock are recognized for management purposes: Gulf of Alaska, eastern Bering Sea, Aleutian Islands, and Aleutian Basin. There appears to be a high degree of interrelationship among the eastern Bering Sea, Aleutian Islands, and Aleutian Basin stocks with suggestions of movement from one area to the others. There appears to be stock separation between the Gulf of Alaska stocks and stocks to the north.

The most abundant stock of pollock is the eastern Bering Sea stock which is primarily distributed over the eastern Bering Sea outer continental shelf between approximately 70-200 m. Information on pollock distribution in the eastern Bering Sea comes from commercial fishing locations, annual bottom trawl surveys and triennial acoustic surveys.

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). Most of the information on pollock distribution in the Aleutian Islands comes from triennial bottom trawl surveys. These surveys indicate that pollock are primarily located on the Bering Sea side of the Aleutian Islands, and have a spotty distribution throughout the Aleutian Islands chain. 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, and secondly many areas of the Aleutian Islands shelf are untrawlable due to rough bottom.

The third stock, Aleutian Basin, appears to be distributed throughout the Aleutian Basin which encompasses the U.S. EEZ, Russian EEZ, and international waters in the central Bering Sea. This stock appears to move throughout the Basin for feeding, but concentrate in deepwater near the continental shelf for spawning. The principal spawning location is near Bogoslof Island in the eastern Aleutian Islands, but data from pollock fisheries in the first quarter of the year indicate that there are other concentrations of deepwater spawning concentrations in the western Aleutian Islands. The Aleutian Basin spawning stock appears to be derived from migrants from the eastern Bering Sea shelf stock, and possibly some western Bering Sea pollock. Recruitment

to the stock occurs generally around age 5, very few pollock younger than age 5 have been found in the Aleutian Basin. Most of the pollock in the Aleutian Basin appear to originate from strong year classes.

The Gulf of Alaska stock extends from southeast Alaska to the Aleutian Islands (170° W), with the greatest abundance in the western and central regulatory areas (147° W to 170° W). Most of the information on pollock distribution in the Gulf of Alaska comes from triennial bottom trawl surveys. These surveys indicate that pollock are distributed throughout the shelf regions of the Gulf of Alaska at depths less than 300 m. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls. The principal spawning location is in Shelikof Strait, but data from pollock fisheries and exploratory surveys indicate that there are other concentrations of spawning in the Shumagin Islands, the east side of Kodiak Island and near Prince William Sound.

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

Spawning occurs pelagically and eggs develop throughout the water column (70-80 m in the Bering Sea shelf, 150-200 m in Shelikof Strait). Development is dependent on water temperature. In the Bering Sea, eggs take about 17-20 days to develop at 4 degrees in the Bogoslof area and 25.5 days at 2 degrees on the shelf. In the Gulf of Alaska, development takes approximately 2 weeks at ambient temperature (5 degrees C). Larvae are also distributed in the upper water column. In the Bering Sea the larval period lasts approximately 60 days. The larvae eat progressively larger naupliar stages of copepods as they grow and then small euphausiids as they approach transformation to juveniles (~25 mm standard length). In the Gulf of Alaska, larvae are distributed in the upper 40 m of the water column and the diet is similar to Bering Sea larvae. FOCI survey data indicate larval pollock may utilize the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which reside in the colder bottom water.

At age 1 pollock are found throughout the eastern Bering Sea both pelagically and on bottom. Age 1 pollock from strong year-classes appear to be found in great numbers on the inner shelf, and further north on the shelf than weak year classes which appear to be more concentrated on the outer continental shelf. From age 2-3 pollock are primarily pelagic and then to be most abundant on the outer and mid-shelf northwest of the Pribilof Islands. As pollock reach maturity (age 4) in the Bering Sea, they appear to move from the northwest to the southeast shelf to recruit to the adult spawning population. Strong year-classes of pollock persist in the population in significant numbers until about age 12, and very few pollock survive beyond age 16. The oldest recorded pollock was age 31.

Growth varies by area with the largest pollock occurring on the southeastern shelf. On the northwest shelf the growth rate is slower. A newly maturing pollock is around 40 cm.

| Age | Mean length (cm) | | | Mean weight (kg) | Maturity |
|---|---|---|---|---|---|
| | Southeast Shelf | Northwest Shelf | eastern Bering Sea | eastern Bering Sea | |
| 2 | 29.8 | 25.9 | 28.2 | 0.170 | 1% |
| 3 | 36.1 | 31.9 | 34.5 | 0.303 | 29% |
| 4 | 41.1 | 36.7 | 39.5 | 0.447 | 64% |
| 5 | 45.1 | 40.6 | 43.4 | 0.589 | 84% |
| 6 | 48.2 | 43.7 | 46.6 | 0.722 | 90% |
| 7 | 50.7 | 46.2 | 49.1 | 0.840 | 95% |
| 8 | 52.6 | 48.3 | 51.1 | 0.942 | 96% |
| 9 | 54.2 | 49.9 | 52.7 | 1.029 | 97% |
| 10 | 55.4 | 51.2 | 54.0 | 1.102 | 97% |
| 11 | 56.4 | 52.3 | 55.0 | 1.163 | 100% |
| 12 | 57.1 | 53.1 | 55.8 | 1.212 | 100% |
| 13 | 57.7 | 53.8 | 56.5 | 1.253 | 100% |
| 14 | 58.2 | 54.4 | 57.0 | 1.286 | 100% |
| 15 | 58.6 | 54.8 | 57.4 | 1.312 | 100% |

| Age | Gulf of Alaska | | |
|---|---|---|---|
| | Mean length (cm) | Mean Weight | 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% |

Fishery

The eastern Bering Sea pollock fishery has, since 1990 been divided into two fishing periods; an "A season" occurring in January-March, and a "B season" occurring in August-October. The A season concentrates fishing effort on prespawning pollock in the southeastern Bering Sea. During the B season fishing is still primarily in the southeastern Bering Sea, but some fishing also occurs on the northwestern shelf. Also during the B season catcher processor vessels are required to fish north of 56° N latitude because the area to the south is reserved for catcher vessels delivering to shoreside processing plants on Unalaska and Akutan.

Since 1990, the Gulf of Alaska 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 Gulf of Alaska (east of 147° W). 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. 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 eastern Bering Sea pollock fishery primarily harvests mature pollock. The 50% selectivity corresponds to the age of 50% maturity, age 4. Fishery selectivity increases to a maximum around age 7-8 and then declines. The reduced selectivity for older ages is due to pollock becoming increasingly demersal with age. Younger pollock form large schools and are semi-demersal, thereby being easier to locate by fishing vessels. Immature fish (ages 2 and 3) are usually caught in low numbers. Generally the catch of immature pollock increases when strong year-classes occur and the abundance of juveniles increase sharply. This occurred with the 1989 year-class, the second largest year-class on record. Juvenile bycatch increased sharply in 1991 and 1992 when this year-class was age 2 and 3. A secondary problem is that strong to moderate year-classes may reside in the Russian EEZ adjacent to the U. S. EEZ as juveniles. Russian catch-age data and anecdotal information suggest that juveniles may comprise a major portion of the catch. There is a potential for the Russian fishery to reduce subsequent abundance in the U. S. fishery.

| Age | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Selectivity | 5% | 27% | 50% | 70% | 90% | 100% | 88% | 89% | 77% | 79% | 79% | 77% | 87% | 87% |

The Gulf of Alaska pollock fishery also 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.

| 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% |

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.

Being the dominant species in the eastern Bering Sea pollock is an important food source for other fish, marine mammals, and birds. On the Pribilof Islands hatching success and fledgling survival of marine birds has been tied to the availability of age 0 pollock to nesting birds.

Upper size limit of juvenile fish

The upper size limit for juvenile pollock in the eastern Bering Sea and Gulf of Alaska is about 38-42 cm. This is the size of 50% maturity.

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.

Habitat and Biological Associations

*Egg-Spawning*: Pelagic on outer continental shelf generally over 100-200 m depth in Bering Sea. Pelagic on continental shelf over 100-200 m depth in Gulf of Alaska.

*Larvae*: Pelagic outer to mid-shelf region in Bering Sea. Pelagic throughout the continental shelf within the top 40 m in the Gulf of Alaska.

*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 Gulf of Alaska, eastern Bering Sea and Aleutian Islands. 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. Exclusive Economic Zone and the basin.

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**SPECIES:** Gulf of Alaska Walleye Pollock

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | 14 d. at 5 C | None | Feb-Apr | OCS, UCS | P | N/A | G? | |
| Larvae | 60 days | copepod naupli and small euphausiids | Mar-Jul | MCS, OCS | P | N/A | G? F | pollock larvae with jellyfish |
| Juveniles | 0.4 to 4.5 years | Pelagic crustaceans, copepods and euphausiids | Aug. + | OCS, MCS, ICS | P, SD | N/A | CL, F | |
| Adults | 4.5 - 16 years | Pelagic crustaceans and fish | Spawning Feb-Apr | OCS, BSN | P, SD | UNK | F UP | Increasingly demersal with age. |

5.1.1.2 Pacific cod

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about 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 maximum recorded age of a Pacific cod from the Bering Sea/Aleutian Islands (BSAI) or Gulf of Alaska (GOA) is 19 years.

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 BSAI, the age at 50% recruitment is 3 years for trawl gear and 4 years for other longline and pot gear. In the GOA, the age at 50% recruitment is 4 years for trawl gear and 5 years for 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 is often causes the Pacific cod fisheries to close prior to reaching the total allowable catch. In the BSAI, trawl fishing is concentrated immediately north of Unimak Island, whereas the longline fishery is distributed along the shelf edge to the north and west of the Pribilof Islands. In the GOA, the trawl fishery has centers of activity around the Shumagin Islands and south of Kodiak Island, while the longline fishery is located primarily in the vicinity of the Shumagins.

Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the BSAI and GOA are polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausids, 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.

What is the approximate upper size limit of juvenile fish (in cm)?

The estimated size at 50% maturity is 67 cm.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Larvae/juveniles: NMFS, Alaska Fisheries Science Center, FOCI Program, Ann Matarese 206-526-4111

Habitat and Biological Associations (if known) Narrative

*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.

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SPECIES: Gulf of Alaska Pacific cod

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | 15-20 d | 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 yr | small invertebrates (mysids, euphausiids, shrimp) | all year | ICS, MCS | D | M, SM, MS, S | U | |
| Late Juveniles | 2-5 yr | pollock, flatfish, fishery discards, crab | all year | ICS, MCS, OCS | D | M, SM, MS, S | U | |
| Adults | 5+ yr | pollock, flatfish, fishery discards, crab | spawning (Jan-May)<br><br>non-spawning (Jun-Dec) | ICS, MCS, OCS<br><br>ICS,MCS, OCS | D | M, SM, MS, S | U | |

5.1.1.3 Deep Water Flatfish

Management Plan and Area Groundfish, GOA

The deep water flatfish management complex in the Gulf of Alaska 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 Gulf of Alaska and the description of its habitat and life history are given herewith to represent the three species.

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 Gulf of Alaska. 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 Gulf of Alaska 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).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 5. They are caught as bycatch in the rex sole, thornyhead and sablefish fisheries and are caught with these species and Pacific halibut in Dover sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate upper size limit of juvenile fish? 32 cm.

Habitat and Biological Associations

*Larvae/Juveniles*: Planktonic larvae for up to 2 years until metamorphosis occurs, juvenile distribution is unknown.

*Adults*: Winter and spring spawning and summer feeding on soft substrates (combination of sand and mud) of the continental shelf and upper slope. Shallower summer distribution mainly on the middle to outer portion of the shelf and upper slope, feeding mainly on polychaetes, annelids, crustaceans and mollusks (Livingston and Goiney 1983).

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SPECIES: Dover sole

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | | NA | spring<br>summer | ICS?<br>MCS<br>OCS<br>UCS | P | | | |
| Larvae | up to 2 years | U<br>phyto/zoo<br>plankton? | all year | ICS?<br>MCS<br>OCS<br>UCS | P | | | |
| Early Juveniles | to 3 years | polychaetes<br>amphipods<br>annelids | all year | MCS?<br>ICS? | D | S, M | | |
| Late Juveniles | 3-5 years | polychaetes<br>amphipods<br>annelids | all year | MCS?<br>ICS? | D | S, M | | |
| Adults | 5+ years | polychaetes<br>amphipods<br>annelids<br>mollusks | spawning<br>Ja. -August<br><br>non-spawning<br>July-January | MCS<br>OCS<br>UCS<br><br>MCS<br>OCS<br>UCS | D | S, M | | |

5.1.1.4 Shallow Water Flatfish

Management Plan and Area Groundfish, GOA

The shallow water flatfish management complex in the Gulf of Alaska 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 Gulf of Alaska 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 Gulf of Alaska, and the description of their habitat and life history best represent the shallow water complex species.

Life History and General Distribution

See Bering Sea yellowfin sole and rock sole description.

Fishery

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.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate upper size limit of juvenile fish?

See Bering Sea yellowfin sole and rock sole description.

Source for additional distribution data

ADF&G, 211 Mission Road, Kodiak, AK 99615 Jim Blackburn (907) 486-1863
Univ. Alaska, Inst. Mar. Science, Dr. Brenda L. Norcross (907) 474-7990

Habitat and Biological Associations

*Larvae/Juveniles*: See Bering Sea yellowfin sole and rock sole description.

*Adults*: See Bering Sea yellowfin sole and rock sole description.

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SPECIES: 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<br>BCH | P | | | |
| Larvae | 2-3 months? | U<br>phyto/zoo plankton? | summer<br>autumn? | BAY<br>BCH<br>ICS | P | | | |
| Early Juveniles | to 5.5 years | polychaetes<br>bivalves<br>amphipods<br>echiurids | all year | BAY<br>ICS<br>OCS | D | S[1] | | |
| Late Juveniles | up to 10 years | polychaetes<br>bivalves<br>amphipods<br>echiurids | all year | BAY<br>ICS<br>OCS | D | S[1] | | |
| Adults | 10+ years | polychaetes<br>bivalves<br>amphipods<br>echiurids | spawning/ feeding May-August<br><br>non-spawning Nov.-April | BAY<br>BEACH<br>ICS<br><br>ICS<br>MCS<br>OCS | D | S[1] | ice edge | |

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SPECIES: 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<br>phyto/zoo<br>plankton? | winter/spring | OCS<br>MCS<br>ICS | P | | | |
| Early Juveniles | to 3.5 years | polychaetes<br>bivalves<br>amphipods<br>misc. crust. | all year | BAY<br>ICS<br>OCS | D | S[1] | | |
| Late Juveniles | up to 9 years | polychaetes<br>bivalves<br>amphipods<br>misc. crust. | all year | BAY<br>ICS<br>OCS | D | S[1] | | |
| Adults | 9+ years | polychaetes<br>bivalves<br>amphipods<br>misc. crust. | feeding<br>May-<br>September<br><br>spawning<br>Dec.-April | MCS<br>ICS<br><br>MCS<br>OCS | D | S[1] | <br><br><br>ice edge | |

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5.1.1.5 Rex sole

Management Plan and Area Groundfish, GOA

Life History and General Distribution

Distributed from Baja California to the Bering Sea and western Aleutian Islands (Hart 1973, Miller and Lea 1972), and are widely distributed throughout the Gulf of Alaska. 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 Gulf of Alaska 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).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3 or 4. They are caught as bycatch in the Pacific ocean perch, Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in rex sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate upper size limit of juvenile fish? Males 15 cm and females 23 cm.

Habitat and Biological Associations

*Larvae/Juveniles*: Planktonic larvae for an unknown time period until metamorphosis occurs, juvenile distribution is unknown.

*Adults*: Spring spawning and summer feeding on a combination of sand, mud and gravel substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on polychaetes, amphipods, euphausids and snow crabs.

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SPECIES: 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?<br>MCS<br>OCS | P | | | |
| Larvae | U | U<br>phyto/zoo plankton? | spring<br>summer | ICS?<br>MCS<br>OCS | P | | | |
| Juveniles | 2 years | polychaetes<br>amphipods<br>euphausiids<br>Tanner crab | all year | MCS<br>ICS<br>OCS | D | G, S, M | | |
| Adults | 2+ years | polychaetes<br>amphipods<br>euphausiids<br>Tanner crab | spawning<br>Feb-May<br><br>non-spawning<br>May-January | MCS, OCS<br>USP<br><br>MCS, OCS,<br>USP | D | G, S, M | | |

5.1.1.6 Flathead sole

Management Plan and Area Groundfish, BSAI and GOA

Life History and General Distribution

Distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the Gulf of Alaska 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 on the eastern Bering Sea shelf and in the Gulf of Alaska. 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). Larve absorb the yolk sac in 6 to 17 days but the extent of their distribution is unknown. The age or size at metamorphosis is unknown as well as the age at 50% 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.

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3. Historically, the fishery has occurred throughout the mid and outer 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.

Relevant Trophic Information

Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length.

Approximate upper size limit of juvenile fish? Unknown age at 50% maturity.

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, feeding mainly on ophiuroids, tanner crab, osmerids, bivalves and polychaetes.

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SPECIES: 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<br>MCS<br>OCS | P | | | |
| Larvae | U | U<br>phyto/zoo plankton? | spring<br>summer | ICS<br>MCS<br>OCS | P | | | |
| Juveniles | U | polychaetes<br>bivalves<br>ophiuroids<br>pollock and Tanner crab | all year | MCS<br>ICS<br>OCS | D | S+M[1] | | |
| Adults | U | polychaetes<br>bivalves<br>ophiuroids<br>pollock and Tanner crab | spawning Jan-April<br><br>non-spawning May-December | MCS<br>OCS<br>ICS<br><br>ICS<br>MCS<br>OCS | D | S+M[1] | ice edge | |

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5.1.1.7 Arrowtooth Flounder

Management Plan and Area Groundfish, BSAI and GOA

Life History and General Distribution

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 from ichthyoplankton sampling over a widespread area of the eastern Bering Sea shelf in April and May and also on the continental shelf east of Kodiak Island during winter and spring (Waldron and Vinter 1978, Kendall and Dunn 1985). The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach the 10-15 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, Wilderbuer and Sample 1996).

Fishery

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.

Relevant Trophic Information

Very important as a large, aggressive and abundant predator of other groundfish species. Groundfish predators include Pacific cod and pollock, mostly on small fish.

Approximate upper size limit of juvenile fish? Males 27 cm and females 37 cm.

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.

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SPECIES: Arrowtooth flounder

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | | NA | winter,<br>spring? | ICS<br>OCS | P | | | |
| Larvae | 2-3 months? | U<br>phyto/zoo<br>plankton? | spring<br>summer? | BAY<br>ICS<br>OCS | P | | | |
| Juveniles | males - 4 yrs<br>females - 5 yrs | euphausiids<br>crustaceans<br>amphipods<br>pollock | all year | ICS<br>OCS<br>USP | D | GMS[1] | | |
| Adults | males - 4+ yrs<br>females- 5+ yrs | pollock<br>misc. fish<br>Gadidae sp.<br>Euphausiids | spawning<br>Nov-March<br><br>non-spawning<br>April-Oct. | OCS<br>USP<br><br>ICS<br>OCS<br>USP<br>BAY | D | GMS[1] | ice edge (BS) | |

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5.1.1.8 Sablefish

Management Plan and Area(s) Groundfish, GOA and BSAI

Life History and General Distribution

Distributed from Mexico through the Gulf of Alaska 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.

Fishery

The major fishery for sablefish in Alaska uses longlines, however sablefish are valuable in the trawl fishery as well. Sablefish enter the longline fishery at 4-5 years of age, perhaps slightly younger in the trawl fishery. The longline fishery takes place primarily in the spring and summer (the regulatory season is between March 15 and November 15). The take of the trawl share of sablefish occurs primarily in association with openings for other species, such as the July rockfish openings, where they are taken as allowed bycatch. Deeper dwelling rockfish, such as Shortraker, Rougheye, and Thornyhead rockfish are the primary bycatch in the longline sablefish fishery. Halibut and rattails (*Albatrossia pectoralis and Corphaenoides acrolepis*) also are taken. By regulation, there is no directed trawl fishery for sablefish, however, directed fishing standards have allowed some trawl hauls to target sablefish, where the bycatch is similar to the longline fishery, in addition perhaps to some deep dwelling flatfish.

Relevant Trophic Information

Larval sablefish feed on a variety of small zooplankton ranging from copepod naupli to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e., euphausiids).

The older demersal juveniles and adults appear to be opportunistic feeders, with food ranging from 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 SE troll fishery during the late summer.

What is the approximate upper size limit of juvenile fish (in cm)?

Size of 50% maturity: Bering Sea: males 65 cm, females 67 cm; Aleutian Islands: males 61 cm, females 65 cm; Gulf of Alaska: males 57 cm, females 65 cm. At the end of the second summer (~1.5 years old) they are 35-40 cm in length.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Eggs and Larvae: NMFS, Alaska Fisheries Science Center, FOCI Program, Art Kendall 206-526-4108, NMFS Auke Bay Lab, Bruce Wing 907-789-6043.

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Habitat and Biological Associations (if known) Narrative

*Egg/Spawning*
*Larvae*
*Juveniles*
*Adults* - other than depth, none is noted.

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SPECIES: Gulf of Alaska 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 | up to 3 years | small prey fish, sandlance, salmon, herring, etc | | OCS, MCS, ICS, during first summer, then obs in BAY, IP, till end of 2nd summer; not obs'd till found on shelf | P when offshore during first summer, then D, SD/SP when inshore | NA when pelagic. The bays where observed were soft bottomed, but not enough obs. to assume typical. | U ? or NA | |
| Late Juveniles | 3-5 yrs | opportunistic: other fish, shellfish, worms, jellyfish, fishery discards | all year | continental slope, and deep shelf gulleys and fjords. | presumably D | varies, generally soft bottoms, | U on slope, ? in fjords | |
| Adults | 5 to 35+ yrs | 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 | varies, generally soft bottoms, | U on slope, ? in fjords | |

5.1.1.9 Pacific ocean perch

Management Plan and Area(s) Groundfish, BSAI and GOA

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 Gulf of Alaska, 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 Gulf of Alaska), 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.

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 Gulf of Alaska, and 7.25 years in the Bering Sea/Aleutian Islands. The fishery in the Gulf in recent years has been concentrated in the summer months, especially July, due mostly to management regulations. In the Bering Sea and Aleutian Islands, most of the fish have been caught during the spring in March and April. Reflecting the summer distribution of this species, the fishery in the Gulf is concentrated in a relatively narrow depth band at 190-250 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 Is. In the Bering Sea and Aleutian Islands, the major fishing grounds are north of Unimak Pass, in Seguam and Amukta Pass, north of Atka Is., on Petrel Bank, south of Amchitka Island, and along the upper continental slope northwest of the Pribilof Islands.

For NPFMC-managed species, the major bycatch species in the Gulf of Alaska 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. There is no information available on the bycatch of non-NPFMC-managed species in the Gulf of Alaska fishery, nor any bycatch information at all for the Aleutian Islands and Bering Sea fisheries.

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 Gulf of Alaska 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.

Describe any potential gear impacts on the habitats of this or other species

Because collection of small juvenile Pacific ocean perch is virtually unknown in any existing type of fishing gear, it is assumed that fishing does not occur in their habitat. Trawling on the offshore fishing grounds of adults may affect the composition of benthic organisms, but the impact of this on Pacific ocean perch or other fish is unknown.

What is the approximate upper size limit of juvenile fish (in cm)?

For Gulf of Alaska: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*. For Aleutian Islands and Bering Sea: unknown for both sexes.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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.

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Habitat and Biological Associations (if known) Narrative

> *Egg/Spawning*: Little information is known. Insemination is thought to occur after adults move to deeper offshore waters in the fall. Parturition is reported to occur from 20-30 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 1960's and 1970's 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.

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SPECIES: Gulf of Alaska Pacific ocean perch

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | Internal incub-tion; ~90 d | NA | Winter | NA | NA | NA | NA | NA |
| Larvae | U; assumed between 60 and 180 days | U; assumed to be micro-zooplankton | Spring-summer | ICS, MCS, OCS, USP, LSP, BSN | P | NA | U | U |
| Juveniles | 3-6 months to 10 years | Calanoid copepods (young juv.); Euphausiids (older juv.) | All year | ICS, MCS, OCS, USP | ?P (early juv. only), D | R (<age 3); CB,G,?M, ?SM,?MS (>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 |

5.1.1.10 Shortraker Rockfish and Rougheye Rockfish

Management Plan and Area(s) Groundfish, BSAI and GOA

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.

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.

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.

What is the approximate upper size limit of juvenile fish (in cm)

For shortraker rockfish, length at 50% sexual maturity is about 45 cm and about 44 cm for rougheye rockfish

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Larvae: NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall, 206-526-4168.

Habitat and Biological Associations (if known) Narrative

*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.

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SPECIES: 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<br>Shrimp & amphipods? | U | U<br>MCS, OCS? | U | U | U | |
| Adults | 15+ yrs of age | Shrimp<br>Squid<br>Myctophids | Year-round? | OCS, USP | SD | M, S, R, SM, CB, MS, G | U | |

5.1.1.11 Northern Rockfish

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Northern rockfish range from northern British Columbia through the Gulf of Alaska and Aleutian Islands to eastern Kamchatka, including the Bering Sea. The species is most abundant from about Portlock Bank in the central Gulf of Alaska 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 Gulf of Alaska, 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 Gulf of Alaska 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 Gulf of Alaska), and an old maximum age of 57 years in Alaska. No information on fecundity is available.

Fishery

Northern rockfish are caught almost exclusively with bottom trawls. Age at 50% recruitment is unknown. The fishery in the Gulf of Alaska in recent years has mostly occurred in the summer months, especially July, due to management regulations. In the Bering Sea and Aleutian Islands, the fishery has occurred mostly in the spring, with smaller catches also taken in the summer. 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 Gulf of Alaska; and Seguam Pass, Petrel Bank, Buldir Reef, and Tahoma Reef in the Aleutian Islands. Outside of these banks, catches are generally sparse. The majority of the catch comes from depths of 75-125 m in the Gulf, and 100-150 m in the Aleutian Islands. There is no summarized information currently available on location of fishing grounds or depths fished in the eastern Bering Sea.

For NPFMC-managed species, the major bycatch species in the Gulf of Alaska 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 Gulf of Alaska northern rockfish fishery, nor any bycatch information for the Aleutian Islands fishery.

Relevant Trophic Information

Although no comprehensive food study of northern rockfish has been done, several smaller studies have all shown euphausiids to be the predominate food item of adults in both the Gulf of Alaska and Bering Sea. Copepods, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities.

Predators of northern rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

What is the approximate upper size limit of juvenile fish (in cm)?

For Gulf of Alaska: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*. For Aleutian Islands and Bering Sea: unknown for both sexes. Because northern rockfish in the Aleutian Islands attain a much smaller size than in the Gulf, the upper size limit of juveniles there is probably much less than in the Gulf.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Eggs and Larvae: None at present

Older juveniles and adults: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, David Clausen, (907) 789-6049.

Habitat and Biological Associations (if known) Narrative

*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.

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SPECIES: 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 |
| Early Juveniles | From end of larval stage to ? | U | All year | ICS, MCS, OCS, | ?P (early juv. only), D | U (juv.< 20 cm); substrate (juv.>20 cm) | U | U |
| Late Juveniles | to 13 yrs | U | All year | OCS | | CB, R | U | U |
| Adults | 13-57 years of age | Euphausiids | U, except that larval release is probably in the spring in the Gulf of Alaska | OCS, USP | SD | CB, R | U | U |

5.1.1.12 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.

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Light dusky rockfish range from Dixon Entrance at the U.S./Canada boundary, around the arc of the Gulf of Alaska, 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 Gulf of Alaska. 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 Gulf of Alaska 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.

Fishery

Light dusky rockfish are caught almost exclusively with bottom trawls. Age at 50% recruitment is unknown. The fishery in the Gulf of Alaska 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. There is no directed fishery in the Aleutians and Bering Sea, and catches there have been generally sparse.

For NPFMC-managed species, the major bycatch species in the Gulf of Alaska 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 Gulf of Alaska light dusky rockfish fishery.

Relevant Trophic Information

Although no comprehensive food study of light dusky rockfish has been done, one smaller study in the Gulf of Alaska showed euphausiids to be the predominate food item of adults. Larvaceans, cephalopods, pandalid shrimp, and hermit crabs were also consumed.

Predators of light dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

What is the approximate upper size limit of juvenile fish (in cm)? For Gulf of Alaska: 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*.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Eggs, Larvae, and Juveniles: None at present.

Adults: Rebecca Reuter, c/o NMFS, Alaska Fisheries Science Center, REFM Division, (206) 526-6546.

Habitat and Biological Associations (if known) Narrative

*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 Gulf of Alaska 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.

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SPECIES: Light 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 |
| Early Juveniles | U | U | All year | ICS, MCS, OCS, | U (small juv.< 25 cm): ?D (Larger juv.) | U (juv.< 25 cm); ?Trawlable substrate (juv.>25 cm) | U | U |
| Late Juveniles | U | U | U | U | U | CB, R, G | U | U |
| Adults | Up to 49-50 years. | Euphausiids | U, except that larval release may be in the spring in the Gulf of Alaska | OCS, USP | SD, SP | CB, R, G | U | U |

5.1.1.13 Demersal Shelf Rockfish

Management Plan and Area(s): GOA, Southeast Outside Subdistrict

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*

Descriptions in text are for yelloweye rockfish, see table for other species.

Life History and General Distribution

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).

Fishery

Demersal shelf rockfish are the target of a directed longline fishery and are the primary bycatch species in the longline fishery for Pacific halibut. They recruit into the fishery at about age 18 to 20 at a length between 45 and 50 cm. The commercial fishery grounds are usually areas of rocky bottom between 20 and 100 fm. The directed fishery now occurs between November and March both because of higher winter prices and limitations imposed due to the halibut IFQ regulations.

Relevant Trophic Information:

Yelloweye rockfish eat a large variety of organisms, primarily fishes included small rockfishes, herring and sandlance as well as caridean shrimp and small crabs (Rosenthal et al 1988). They also opportunistically consume lingcod eggs. Young rockfishes are in turn eaten by a variety of predators including lingcod, large rockfish, salmon, and halibut.

What is the approximate upper size limit of juvenile fish (in cm)

Length at 50% sexual maturity is 45 cm for females and 50 cm for males?

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Habitat and Biological Associations (if known) Narrative

Young juveniles between 2.5 (1 inch) and 10 cm (4 inches) have been observed in areas of high relief (vertical walls, cloud sponges, fjord-like areas) in depths deeper than 15 m (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 shows an increasing density with increasing habitat complexity: deep water boulder fields consisting of very large boulders have significantly higher densities than other rock habitats (O'Connell and Carlile 1993). Although yelloweye do occur over cobble and sand bottoms, generally this is when foraging and often these areas directly interface with a rock wall or outcrop.

Literature


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SPECIES: Yelloweye Rockfish

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | na | | | | | | | |
| Larvae | <6 mo? | Copepod? | Spring/ Summer | U | N? | U | U | |
| Early Juveniles | to 10 yrs | U | | ICS, MCS, OCS, BAY, IP, Other? | D | R, C, Other? | U | |
| Late Juveniles | 10-18 yrs | U | | ICS, MCS, OCS, BAY, IP, Other? | D | R, C, Other? | U | |
| Adults | At least 118 years | Fish, shrimp, crab | Parturition: Apr-Jul | ICS, MCS, OCS, USP, BAY, IP | D | R, C, CB | U | |

Larvae and juvenile level 0, late juvenile and adult level 1: primarily ICS, OCS, US over R, CB bottom

| Species | Range/Depth | Maximum Age | Trophic | Parurition | Known Habitat |
|---|---|---|---|---|---|
| Quillback | Kodiak Island to San Miguel Island, CA<br><br>To 274 m (commonly 12-76 m) | At least 32<br><br>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<br><br>Shallow to 183 m (commonly to 122 m) | At least 31 years<br><br>50% SM=5 yr | Crustaceans<br>Octopi<br>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<br><br>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<br><br>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<br><br>To 25 m to 549 m | To 87 yrs<br><br>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<br><br>To 424 m (commonly to 137 m) | To 75 yrs<br><br>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. |

5.1.1.14 Thornyhead Rockfish

Management Plan and Area(s) Groundfish, BSAI and GOA

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 Gulf of Alaska. 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 Gulf of Alaska, 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.

Fishery

Trawl and longline gear are the primary methods of harvest. The bulk of the fishery occurs in late winter or early spring through the summer. In the past, this species was seldom the target of a directed fishery. Today thornyheads are one of the most valuable of the rockfish species, with most of the domestic harvest exported to Japan. Thornyheads are taken with some frequency in the longline fishery for sablefish and cod and is often part of the bycatch of trawlers concentrating on pollock and Pacific ocean perch.

Relevant Trophic Information

Shortspine thornyheads prey mainly on epibenthic shrimp and fish. Yang (1993, 1996) showed that shrimp were the top prey item for shortspine thornyheads in the Gulf of Alaska; whereas, cottids were the most important prey item in the Aleutian Islands region. Differences in abundance of the main prey between the two areas might be the main reason for the observed diet differences. Predator size might by another reason for the difference since the average shortspine thornyhead in the Aleutian Islands area was larger than that in the Gulf of Alaska (33.4 cm vs 29.7 cm).

What is the approximate upper size limit of juvenile fish (in cm)

Female shortspine thornyheads appear to be mature at about 21-22 cm.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Larvae: NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall, 206-526-4108.

Habitat and Biological Associations (if known) Narrative

*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). Two congeneric thornyhead species, the longspine thornyhead (*Sebastolobus altivelis*) and a species common off of Japan, *S. Macrochir*, are infrequently encountered in the Gulf of Alaska.

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SPECIES: Thornyheads

| 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 and early spring | U | P | U | U | |
| Larvae | <15 Months | U | Early spring through summer | U | P | U | U | |
| Juveniles | > 15 months when settling to bottom occurs (?) | U<br>Shrimp, Amphipods, Mysids, Euphausiids? | U | MCS, OCS, USP | D | M, S, R, SM, CB, MS, G | U | |
| Adults | U | Shrimp<br>Fish (cottids), Small crabs | Year-round? | MCS, OCS, USP, LSP | D | M, S, R, SM, CB, MS, G | U | |

5.1.1.15 Atka mackerel

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Distributed from the Gulf of Alaska 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. r-traits: 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 low fecundity (only about 30,000 eggs/female/year, large egg diameters (1-2 mm) and male nest-guarding behavior).

Fishery

Bottom trawls, some pelagic trawling, recruit at about age 3, conducted in the Aleutian Islands and western 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. Currently, the fishery occurs on reefs west of Kiska Island, south and west of Amchitka Island, in Tanaga Pass and near the Delarof Islands, and south of Seguam and Umnak Islands. Historically fishery occurred east into the GOA as far as Kodiak Island (through the mid-1980s), but is no longer there. Fishery used to be entirely during summer, during spawning season; now occurs throughout the year. Very "clean" fishery; bycatch of other species is minimal.

Relevant Trophic Information

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.

What is the approximate upper size limit of juvenile fish (in cm)? 35 cm

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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

Habitat and Biological Associations (if known) Narrative

*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.

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SPECIES: Atka mackerel

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | 40-45 d | NA | summer | IP,ICS | D | GR,R,K | U | develop 3-20°C<br>optimum 9-13°C |
| Larvae | up to 6 mos | U<br>copepods? | fall-winter | U | U<br>N? | U | U | 2-12°C<br>optimum 5-7°C |
| Juveniles | ½-2 yrs of age | U<br>copepods & euphausiids? | all year | U | U | U | U | 3-5°C |
| Adults | 3+ yrs of age | copepods<br>euphausiids<br>meso-pelagic fish (myctophids) | spawning (May-Oct)<br><br>non-spawning (Nov-Apr)<br><br>tidal/diurnal, year-round? | ICS and MCS, IP<br><br>MCS and OCS, IP<br><br>ICS,MCS, OCS,IP | D (males)<br>SD females<br><br>SD/D all sexes<br><br>D when currents high/day<br><br>SD slack tides/night | GR,R,K | F,E | 3-5°C<br>all stages >17 ppt only |

5.1.1.16 Capelin

Management Plan and Area(s): BSAI & GOA groundfish

Species Representative:
Capelin (*Mallotus villosus*)

Life History and General Distribution

Capelin is a short-lived marine (neritic), pelagic, filter-feeding schooling fish distributed along the entire coastline of Alaska and the Bering Sea, and south along British Columbia to the Strait of Juan de Fuca; circumpolar. In the N. Pacific, capelin grow to a maximum of 25 cm and 5 years of age. 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, along the Alaska Peninsula and near Kodiak. Age at 50% maturity=2 years. Fecundity: 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.

Fishery

Not a target species in groundfish fisheries of BSAI or GOA, but caught as bycatch (up to several hundred tons per year in the 1990s) principally by yellowfin sole trawl fishery in Kuskokwim and Togiak Bays in spring in BSAI; almost all discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Capelin are important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts 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; Yang 1993; Livingston, in prep.).

What is the approximate upper size limit of juvenile fish (in cm)? 13 cm

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
Jim Blackburn, ADFG, Kodiak AK 907-486-1861

Habitat and Biological Associations (if known) Narrative

*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, in the western GOA, and around Kodiak 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.

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SPECIES: 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<br>NA? | U | |
| Juveniles | 1.5+ yrs<br>up to age 2 | Copepods<br>Euphausiids | all year | ICS-MCS | P | U<br>NA? | U<br>F?<br>Ice edge in winter | |
| Adults | 2 yrs<br>ages 2-4+ | | spawning (May-August) | BCH (to 10 m) | D,SD | S,CB | | |
| | | Copepods<br>Euphausiids<br>polychaetes<br>small fish | non-spawning (Sep-Apr) | ICS-MCS-OCS | P | NA? | F<br>Ice edge in winter | -2 - 3°C Peak distributions in BS? |

5.1.1.17 Eulachon

Management Plan and Area(s): BSAI & GOA groundfish

Species Representative:

Eulachon, candlefish *(Thaleichthys pacificus)*

Life History and General Distribution

Eulachon is a short-lived anadromous, pelagic schooling fish distributed from the Pribilof Islands in the eastern Bering Sea, throughout the Gulf of Alaska, and south to California. Consistently found pelagically in Shelikof Strait (hydroacoustic surveys in late winter-spring) and between Unimak Island and the Pribilof Islands (bycatch in groundfish trawl fisheries) from the middle shelf to over the slope. In the North Pacific, eulachon grow to a maximum of 23 cm and 5 years of age. 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=3 years. Fecundity: ~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.

Fishery

Not a target species in groundfish fisheries of BSAI or GOA, but caught as bycatch (up to several hundred tons per year in the 1990s) principally by midwater pollock fisheries in Shelikof Strait (GOA), on the east side of Kodiak (GOA), and between the Pribilof Islands and Unimak Island on the outer continental shelf and slope (EBS); almost all discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information:

Eulachon may be important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, 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; Yang 1993; Livingston, in prep.).

What is the approximate upper size limit of juvenile fish (in cm)? 14 cm

Source of Additional Data

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
Jim Blackburn, ADFG, Kodiak AK 907-486-1861

Habitat and Biological Associations (if known) Narrative

*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 Shelikofeast of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

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SPECIES: 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 | April-June | Rivers-FW | D | S (CB?) | | 4 - 8°C for egg development |
| Larvae | 1-2 months ? | Copepods<br>phytoplankton<br>mysids, larvae | summer/fall | ICS ? | P? | U<br>NA? | U | |
| Juveniles | 2.5+ yrs<br>up to age 3 | Copepods<br>Euphausiids | all year | MCS-<br>OCS-USP | P | U<br>NA? | U<br>F? | |
| Adults | 3 yrs<br>ages 3-5+ | <br><br>Copepods<br>Euphausiids | spawning<br>(May-June)<br><br>non-spawning<br>(July-Apr) | Rivers-FW<br><br>MCS-<br>OCS-USP | D<br><br>P | S (CB?)<br><br>NA? | <br><br>F? | |

5.1.1.18 Sculpins

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Yellow Irish lord (*Hemilepidotus jordani)*
Red Irish lord (*Hemilepidotus hemilepidotus*)
Butterfly sculpin (*Hemilepidotus papilio*)
Bigmouth sculpin (*Hemitripterus bolini*)
Great sculpin (*Myoxocephalus polyacanthocephalus*)
Plain sculpin (*Myoxocephalus jaok*)

Life History and General Distribution:

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. 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 southeast Bering Sea and Gulf of Alaska. 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 Gulf of Alaska; 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 Gulf of Alaska; 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 Gulf of Alaska, 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 Gulf of Alaska (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.

Fishery

Not a target of groundfish fisheries of BSAI or GOA, but sculpin bycatch (second to skates in weight amongst the Other Species) has ranged from 6,000-11,000 mt per year in the BSAI from 1992-95, and 500-1,400 mt per year in the GOA. Bycatch occurs principally in bottom trawl fisheries for flatfish, Pacific cod and pollock, but also while longlining for Pacific cod; almost all is discarded. Annual sculpin bycatch in the BSAI ranges between 1-4% of annual survey biomass estimates, however little is known of the species distribution of the bycatch.

Relevant Trophic Information

Feed on bottom invertebrates (e.g., crabs, barnacles, mussels and other molluscs); larger species eat fish.

What is the approximate upper size limit of juvenile fish (in cm)? Unknown

Sources for Additional Data:

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
Jim Blackburn, ADFG, Kodiak AK 907-486-1861

Habitat and Biological Associations (if known) Narrative

*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.

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SPECIES: 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 (MSC-OSC?) | D | R (others?) | U | |
| Larvae | U | copepods | all year? | ICS-MSC,OCS,US | N,P | na? | U | |
| Juveniles and Adults | U | bottom invertebrates (crabs, molluscs, barnacles) and small fish | all year | BCH,ICS, MSC, OSC, US | D | R, S, M, SM | U | |

5.1.1.19 Sharks

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

| | |
|---|---|
| Lamnidae: | Salmon shark (*Lamna ditropis*) |
| Squalidae: | Sleeper shark (*Somniosus pacificus*) |
| | Spiny dogfish (*Squalus acanthias*) |

Life History and General Distribution:

Sharks of the order Squaliformes (which includes the two families Lamnidae and Squalidae) are the higher sharks with five gill slits and two dorsal fins. The Lamnidae are large, ovoviviparous (with small litters, 1-4; embryos nourished by intrauterine cannibalism), widely migrating sharks which are highly aggressive predators (salmon and white sharks). The Lamnidae are partly warm-blooded; the heavy trunk muscles are warmer than water for greater power and efficiency. Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the Gulf of Alaska (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, occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near coast to the outer shelf in the Gulf of Alaska, particularly near Kodiak Island. Not commonly seen in Aleutian Islands. They are believed to eat primarily fish, including salmon, sculpins and gadids, and can be up to 3 m in length.

The Pacific sleeper shark is distributed from California around the Pacific rim to Japan and in the 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 up to 8 m in length. Voracious, omnivorous predator of flatfish, cephalopods, rockfish, crabs, seals, salmon; may also prey on pinnipeds. In groundfish fishery and survey data, occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near coast to the outer shelf in the Gulf of Alaska, particularly near Kodiak Island.

Spiny dogfish (or closely related species?) are widely distributed through the Atlantic, Pacific and Indian Oceans. In the north Pacific, may be most abundant in the Gulf of Alaska, but also common in the Bering Sea. Pelagic species, found at surface and to depths of 700 m; mostly 200 m or less on shelf and neritic; often found in aggregations. 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 slows 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, 72 cm and 19 years old. Females give birth in shallow coastal waters, usually in Sept-Jan. Dogfish eat a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus). Tagging experiments indicate local indigenous populations in some areas and widely migrating groups in others. May move inshore in summer and offshore in winter.

Fishery

Not a target of groundfish fisheries of BSAI or GOA, but shark bycatch has ranged from 300-700 mt per year in the BSAI from 1992-95; 500-1,400 mt per year in the GOA) principally by pelagic trawl fishery for pollock, longline fisheries for Pacific cod and sablefish, and bottom trawl fisheries for pollock, flatfish and cod; almost all discarded. Little is known of shark biomass in BSAI or GOA.

What is the approximate upper size limit of juvenile fish (in cm)? Unknown for salmon sharks and sleeper sharks; for spiny dogfish: 94 cm for females, 72 cm for males.

Source of Additional Data

William Raschi, Bucknell University,

Habitat and Biological Associations (if known) Narrative

*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 on shelf in the GOA, and along outer shelf in the BS; apparently not as commonly found in the Aleutian Islands and not commonly at depths > 200 m.

Salmon sharks found throughout the GOA, but less common in the BS and AI; epipelagic, primarily over shelf/slope waters in GOA, and outer shelf in BS.

Sleeper sharks are widely dispersed on shelf/upper slope in the GOA, and along outer shelf/upper slope only in the BS; generally demersal, and may be less commonly found in the Aleutian Islands.

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SPECIES: SHARKS

| Stage - EFH Level | Duration or Age | Diet/Prey | Season-Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | | | | | | | | |
| Larvae | | | | | | | | |
| Juveniles and Adults | | | | | | | | |
| Salmon shark | U | fish (salmon, sculpins and gadids) | all year | ICS, MSC. OCS, US in GOA; OCS, US in BSAI | P | NA | U | |
| Sleeper shark | U | omnivorous; flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds | all year | ICS, MSC, OCS, US in GOA; OCS, US in BSAI | D | U | U | |
| Spiny dogfish | 40 years | fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus) | all year | ICS, MSC, OCS in GOA; OCS in BSAI<br><br>give birth ICS in fall/winter? | P | U | U | Euhaline 4-16°C |

5.1.1.20 Skates

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Alaska skate (*Bathyraja parmifera*)
Aleutian skate (*Bathyraja aleutica*)
Bering skate (*Bathyraja interrupta*)

Life History and General Distribution:

Skates (Rajidae) that occur in the BSAI and GOA are grouped into two genera: *Bathyraja* sp., or soft-nosed species (rostral cartilage slender and snout soft and flexible), and *Raja* sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). Skates are oviparous; fertilization is internal and eggs (one to five or more in each case) are deposited in horny cases for incubation. Adults and juveniles are demersal, and feed on bottom invertebrates and fish. Adult distributions from survey: Alaska skate: mostly 50-200 m on shelf in eastern Bering Sea (EBS) and Aleutian Islands (AI), less common in the Gulf of Alaska (GOA); Aleutian skate: throughout EBS and AI, but less common in GOA, mostly 100-350 m; Bering Skate: throughout EBS and GOA, less common in AI, mostly 100-350 m. Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. BSAI skate biomass estimate more than doubled between 1982-96 from bottom trawl survey; may have decreased in GOA and remained stable in the AI in the 1980s.

Fishery

Not a target of groundfish fisheries of BSAI or GOA, but caught as bycatch (13,000-17,000 mt per year in the BSAI from 1992-95; 1,000-2,000 mt per year in the GOA) principally by the longline Pacific cod and bottom trawl pollock and flatfish fisheries; almost all discarded. Skate bycatches in the EBS groundfisheries ranged between 1-4% of the annual EBS trawl survey biomass estimates in 1992-95.

Relevant Trophic Information feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

What is the approximate upper size limit of juvenile fish (in cm)? Unknown

Source of Additional Data

William Raschi, Bucknell University

Habitat and Biological Associations (if known) Narrative

*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.

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SPECIES: SKATES

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | U | na | U | MCS,OCS, USP | D | U | U | |
| Larvae | na | na | na | na | na | na | na | |
| Juveniles | U | Invertebrates small fish | all year | MCS,OCS, USP | D | U | U | |
| Adults | U | Invertebrates small fish | all year | MCS,OCS, USP | D | U | U | |

5.1.1.21 Squid

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Gonaditae:

Red or magistrate armhook squid (*Berryteuthis magister*)

Onychoteuthidae:

Boreal clubhook squid (*Onychoteuthis banksii borealjaponicus)*

Giant or robust clubhook squid (*Moroteuthis robusta*);

Sepiolidae:

eastern Pacific bobtail squid (*Rossia pacifica*).

Life History and General Distribution:

Squid are members of the molluscan class Cephalopoda, along with octopus, cuttlefish and nautiloids. In the BSAI and GOA, gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities > 30 ppt. Fertilization is internal, and development is direct ("larval" stages are only small versions of adults). The eggs of inshore neritic species are often enveloped in a gelatinous matrix attached to rocks, shells or other hard substrates, while the eggs of some offshore oceanic species are extruded as large, sausage-shaped drifting masses. Little is known of the seasonality of reproduction, but most species probably breed in spring-early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2-3 years, but the giant *Moroteuthis robusta* clearly lives longer.

***B magister*** is 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. Migrates seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. Maximum size: females-50 cm mantle length (ML); males-40 cm ML. Spermatophores transferred into the mantle cavity of female, and eggs are laid on the bottom on the upper slope (200-800 m). Fecundity 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, and most die after mating.

***O. banksii borealjaponicus,*** an active, epipelagic species, is distributed in the north Pacific from the Sea of Japan, throughout the 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 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 Gulf of Alaska. Mantle length can be up to 2.5 m long; with tentacles, at least 7 m, but most are about 2 m long.

***R. pacifica*** is a small (maximum length with tentacles of less than 20 cm) demersal, neritic and shelf, boreal species, distributed from Japan to California in the North Pacific and in the Bering Sea in waters of about 20-300 m depth. Other *Rossia* spp. deposit demersal egg masses.

Fishery:

Not currently a target of groundfish fisheries of BSAI or GOA. A Japanese fishery catching up to 9,000 mt of squid annually existed until the early 1980s for *B. magister* in the 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, and between 30-150 mt in the GOA; in the BSAI, almost all squid bycatch is in the midwater pollock fishery near the continental shelf break and slope, while in the GOA, trawl fisheries for rockfish and pollock (again mostly near the edge of the shelf and on the upper slope) catch most of the squid bycatch.

Relevant Trophic Information

The principal prey items of squid are small forage fish pelagic crustaceans (e.g., euphausiids and shrimp), and other cephalopods; cannibalism is not uncommon. After hatching, small planktonic zooplankton (copepods) are eaten. Squid are preyed upon by marine mammals, seabirds, and, to a lesser extent by fish, and occupy an important role in marine food webs worldwide. Perez (1990) estimated that squids comprise over 80% of the diets of sperm whales, bottlenose whales and beaked whales, and about half of the diet of Dall's porpoise in the eastern Bering Sea and Aleutian Islands. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break (e.g., Buldir Island, Pribilof Islands) are also known to feed heavily on squid (Hatch et al. 1990; Byrd et al. 1992; Springer 1993). In the Gulf of Alaska, only about 5% or less of the diets of most groundfish consisted of squid (Yang 1993). However, squid play a larger role in the diet of salmon (Livingston and Goiney 1983).

What is the approximate upper size limit of juvenile fish (in cm)?

For *B. magister*, approx. 20 cm ML for males, 25 cm ML for females; both at approximately 1 year of age.

Additional source of information

Beth Sinclair, NMFS, Seattle, WA 206-526-6466

Habitat Narrative 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.

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SPECIES: 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 yrs) | euphausiids, shrimp, small forage fish, and other cephalopods | summer<br><br>winter | All shelf, USP,LSP,BSN<br><br>OS,USP,LSP,BSN | SP<br><br>SP | U<br><br>U | UP,F?<br><br>UP,F? | Euhaline waters, 2-4°C |

5.1.1.22 Octopus

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Octopoda:

Octopus *(Octopus gilbertianus; O. dofleini)*

Vampyromorpha:

Pelagic octopus (*Vampyroteuthis infernalis*)

Life History and General Distribution:

Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish and nautiloids. In the BSAI and GOA, the most commonly encountered octopods are the shelf demersal species *O. gilbertianus* and *O. dofleini*, and the bathypelagic finned species, *V. infernalis*. Octopods, like other cephalopods are dioecious, with fertilization of eggs (usually within the mantle cavity of the female) requiring transfer of spermatophores during copulation. Octopods probably do not live longer than about 2-4 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 Gulf of Alaska (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.

Fishery

Not currently a target of groundfish fisheries of BSAI or GOA. Bycatch has ranged between 200-1,000 mt in the BSAI and 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/size at 50% recruitment is unknown. Most of the bycatch occurs on the outer continental shelf (100-200 m depth), chiefly north of the Alaskan peninsula from Unimak I. To Port Moller and northwest to the Pribilof Islands; also around Kodiak Island and many of the Aleutian Islands.

Relevant Trophic Information

Octopus are eaten by pinnipeds (principally Steller sea lions, and spotted, bearded, and harbor seals) and a variety of fishes, including Pacific halibut and Pacific cod (Yang 1993). When small, octopods eat planktonic and small benthic crustaceans (mysids, amphipods, copepods). As adults, octopus eat benthic crustaceans (crabs) and molluscs (clams).

What is the approximate upper size limit of juvenile fish (in cm)? Unknown

Additional source of information Unknown

Habitat Narrative for *Octopus* spp.:

*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.

Literature

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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.

SPECIES: *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 (IS, MS?) | D | R, G? | U | Euhaline waters |
| Young juveniles | U | zooplankton | summer-fall? | U (IS, MS, OS, USL?) | D,SD | U | U | Euhaline waters |
| Older Juveniles and Adults | U (2-3 yrs? for *O.gilbertianus*; older for *O.dofleini*) | crustaceans, molluscs | all year | IS, MS, OS, USL | D | R, G, S, MS? | U | Euhaline waters |

### 5.1.2 Status of Stocks

This section summarizes the status of the various groundfish stocks of commercial importance in the Gulf of Alaska. The discussion is limited to general historical trends in stock abundance and estimates of maximum sustainable yields. More detailed discussions and current estimates of biomass and acceptable biological catches can be found in the Stock Assessment and Fishery Evaluation Report (SAFE) produced yearly by the Gulf of Alaska Plan Team. The SAFE contains summaries of the various species sections from the yearly Status of Stocks documents produced by the Northwest and Alaska Fisheries Center. These documents contain further details on fishery statistics, resource assessment surveys, and the analytical techniques applied to the various species.

#### 5.1.2.1 Pollock

Annual catches of pollock in the Gulf of Alaska have increased steadily since 1978 reaching a peak of 306,700 mt in 1984. Catches declined in 1985 and 1986. Most of the catches have been taken from the Western and Central Regulatory Areas.

Estimates of population biomass from catch-at-age analysis indicated an increasing trend in biomass until 1981. The analysis showed a decline in biomass from 1982-85. The NMFS hydroacoustic surveys which have been conducted since 1981, provide abundance estimates of pollock age 2 and older from the Western and Central Regulatory Areas. The surveys show a decline in pollock abundance from 3,770,000 mt in 1981 to 620,000 mt in 1986. A series of weak year classes (1980-82 and possibly 1983) have contributed to the decline in biomass. Pollock biomass from the eastern Gulf of Alaska was estimated at 89,000-177,000 mt based on resource assessment surveys conducted in the mid-1970s.

The rise and decline of pollock biomass appears to be associated with recruitment. In the absence of a stock recruitment relationship, year class strengths have been associated with various levels of biomass. Strong year classes have been produced by stock biomasses which ranged from 768,000-1,830,000 mt. When biomass has exceeded 2,000,000 mt, poor year classes have been produced.

#### 5.1.2.2 Pacific cod

Pacific cod catches in the Gulf of Alaska have increased since 1971, reaching an average of 34,000 mt during 1980-83. The total 1985 catch fell to 14,442 mt, primarily due to restrictions on the total allowable level of foreign fishing. The majority of foreign catches have come from the Shumagin and Chirikof INPFC areas, while most of the U.S. and joint venture catches have been taken from the Kodiak INPFC area. Japanese longline CPUEs indicated an increase in relative abundance of Pacific cod in the Shumagin and Chirikof INPFC areas since 1978. This increase is attributed to both an actual increase in abundance and increased knowledge of the stock's distribution. Size compositions of Pacific cod sampled from Japanese longliners indicated that the 1977, 1978, and possibly the 1980 and 1982 year classes were relatively strong.

The 1984 NMFS triennial trawl survey provided a total biomass estimate of 539,000 mt for the Western and Central Regulatory Areas. There is no biomass estimate for the Eastern Regulatory Area. Biomasses from the Western and Central areas were estimated at 170,000 mt and 344,000 mt, respectively. These estimates are close to the 1:2 proportional allocation used to assign OYs in these areas.

Assuming that the 1984 biomass estimate approximates the virgin biomass level, and using a natural mortality estimate of 0.45, the potential yield model provides an estimate of MSY of 115,600 mt for the Western and Central Areas. Although this estimate does not include the Eastern Regulatory Area, the contribution by this area would be relatively small and probably add about 10,000 mt to MSY. The resulting potential yield is

125,600 mt, which is somewhat smaller than previous estimates of 133,000 mt and 142,000 mt based on earlier surveys.

5.1.2.3 Flounders

The flatfish fishery in the Gulf of Alaska began changing from a foreign dominated (97%) fishery in 1981 to a domestic (22%) and joint venture (73%) dominated fishery by 1985. The domestic fishery has continued expanding and received 83% of the flounder allocation in 1987. The total catch of flounders had declined 77% from a peak 15,800 mt in 1980 to 3,000 mt in 1985. The decline is attributed to foreign fisheries restrictions and does not represent a decline in abundance.

The 1984 NMFS triennial survey provided flounder biomass estimates of 282,000 mt, 1,357,000 mt, and 314,000 mt for the Western, Central, and Eastern Regulatory Areas, respectively. Based on information from the 1984 survey the maximum sustainable yield for flounders was estimated at 477,000 mt. Equilibrium yield at the F0.1 level was estimated at 270,000 mt. The resource is being harvested well below its estimated potential level.

5.1.2.4 Rockfish

This group consists of four assemblages separated on the basis of habitat and behavioral characteristics: slope, shelf demersal, shelf pelagic, and thornyhead rockfish.

Biomass estimates are lacking for the shelf demersal and shelf pelagic assemblages which are not assessed by the NMFS surveys. The lack of biological parameters and time series of catch and effort data precludes the estimation of potential sustainable yields for these two assemblages.

The slope assemblage was assessed by the 1984 NMFS triennial survey. Only species of the Pacific Ocean perch (POP) complex appeared in significant numbers. Biomass estimates were not made for the other species of the slope assemblage as they occurred in very low densities. The biomass estimate of the POP complex was 552,325 mt. Sebastes alutus comprised 60% or 334,909 mt of the biomass estimate. Although S. alutus comprised most of the survey biomass, this stock is at very low levels of abundance. Historical CPUE data from Japanese trawlers indicated a fairly steady decline in the abundance of S. alutus since 1965. The data indicated that the stock declined to extremely low levels by 1978. The maximum sustainable yield of S. alutus was estimated from a Virtual Population Analysis to be 95,525 mt. Stock Reduction Analysis estimated maximum sustainable yield to range from 17,160-30,849 mt.

The thornyhead rockfish group consists of two species: shortspine thornyheads (Sebastolobus alascanus) and longspine thornyheads (Sebastolobus altivelis). Shortspine thornyheads are the most abundant of the two species.

The catches of thornyheads have been declining since at least as early as 1980. Catches declined markedly since 1983 but the decline is attributed to foreign fisheries restrictions. Relative abundance indices from U.S.-Japan cooperative longline surveys indicated a 53% decrease over the period of 1980-84. Biomass was estimated to be 80,637 mt in the Gulf of Alaska based on the 1984 NMFS triennial survey.

The maximum sustainable yield of thornyhead rockfish has been estimated at 3,750 mt. Since the relative abundance index from the longline surveys has decreased, the stock is probably below the biomass level that will produce maximum sustainable yield.

The year 1988 is the first year rockfish will be managed by the four assemblages. Currently, estimates of the current condition and potential yields of the assemblages are lacking. Forthcoming information will be summarized in the Stock Assessment and Fishery Evaluation Documents provided yearly by the plan team.

5.1.2.5 Sablefish

The Gulf of Alaska sablefish resource has recovered from depleted conditions that existed during the late 1970s and rebuilding is no longer necessary. In response to the improved stock condition, the Gulf OY which was decreased drastically from 22,000 mt in 1977 to 8,980 mt by 1983, was increased to 20,000 mt for 1987. The recovery is evident in statistically significant increases in the relative population estimate obtained each year from the U.S.-Japan cooperative longline survey (Sigler and Fujioka, 1986), as well as by high catch rates reported in the fishery. The increase is due to a very abundant 1977 year class which occurred in the Gulf of Alaska, Bering Sea/ Aleutian region, and British Columbia waters, and an apparent successful 1980 or 1981 year class.

The 1984 NMFS triennial trawl survey provided a sablefish biomass estimate of 540,000 mt for the Gulf of Alaska. Over 40% of the biomass was estimated to be from depths less than 200 m where catch rates are highly variable and the fish are smaller. Thus, the biomass estimate is highly variable, not uniform in size composition, and must be applied cautiously.

Applying the generalized production model (Pella and Tomlinson, 1969), the maximum sustainable yield for the sablefish stock in the Gulf of Alaska was estimated by Low et al. (1976) and Low and Wespestad (1979) to range from 22,000-25,100 mt. Funk and Bracken (1984) re-estimated MSY under the assumption that fishing power gradually increased over the time period 1964 to 1977, which resulted in estimates ranging from 18,000-23,950 mt. It is noted that production models are most appropriate for relatively short-lived stocks in which annual recruitment is relatively stable. The lifespan of sablefish may be much longer than previously thought and the stock is apparently composed of infrequent strong year classes. Therefore, production modeling may be an over-simplification of the stock's dynamics.

5.1.2.6 Pacific halibut

The Pacific halibut resource continued to grow in 1986, increasing in coastwide abundance by 3.5% from 1985. Abundance increases occurred principally in the southeastern, Yakutat and Kodiak regions, with stable to slightly declining biomass in other regions. Age classes of 8- and 9-year-old halibut are in high abundance, which should add support to the exploitable adult stock over the next three years as they become fully recruited into the fishery.

Annual surplus production (ASP) is a basic measure of stock productivity and is defined as the excess of biomass above what is needed to replenish the population each year. The estimated total coastwide surplus in 1986 was estimated at 50,000 mt, of which approximately 40,000 mt remained after accounting for sport catch, bycatch, and wastage. The surplus production was estimated from 33,000-44,000 mt for the Gulf of Alaska, of which 25,000-36,000 mt remained after accounting for removals.

Estimates of available yield are based on constant exploitation yield (CEY), an approach where a fixed percentage of the adult stock is taken each year. At a total exploitation rate of 35%, total coastwide CEY estimates for 1986 ranged from 44,000-56,000 mt, and 31,000-51,000 mt in the Gulf of Alaska. Using a 28% exploitation rate to account for other losses, the estimated total coastwide setline CEY for 1986 is 39,000-46,000 mt. Setline CEY was estimated at 29,000-34,000 mt for the Gulf of Alaska.

Halibut harvest has continued an increasing trend through 1986 for the entire resource and for the Gulf of Alaska (Table 5.1). The 1986 fishery landed 41,600 mt (preliminary) and slightly exceeded the 40,200 mt catch limit; the Gulf of Alaska catch of 31,300 mt exceeded the catch limit by 1,300 mt.

The 1985 and 1986 ASP estimates are the highest values for the last 50 years and exceed the previous cyclical high point of that occurring in 1958. The current up cycle began around 1978. This upward trend has lasted eight years, although there are preliminary signs that it is now leveling off at the current high level. The previous plateau of ASP lasted for 22 years (from 1939 to 1960), and another long period of sustainable high yields is possible.

Estimates for ASP and CEY for 1986 are slightly near the estimated MSY of 48,900 mt for the entire halibut resource. However, in the Gulf of Alaska, ASP and CEY exceed the MSY of 31,000 mt.

Table 5.1 Commercial catch (mt) of Pacific halibut for all areas and for the Gulf of Alaska

| Year | Gulf of Alaska | Total |
|---|---|---|
| 1980 | 9,400 | 12,300 |
| 1981 | 11,300 | 15,600 |
| 1982 | 13,200 | 17,500 |
| 1983 | 17,100 | 23,200 |
| 1984 | 19,500 | 27,200 |
| 1985 | 24,800 | 33,900 |
| 1986 | 31,300 | 41,700 |

### 5.1.3 Description of habitat types in the Gulf of Alaska

Marine habitats within the Gulf of Alaska 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 Gulf of Alaska. More detailed information can be found in Alton (1981), Morris et al., (1983), Sharma (1979), and Rosenberg (1972).

The Gulf of Alaska 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 Gulf of Alaska. 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 Gulf of Alaska, 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 Gulf 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 Gulf of Alaska. 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 Gulf of Alaska 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 Gulf of Alaska and swings to the west and southwest off Kodiak Island and westward toward Unimak Pass. 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 degrees North, 138 degrees West. 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 Gulf of Alaska. 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 and rattails 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.

## 5.2 Description of the Fishery

The oldest fisheries in the Gulf of Alaska 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 Gulf 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 groundfish fisheries in the Gulf since the beginning of this century and directed most of their effort on halibut. Canadian fishing in the Gulf of Alaska ended in 1981 as a result of extended jurisdiction.

The Asian trawl fisheries on Gulf of Alaska groundfish began in 1962 when a Soviet fleet of 70 trawlers and support ships targeted on Pacific ocean perch, an abundant bottomfish of the outer continental shelf and upper slope. The next year Japanese fishing vessels of lesser numbers entered the Gulf and began directed fisheries on Pacific ocean perch and sablefish. The Asian trawl fisheries expanded rapidly in the 1960s. Pacific ocean perch (POP) was the first major specie targeted by foreign fisheries. The combined effort of the Asian fisheries on POP fisheries accounted for approximately 152,000 mt in 1966. The Gulf of Alaska 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 sufficient quantities for bycatch purposes were allocated by NPFMC. In addition to POP, foreign fisheries have targeted on pollock, sablefish, flounder, rockfish, Pacific cod, Atka mackerel and squid. Since 1985 directed foreign harvests have been limited to pollock and cod due to the rapid expansion of domestic fisheries capable of harvesting other species. It is anticipated that domestic fisheries will harvest all available groundfish quotas in the near future. The historical Gulf of Alaska groundfish catch of major species attributed to Japan, U.S.S.R., and Republic of Korea is presented in Tables 5.2a through 5.2c. Historically, groundfish have also been harvested in the Gulf of Alaska by Canada, Poland, and Mexico, but their catches have been relatively insignificant and their participation limited.

Table 5.2a Approximate groundfish catches of major species by Japanese vessels from the Gulf of Alaska (mt).

| Species | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pollock | 6,000 | 6,000 | 18,000 | 9,000 | 9,000 | 14,000 | 7,000 | 30,000 | 10,000 | NA | 41,000 | 26,000 | 30,000 |
| Pacific cod | -- | -- | -- | -- | -- | 1,000 | 3,000 | 3,000 | 3,000 | 3,000 | 1,000 | 9,000 | 10,000 |
| Flounder | 5,000 | 3,000 | 3,000 | 4,000 | 2,000 | 8,000 | 19,000 | 7,000 | 2,000 | NA | 15,000 | 14,000 | 12,000 |
| Pacific ocean perch/ other rockfish | 54,000 | 56,000 | 55,000 | 45,000 | 49,000 | 53,000 | 54,000 | 41,000 | 34,000 | 35,000 | 19,000 | 5,000 | 7,000 |
| Sablefish | 5,000 | 15,000 | 19,000 | 24,000 | 25,000 | 36,000 | 27,000 | 24,000 | 18,000 | 22,000 | 14,000 | 6,000 | 6,000 |

| Species | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|
| Pollock | 37,000 | 52,000 | 55,000 | 47,000 | 55,000 | 23,000 | trace |
| Pacific cod | 31,000 | 28,000 | 24,000 | 29,000 | 15,000 | 9,100 | 15,300 |
| Flounder | 12,000 | 9,000 | 7,000 | 7,000 | 2,000 | trace | trace |
| Pacific ocean perch/ other rockfish | 11,000 | 10,000 | 7,000 | 5,000 | 3,000 | trace | trace |
| Sablefish | 5,000 | 7,000 | 5,000 | 4,000 | 1,000 | trace | trace |

trace = less than 500 mt

Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea.

Table 5.2b Approximate groundfish catches of major species by Soviet vessels from the Gulf of Alaska (mt).

| Species | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|---|
| Pollock | -- | -- | -- | -- | trace | 20,000 | 30,000 | 31,000 | 38,000 |
| Pacific cod | -- | -- | -- | -- | trace | 3,000 | 3,000 | 2,000 | 3,000 |
| Flounder | -- | -- | -- | -- | -- | 2,000 | 1,000 | 2,000 | 2,000 |
| Pacific ocean perch/ other rockfish | 66,000 | 45,000 | 19,000 | trace | 30,000 | 24,000 | 4,000 | 17,000 | 10,000 |
| Sablefish | -- | -- | -- | trace | trace | 1,000 | 1,000 | trace | trace |
| Atka mackerel | -- | -- | -- | -- | -- | -- | 9,000 | 18,000 | 20,000 |

| Species | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|
| Pollock | | 40,000 | 42,000 | 14,000 | 41,000 |
| Pacific cod | 3,000 | trace | 1,000 | 1,000 | 2,000 |
| Flounder | | trace | trace | trace | 2,000 |
| Pacific ocean perch/ other rockfish | 10,000 | 2,000 | trace | 1,000 | 1,000 |
| Sablefish | trace | trace | trace | trace | trace |
| Atka mackerel | 20,000 | 19,000 | 18,000 | 10,000 | 10,000 |

trace = less than 500 mt

Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea.

Table 5.2c Approximate groundfish catches of major species by Korean vessels from the Gulf of Alaska (mt).

| Species | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pollock | | 36,000 | 27,000 | 23,000 | 27,000 | 39,000 | 38,000 | 32,000 | 39,000 | 9,000 |
| Pacific cod | | -- | 1,000 | 1,000 | 2,000 | 7,000 | 2,000 | 1,000 | 1,000 | trace |
| Flounder | | -- | trace | 1,000 | 2,000 | 5,000 | 2,000 | 3,000 | 1,000 | trace |
| Pacific ocean perch/ other rockfish | | trace | 3,000 | trace | trace | 2,000 | 1,000 | trace | trace | trace |
| Sablefish | | 2,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | trace | trace |

trace = less than 500 mt

Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea.

5.2.1 Domestic Fisheries

Domestic commercial groundfish fisheries in the Gulf of Alaska began in the late 1960s and early 1970s and have steadily increased since 1978. Including both the joint venture and shorebased fisheries, the catch have increased substantially each year and by 1984 the total domestic catch (DAH) was 222,000 mt. In 1985 the DAH increased to approximately 286,000 mt. Currently, the Gulf of Alaska harvest represents 35% to 40% of the total domestic groundfish catch off Alaska. The domestic annual processed catch (DAP) and the joint venture catch (JVP) for the Gulf of Alaska during 1967 to present are provided in Table 5.3.

U.S. fishermen are involved in several Gulf of Alaska groundfish fisheries: sablefish setline, pot, and trawl fishery, bait fisheries, a pollock fishery, a Pacific cod fishery, a Pacific ocean perch fishery, and small fisheries including flounders, Atka mackerel, and rockfish. Many groundfish fishermen are also involved in the fishery for halibut.

5.2.1.1 North American Halibut Fishery

The commercial fishery for halibut began in coastal waters off Washington and British Columbia and expanded from there into the Gulf of Alaska 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 Gulf of Alaska reached an all-time high of 31,400 mt (Table 5.4). High annual catches continued until 1966 followed by a decline so that by 1977 only 9,200 mt were landed. From 1975 to 1981 the average catch of halibut was 10,500 mt and ranged from 11,900 mt in 1975 to 9,200 mt in 1977. In 1982 the catch of halibut increased to 13,800 mt. Since then, rapid stock rebuilding occurred, and 1986 landings in the Gulf of Alaska reached 31,250 mt.

As a result of the U.S. and Canada extending their jurisdiction over fishery resources out to 200 miles, the Halibut Convention was amended by a protocol in 1979. This protocol called for a phasing out of each country fishing in the other's waters over a two-year period starting in 1979, and required dividing the catch in IPHC Area 2 between the U.S. and Canada at a proportion of 40% to 60%. The IPHC dropped the 40-60 split in 1985 and has since set quotas in Area 2 on a biological basis.

The greatest proportion of halibut taken by U.S. and Canadian nationals in the northeast Pacific and eastern Bering Sea came from the Gulf of Alaska. During the period 1955-84, between 65% and 80% of the total halibut landed annually came from the Gulf of Alaska (Table 5.4). In 1981 Canadian halibut vessels were excluded from the Gulf of Alaska. The 252 mt caught by Canada in 1981 was attributed to research studies. U.S. fishermen have harvested 100% of the total Gulf of Alaska halibut catch since 1982.

A combination of factors may have brought about the decrease in the abundance of halibut which began in the 1960s. The catch limits during the period of peak production may have been set too high for the North American fishery. A reduction in the number of young fish being recruited to the fishery became evident in the mid-1960s and continued through 1975. The intensive foreign trawl fisheries in the Gulf of Alaska, active since 1962, aggravated this decline by catching juvenile halibut incidentally to their target species. Conditions of the stocks both in abundance of young recruits and in availability of fish began improving in the late 1970s. According to IPHC migratory catch-age analysis, from 1967 to 1983, halibut stocks exhibited a period of decline during the mid-1970s and then a period of increasing abundance during the late 1970s. In 1980, IPHC's juvenile surveys and commercial catch data indicated that the abundance of juveniles in the Gulf of Alaska was the highest in any year since the survey began in 1963. Current IPHC data indicates that halibut stocks in the Gulf of Alaska have rebuilt to MSY levels.

Table 5.3 United States domestic and joint venture landings of Gulf of Alaska groundfish according to species from 1965-1986 (in metric tons).

| | | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pollock | DAP | | | | | | | | | | | | 60 | 181 |
| | JVP | | | | | | | | | | | | | |
| | Total | | | | | | | | | | | | 60 | 181 |
| Pacific cod | DAP | 14 | 5 | 4 | | 21 | 14 | 62 | | 58 | 71 | 127 | 217 | 164 |
| | JVP | | | | | | | | | | | | | |
| | Total | 14 | 5 | 4 | | 21 | 14 | 62 | | 58 | 71 | 127 | 217 | 164 |
| Flounders | DAP | | | | 4 | 7 | 1 | | 69 | 450 | 325 | 2 | 153 | 684 |
| | JVP | | | | | | | | | | | | | |
| | Total | | | | 4 | 7 | 1 | | 69 | 450 | 325 | 2 | 153 | 684 |
| Pacific ocean perch | DAP | | | | | | 484 | 20 | | | | 94 | 126 | 12 |
| | JVP | | | | | | | | | | | | | |
| | Total | | | | | | 484 | 20 | | | | 94 | 126 | 12 |
| Sablefish | DAP | | | | 3 | | 13 | 273 | 726 | 866 | 777 | 1,088 | 803 | 823 |
| | JVP | | | | | | | | | | | | | |
| | Total | | | | 3 | | 13 | 273 | 726 | 866 | 777 | 1,088 | 803 | 823 |
| Atka mackerel | DAP | | | | | | | | | | | | | |
| | JVP | | | | | | | | | | | | | |
| | Total | | | | | | | | | | | | | |
| Other rockfish | DAP | | | | | | | | 26 | 111 | 23 | | | 37 |
| | JVP | | | | | | | | | | | | | |
| | Total | | | | | | | | 26 | 111 | 23 | | | 37 |
| Squid | DAP | | | | | | | | | | | | | |
| | JVP | | | | | | | | | | | | | |
| | Total | | | | | | | | | | | | | |
| Other species | DAP | | | 26 | 39 | 24 | 251 | 16 | | 64 | 401 | 48 | 158 | 128 |
| | JVP | | | | | | | | | | | | | |
| | Total | | | 26 | 39 | 24 | 251 | 16 | | 64 | 401 | 48 | 158 | 128 |
| GRAND TOTAL | | 14 | 5 | 30 | 46 | 52 | 763 | 397 | 906 | 1,461 | 1,574 | 1,359 | 1,517 | 2,029 |

Table 5.3 continued

| | | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pollock | DAP | 1,064 | 2,031 | 2,004 | 783 | 2,237 | 113 | 330 | 22,012 | 10,088 |
| | JVP | | 582 | 1,847 | 16,836 | 74,294 | 134,079 | 199,539 | 237,860 | 62,587 |
| | Total | 1,064 | 2,613 | 3,851 | 17,619 | 76,531 | 134,182 | 199,869 | 259,872 | 72,675 |
| Pacific cod | DAP | 791 | 983 | 974 | 990 | 4,100 | 4,086 | 2,137 | 3,090 | 5,344 |
| | JVP | | 712 | 465 | 58 | 194 | 2,364 | 4,272 | 2,266 | 1,361 |
| | Total | 791 | 1,695 | 1,439 | 1,048 | 4,294 | 6,450 | 6,409 | 5,356 | 6,705 |
| Flounders | DAP | 861 | 141 | 349 | 259 | 163 | 170 | 307 | 752 | 1,263 |
| | JVP | | 77 | 208 | 18 | 18 | 2,648 | 3,038 | 2,447 | 976 |
| | Total | 861 | 218 | 557 | 277 | 181 | 2,818 | 3,345 | 3,199 | 2,239 |
| Pacific ocean perch | DAP | 7 | 83 | 24 | 1 | 2 | 7 | 89 | 863 | 2,821 |
| | JVP | | 58 | 20 | *TR | 3 | 1,978 | 1,655 | 254 | 36 |
| | Total | 7 | 141 | 44 | 1 | 5 | 1,985 | 1,744 | 1,117 | 2,857 |
| Sablefish | DAP | 1,235 | 2,320 | 1,574 | 1,153 | 1,928 | 2,428 | 8,564 | 11,622 | 20,748 |
| | JVP | | 20 | 20 | | 1 | 279 | 411 | 226 | 45 |
| | Total | 1,235 | 2,340 | 1,594 | 1,153 | 1,929 | 2,707 | 8,975 | 11,848 | 20,793 |
| Atka mackerel | DAP | | | | | | | 0 | 0 | 0 |
| | JVP | | 1 | 3 | | | 789 | 576 | 1,846 | 4 |
| | Total | | 1 | 3 | | | 789 | 576 | 1,846 | 4 |
| Other rockfish | DAP | 90 | 247 | 204 | 290 | 257 | 349 | 584 | 389 | 3,701 |
| | JVP | | 38 | 8 | | | 297 | 284 | 45 | 29 |
| | Total | 90 | 285 | 212 | 290 | 257 | 646 | 868 | 434 | 3,730 |
| Squid | DAP | | | | | | 0 | 0 | 0 | 0 |
| | JVP | | | | | | 4 | 5 | 7 | 9 |
| | Total | | | | | | 4 | 5 | 7 | 9 |
| Other species | DAP | 1,318 | 284 | 532 | 193 | 109 | 77 | TR | TR | 260 |
| | JVP | | | | 43 | 313 | 386 | 278 | 2,246 | 251 |
| | Total | 1,318 | 284 | 532 | 236 | 422 | 463 | 278 | 2,246 | 511 |
| GRAND TOTAL | | 5,366 | 7,577 | 8,232 | 20,624 | 83,619 | 150,033 | 222,069 | 285,925 | 109,523 |

*TR - Trace, less than 1 metric ton. Source: For Years 1965-1978: All Nation Removals of Groundfish, Herring and Shrimp from the Eastern Bering Sea and Northeast Pacific Ocean, 1964-1980. For Years 1979 to present: ADF&G Annual Reports and PacFIN Data Network

Table 5.4 Catch of Pacific halibut by U.S. and Canadian vessels in the Gulf of Alaska (1955-1986). Catch in metric tons (round weight).

| Year | Gulf of Alaska U.S. | % | Gulf of Alaska Canada | % | Total (A) | Total for N.E. Pacific and E. Bering Sea (B) | % | A/B |
|---|---|---|---|---|---|---|---|---|
| 1955 | 17,394 | (75) | 5,659 | (25) | 23,053 | 34,702 | | (66) |
| 1956 | 21,118 | (77) | 6,476 | (23) | 27,594 | 40,171 | | (69) |
| 1957 | 19,172 | (75) | 6,487 | (25) | 25,659 | 36,712 | | (70) |
| 1958 | 18,280 | (70) | 7,855 | (30) | 26,135 | 38,917 | | (67) |
| 1959 | 20,687 | (69) | 9,204 | (31) | 29,891 | 42,956 | | (70) |
| 1960 | 18,658 | (66) | 9,634 | (34) | 28,292 | 43,198 | | (65) |
| 1961 | 20,296 | (69) | 9,104 | (31) | 29,400 | 41,792 | | (70) |
| 1962 | 20,388 | (65) | 11,008 | (35) | 31,396 | 45,163 | | (70) |
| 1963 | 16,917 | (60) | 11,502 | (40) | 28,419 | 42,976 | | (66) |
| 1964 | 14,049 | (51) | 13,297 | (49) | 27,341 | 36,067 | | (76) |
| 1965 | 16,536 | (55) | 13,422 | (45) | 29,958 | 38,113 | | (79) |
| 1966 | 16,763 | (56) | 13,116 | (44) | 29,879 | 37,413 | | (80) |
| 1967 | 16,246 | (63) | 9,394 | (37) | 25,640 | 33,315 | | (77) |
| 1968 | 10,503 | (47) | 11,807 | (53) | 22,310 | 29,316 | | (76) |
| 1969 | 13,935 | (53) | 12,550 | (47) | 26,485 | 35,156 | | (75) |
| 1970 | 14,984 | (58) | 11,065 | (42) | 26,049 | 33,143 | | (79) |
| 1971 | 12,103 | (56) | 9,386 | (44) | 21,489 | 28,146 | | (76) |
| 1972 | 11,496 | (60) | 7,578 | (40) | 19,074 | 25,871 | | (74) |
| 1973 | 10,000 | (68) | 4,753 | (32) | 14,753 | 19,148 | | (77) |
| 1974 | 7,772 | (81) | 1,855 | (19) | 9,267 | 12,854 | | (75) |
| 1975 | 9,058 | (76) | 2,887 | (24) | 11,945 | 16,660 | | (72) |
| 1976 | 8,658 | (73) | 3,126 | (27) | 11,784 | 16,611 | | (71) |
| 1977 | 7,077 | (77) | 2,172 | (23) | 9,249 | 13,193 | | (70) |
| 1978 | 7,147 | (73) | 2,589 | (27) | 9,736 | 13,265 | | (73) |
| 1979 | 8,719 | (87) | 1,330 | (13) | 10,049 | 13,590 | | (74) |
| 1980 | 8,162 | (86) | 1,324 | (14) | 9,486 | 13,191 | | (72) |
| 1981 | 11,276 | (98) | 252 | ( 2) | 11,528 | 15,524 | | (84) |
| 1982 | 13,781 | (100) | --- | ( 0) | 13,781 | 17,500 | | (79) |
| 1983 | 18,290 | (100) | --- | ( 0) | 18,290 | 23,156 | | (79) |
| 1984 | 20,080 | (100) | --- | ( 0) | 20,080 | 27,130 | | (74) |
| 1985 | 25,653 | (100) | --- | ( 0) | 25,653 | 33,852 | | (76) |
| 1986 | 31,250 | (100) | --- | ( 0) | 31,250 | 41,602 | | (75) |

Source: I.P.H.C.

Recovery of the halibut stock has been attributed to a variety of factors. One of the most important has been an upper limit on the amount of halibut killed as bycatch to other fisheries. Reduction of foreign fishing in the Gulf of Alaska significantly relieved the bycatch mortality. Reduction in quotas allowed more halibut to escape the fishery and help rebuild the stock. Improved environmental conditions may have also contributed to the increased abundance.

5.2.1.1.1 Vessels and Gear

The halibut fleet has undergone major changes during the last decade. Canada introduced license limitation to its halibut fleet in 1979, which resulted in a two-thirds reduction in fleet size. A moratorium was proposed for United States halibut vessels, but was not enacted. However, the proposal had the effect of stimulating fleet size as fishermen attempted to secure their claims of a history of halibut fishing. This growth was further influenced by the fact that other fisheries were already limited as to the numbers of vessels that could participate, whereas halibut was an open and improving fishery. Approximately 2,800 vessels fished for halibut off Alaska in 1986.

Commencing in 1984, all commercial and recreational-charter vessels that fish for halibut must have an annual license issued by the International Pacific Halibut Commission. Prior to that time, only vessels that fished with setline gear, and were five net tons or larger required a Commission license. The mainstay of the halibut fleet traditionally consisted mainly of schooners and the more versatile seine-type vessels that can be used for trawling and seining in other fisheries. However, the modern halibut fleet now includes highly efficient crab boats and many smaller vessels originally built for the salmon gillnet fishery and small boat seine fisheries. The smaller, one-to-three person boats fish for halibut with a variety of hook and line gear. Although vessels less than 20 net tons constitute nearly 85% of the halibut fleet they caught only 38% of the catch in 1984.

Setline vessels use a unit of gear called a "skate" which consists of a longline on which branchlines or gangions, each with a hook, are spaced at regular intervals. Traditionally, gangions were permanently fixed to the groundline; many vessels now use removable gangions that snap onto the groundline. The original "J" shaped hooks common through 1982-83 have been replaced by the "circle" hooks which catch halibut about twice as efficiently as J-hooks. Skates are generally about 550 m in length, and several of these are joined end-to-end to form a 3-4 km long "string" which is set on the sea bottom with baited hooks. The gear is left on the bottom for periods of 4 to 30 hours. Fishing usually is conducted at depths between 80-275 m, but may take place as shallow as 27 m or as deep as 550 m.

5.2.1.1.2 Catch and Effort

During the early years of the Gulf of Alaska fishery the catch of halibut by U.S. nationals dwarfed that of the Canadians. In 1929 the U.S. catch of 24,100 mt was the highest ever recorded from the Gulf of Alaska by U.S. fishermen. From 1930 to 1945 the U.S. annual catch averaged 19,100 mt and that of the Canadians about 1,167 mt. After 1945 the Canadian catch gradually increased and by the 1960s and early 1970s between 37% and 53% of the total Gulf of Alaska annual halibut catches were landed by Canadians. Their peak catch was about 13,400 mt in 1965. During the early and mid-1970s, Canadian vessels comprised between 40% and 21% of the total Gulf of Alaska annual halibut catch. Canadian catches continued to decrease from 22% in 1977 to 12% in 1980. In 1981, Canadian halibut vessels were excluded from the Gulf of Alaska.

U.S. catches were relatively high during the years 1955 to 1962 but have gradually declined, to an all-time low of some 9,249 mt in 1977 (Table 5.3). Landings gradually increased for several years before the rapid increase from 1984-86. Catch per effort reflected the trend in landings and increased by a factor of three in the Gulf when compared to the period 1965-1985 (Table 5.5).

Table 5.5 Preliminary CPUE estimates for Pacific halibut in the Gulf of Alaska. Data are standardized to "J" hook equivalence and adjusted to equal catchability between regulatory areas (Source: IPHC).

CPUE by IPHC Regulatory Area (lbs/skate0

| Year | 2C | 3A | Cherikof Shumagin |
|---|---|---|---|
| 1974 | 57.2 | 64.7 | 56.7 |
| 1975 | 53.4 | 66.0 | 67.9 |
| 1976 | 42.2 | 59.7 | 64.6 |
| 1977 | 45.2 | 61.2 | 73.3 |
| 1978 | 56.4 | 78.1 | 52.9 |
| 1979 | 80.3 | 85.9 | 36.7 |
| 1980 | 79.4 | 118.5 | 113.4 |
| 1981 | 99.5 | 114.0 | 133.9 |
| 1982 | 129.4 | 124.6 | 136.7 |
| 1983 | 124.7 | 158.9 | 152.5 |
| 1984 | 119.5 | 187.6 | 160.5 |
| 1985 | 128.8 | 182.4 | 191.0 |
| 1986 | 107.8 | 187.2 | 146.5 |

5.2.1.2 Sablefish Fishery

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 Gulf of Alaska with the entire quota being taken by domestic fishermen. In 1983 the sablefish quota was reduced to a range of 8,230-9,478 mt to provide for accelerated rebuilding of this resource. As a result of this program, the sablefish resource has recovered and the quota was increased in 1986 to 15,000 mt. This fishery, now fully U.S. utilized, has experienced increasing effort with the sablefish harvest now taken in a relatively short period. Currently, the three forms of legal gear for this fishery are hook and longline, pots, and trawl. However, due to increasing gear conflicts between longline and pot gear, time/area restrictions and gear regulations have been implemented which will eventually phase out the use of pot gear.

5.2.1.2.1 Vessels and Gear

In 1985 about 200 vessels harvested sablefish with 89% of the catch being taken by hook and longline gear. Technological advances are presently changing the fishery for sablefish. In recent years Alaskan fishermen have switched from J-hooks to circle-hooks and have shortened their spacing along the ground line. Most of the fish are dressed at sea and packed in ice. Some vessels process and freeze their catch on board.

5.2.1.2.2 Catch and Effort

Since the inception of the Alaska sablefish fishery, demand has dictated catch level more than has stock size, with rapid increases in catch during the 1940s because of the expanded market for the vitamins from liver. Harvest levels gradually decreased after 1945 mainly because of the declining market. However, catch per skate, derived from logbook records from the early 1930s through 1960, also indicates a consistent downward trend. The data also indicates a marked decline in the average size of fish during this period. Landings and effort during the late 1960s and early 1970s reached a record low primarily because of a movement of fishermen into other fisheries as a result of poor prices and depressed stock levels in favored fishing areas. Effort increased considerably in 1972 in conjunction with rising prices. In 1973 the State of

Alaska instituted a quota of one million pounds (454 mt) for the northern districts of southeastern Alaska to stop the decline of stocks in those districts. During 1974, higher costs, relatively low prices, and poor stock condition all were instrumental in keeping the effort down. The sablefish resource of the Gulf of Alaska generally remained depressed until the mid-1980s when catch rates in the fishery and in surveys improved due to the recruitment of successful year classes. This coincided with the regulated removal of foreign competition for sablefish landings from the Gulf, providing increased foreign markets and attractive prices to the domestic fleet.

5.2.1.3 Bait Fishery

The Gulf of Alaska bait fishery arose mainly in response to the need for bait in the growing crab fisheries of Alaska. The halibut fishery also required substantial amounts of groundfish for bait. The bait fishery occurs from Prince William Sound west to the Aleutians, but some two-thirds of the catch is landed in Kodiak. The catch consists largely of pollock, Pacific cod, and various flounder species.

5.2.1.3.1 Vessels and Gear

Groundfish for bait was taken primarily as a bycatch in the Kodiak shrimp fishery during the early to mid-1970s. Several shrimp fishermen invested in groundfish gear in order to target on various bait species. This action appeared to initiate a trend among shrimp vessels of carrying trawls with large mesh web aboard so that concentrations of groundfish encountered in the shrimp grounds could be fished when bait prices were high. Currently, the bait fishery is characterized by trawlers and longline vessels which target on groundfish species.

5.2.1.3.2 Catch and Effort

The ability to measure the catch of groundfish for bait is limited. The unrecorded catch of bait may be equal to or exceed the recorded catch. Large amounts of cod are caught and utilized on board halibut vessels. Bait is also transferred to crab and halibut vessels on the fishing grounds. From 1972 to 1976 the catch of groundfish for bait increased from 96 mt to 303 mt. Catches continued to increase through the late 1970s and by 1982 accounted for 1,059 mt. The catch of groundfish for bait has decreased in recent years due to a reduction in crab harvests.

5.2.1.4 Trawl Fishery

The domestic pollock fishery began in the Gulf of Alaska 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. Since then wholly domestic harvests have fluctuated from a low of 113 mt in 1983 to a high of 9,080 mt in 1985 (Table 5.3). Trawl gear has become the principle gear type that is utilized in the pollock fishery; trawl gear consists primarily of beam and otter trawls. A large majority of the domestic pollock fisheries is concentrated in the Central Regulatory Area, specifically in Shelikof Strait, although quantities of pollock are landed from the Western area.

Pacific cod have been landed domestically since the late 1950s and early 1960s. The Pacific cod fishery didn't really begin to develop until 1978. From 1965 to 1977 the average annual catch was about 58 mt. In 1978 the catch increased to 791 mt and during the next three years increased to 990 mt. In 1982 the catch increased to about 4,100 mt. The Kodiak INPFC area accounted for 97% of the total Gulf of Alaska domestic Pacific cod catch. The Pacific cod fishery utilizes two types of gear, trawls and longlines. In 1983 about 3,900 mt of Pacific cod were landed by domestic trawlers; domestic longline vessels landed approximately 40 mt the same year.

5.2.1.5 Joint Ventures

The development of joint ventures has rapidly expanded since their beginning in 1979. Joint venture processing (JVP) are fisheries that are conducted by American trawlers that deliver their catches directly to

foreign processing ships on the fishing grounds. JVP catches have exceeded DAP since 1980. Figure 5.1 provides a Gulfwide summary of annual groundfish catches by U.S. vessels in the FCZ from 1978 to 1986. Gulf of Alaska joint ventures target primarily on pollock, Pacific cod, Atka mackerel, and flounder. Other species, including Pacific ocean perch, sablefish, and other rockfish that are caught in small quantities are allocated to joint ventures for bycatch purposes only. These incidentally caught species are fully utilized by domestic fishermen.

5.2.1.5.1 Vessels and Gear

From 1979 to 1984 the number of domestic trawlers participating in the Gulf of Alaska joint ventures increased from 3 to 54 vessels. The use of trawlers in the 60-100 foot range with main engines of 300-850 horsepower (hp) has proven operationally and economically viable in several Alaska groundfish joint ventures (NPFMC Document #28). The domestic fleet presently participating in Gulf of Alaska joint ventures stems primarily from upgrading west coast groundfish trawlers, conversion of crabbers, or from construction of fairly new and specialized trawlers (NPFMC Document #28).

5.2.1.5.2 Catch and Effort

The total Gulf of Alaska joint venture catch increased from about 1,500 mt in 1979 to about 241,000 mt in 1985 (Table 5.3). In 1979 pollock and Pacific cod represented 85% of the total Gulf of Alaska joint venture catch. Pollock became the principle target species in 1980. The catch of pollock increased from about 16,900 mt in 1981 to about 232,000 mt in 1985 and comprises approximately 99% of the joint venture catch. The Shelikof Strait pollock roe fishery accounted for 94% of the pollock joint venture catch from 1982 to 1985.

5.2.2 Foreign Fisheries

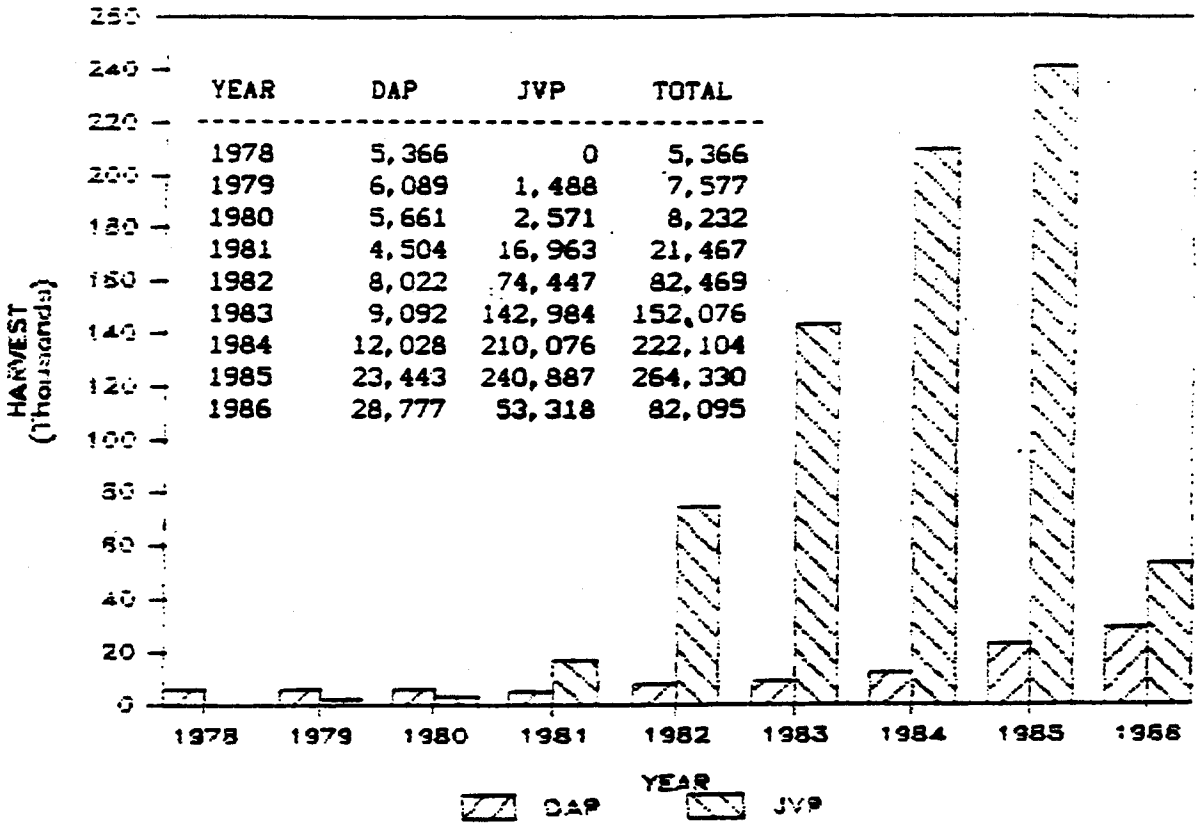
5.2.2.1 Canada

Canadians began fishing Alaskan waters around the turn of the century when they participated to a very limited extent in the former setline fishery for cod. It is not clear whether such participation occurred prior to 1900 during the early period of the cod fishery, but it is known that one or two Canadian operations for cod took place off Alaska about 1902 and 1913 (Forrester, et al., in press). Information on the extent and area of origin of these Canadian catches of cod is not available so it cannot be determined whether they were caught in the Gulf of Alaska or in the Bering Sea.

Canadian involvement in the North American setline fishery for halibut in the Gulf of Alaska dates back to the 1920s and presently continues off British Columbia.

Canadian vessels also took relatively small amounts of other groundfish (cod, lingcod, and rockfish) entirely from southeastern Alaska waters.

Figure 5.1




| YEAR | DAP | JVP | TOTAL |
|---|---|---|---|
| 1978 | 5,366 | 0 | 5,366 |
| 1979 | 6,089 | 1,488 | 7,577 |
| 1980 | 5,661 | 2,571 | 8,232 |
| 1981 | 4,504 | 16,963 | 21,467 |
| 1982 | 8,022 | 74,447 | 82,469 |
| 1983 | 9,092 | 142,984 | 152,076 |
| 1984 | 12,028 | 210,076 | 222,104 |
| 1985 | 23,443 | 240,887 | 264,330 |
| 1986 | 28,777 | 53,318 | 82,095 |

Figure 5.1 Summary of annual groundfish harvests by U.S. vessels in the Gulf of Alaska, 1978-1986.

Source: DAP 1978-1981 from trade journals
DAP 1982-1986 from PACFIN
JVP from NMFS

5.2.2.1.1 Vessels and Gear

Canadian fisheries on Pacific halibut are carried out by small longline vessels (see Section 5.2.1.1.1 on North American halibut setline fishery). Other groundfish are harvested by several types of small vessels.

5.2.2.1.2 Catch and Effort Trends

The annual average Canadian harvest of groundfish from the Gulf of Alaska during the period 1963-1981 was reported as being 7,020 mt of halibut and 118 mt of other groundfishes. The annual Canadian harvest of halibut from the Gulf steadily increased from less than 2,600 mt prior to 1947 to a maximum of 13,400 mt in 1965. Since 1973 their annual catch has been less than 4,000 mt and has comprised between 0% and 32% of the total U.S.-Canadian halibut catch in the Gulf for the years 1973 through 1983. Canada was excluded from fishing in the Gulf of Alaska in 1981.

5.2.2.2 U.S.S.R.

Soviet fishing vessels first appeared off Alaska in the eastern Bering Sea in 1959, and by 1962 Soviet trawling operations had expanded into the Gulf of Alaska. Their principal target species was Pacific ocean perch, but with the decline of these stocks in the late 1960s and early 1970s, the Soviet fisheries shifted to other less heavily exploited fish, such as pollock, Atka mackerel, and flounders (see Table 5.2b). In contrast to Japan's fishery, which includes both trawls and longlines, all fishing by the U.S.S.R. in the Gulf of Alaska has been with trawls.

5.2.2.2.1 Vessels and Gear

The U.S.S.R., more than any other nation, has utilized the expeditionary or flotilla concept in its fishing operations off the Pacific and Bering Sea coasts of the United States. This involves the deployment of several kinds of vessels in support of its catcher fleet. In the Gulf of Alaska these support vessels have included factory ships for receiving and processing catches; refrigerator transports to replenish stores aboard the catcher vessels and to receive, freeze, and transport their catches to the homeland; oil tankers; tugs; patrol vessels; passenger ships and research vessels. Refrigerator transports are the mainstay of the support operations and some are upwards of 200 meters in length and 25,000 gross tons or more. A large refrigerator transport, 25,000 gross tons, has a hold capacity of about 12,000 tons of frozen products, which is equivalent to the capacity loads of about 13 of the factory stern trawlers.

Side trawlers (small) and factory stern trawlers (large) are the two types of catcher vessels which have been employed by the U.S.S.R. (Hitz, 1968). Side trawlers shoot and haul their nets over the side of the vessel and are smaller and less versatile than the factory trawlers which deploy their nets over the stern. Three classes of side trawlers have been used. Smallest and oldest of the side trawlers is the SRT class of 265-355 gross tons and a crew of 22 to 26. Next largest of the side trawlers is the SRTR class of refrigerated medium trawlers of 505-630 gross tons and a crew of 26-28. Largest of the refrigerated side trawlers is the SRTM class of around 700 gross tons with a crew of about 30. Side trawlers, particularly SRTMs, often operate independently by processing and freezing their own catches; however, they also may offload their catches to factory ships for processing. Side trawlers were being phased out of Soviet operations off Alaska during the mid-1970s.

Factory stern trawlers are the largest of the catcher vessels used by the Soviets. They typically process and freeze their own catches. Because of their larger size and more efficient layout for handling the net over the stern, factory trawlers are capable of fishing under worse weather conditions than side trawlers. The most common factory stern trawler in use off the Pacific and Bering Sea coasts of the United States has been the so-called BMRT of 3,170 gross tons and a crew of about 90. In recent years a new class of factory stern trawler, the RTM, has come into use. It is of the same general size as a BMRT but has the advantage of a larger deck area aft for handling gear and fish. Recent Soviet Gulf of Alaska groundfish harvests are presented in Tables 5.6a through 5.6j, according to species and vessel type.

Table 5.6a Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Pollock

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 6,743 | 5,512 | 8,622 | 12,300 | 14,517 | 10,582 | 11,655 |
| Med Trawler | 1,461 | 15,746 | 20,426[1/] | 30,408[1/] | 34,021[1/] | 31,507[1/] | 45,124[1/] |
| Lrg Trawler | 17,796 | 10,625 | 8,442[2/] | 8,784[2/] | 6,244[2/] | 5,281[2/] | 1,033[2/] |
| Longliner | 94 | 37 | 407 | 394 | 265 | 354 | 63 |
| TOTAL | 26,094 | 31,920 | 37,897 | 51,886 | 55,047 | 47,724 | 57,875 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 41,056 | 17,300 | 37,001 | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 41,056 | 17,300 | 37,001 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 1,227 | 19,551 | 13,085[2/] | 39,886[2/] | -- | -- | 2,832 |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 1,227 | 19,551 | 13,085 | 39,886 | -- | -- | 2,832 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 4,896 | 3,178 | 4,055 | 2,260 |
| Lrg Trawler | 27,052 | 25,739 | 25,005[2/] | 33,656[2/] | 34,389 [2/] | 29,578[2/] | 36,293[2/] |
| Longliner | -- | -- | 8 | -- | -- | -- | -- |
| TOTAL | 27,052 | 25,759 | 25,013 | 38,552 | 37,567 | 33,633 | 38,553 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 6,926 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 1,751 | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 8,677 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6b Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Pacific cod

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 433 | 312 | 1,525 | 1,032 | 702 | 530 | 164 |
| Med Trawler | 346 | 385 | 558[1/] | 636[1/] | 226[1/] | 195[1/] | 205[1/] |
| Lrg Trawler | 1,267 | 187 | 727[2/] | 825[2/] | 1,024[2/] | 1,164[2/] | 303[2/] |
| Longliner | 6,800 | 9,545 | 27,771 | 25,274 | 22,499 | 26,642 | 14,579 |
| TOTAL | 8,846 | 10,429 | 30,581 | 27,767 | 24,451 | 28,531 | 15,251 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 1,140 | 835 | 1,942[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 1,140 | 835 | 1,942 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 14 | 127 | 54[2/] | 135[2/] | -- | -- | 10[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 14 | 127 | 54 | 135 | -- | -- | 10 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 988 | 237 | 68 | 50 |
| Lrg Trawler | 1,369 | 844 | 1,657[2/] | 6,074[2/] | 2,249[2/] | 1,127[2/] | 586 |
| Longliner | -- | -- | 9 | 3 | TR | 51 | -- |
| TOTAL | 1,369 | 844 | 1,666 | 7,065 | 2,486 | 1,246 | 636 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 883 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 56 | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 939 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6c Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Flounder

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 3,866 | 4,456 | 3,952 | 3,714 | 1,632 | 2,297 | 730 |
| Med Trawler | 884 | 5,974 | 1,270[1/] | 789[1/] | 229[1/] | 204[1/] | 310[1/] |
| Lrg Trawler | 8,632 | 1,563 | 6,263[2/] | 4,462[2/] | 4,450[2/] | 3,751[2/] | 978[2/] |
| Longliner | 428 | 376 | 439 | 437 | 291 | 634 | 171 |
| TOTAL | 13,810 | 12,369 | 11,924 | 9,402 | 6,602 | 6,886 | 2,189 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 196 | 369 | 1,838[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 196 | 369 | 1,838 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 13 | 19 | TR[2/] | 15[2/] | -- | -- | 23[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 13 | 19 | TR | 15 | -- | -- | 23 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 484 | 171 | 88 | 29 |
| Lrg Trawler | 296 | 604 | 1,734[2/] | 4,542[2/] | 2,211[2/] | 2,553[2/] | 790[2/] |
| Longliner | -- | -- | -- | -- | 2 | 3 | -- |
| TOTAL | 296 | 604 | 1,734 | 5,026 | 2,384 | 2,644 | 819 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 108 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 5 | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 113 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6d Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Pacific ocean perch

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 1,289 | 2,122 | 3,848 | 3,358 | 1,923 | 1,442 | 883 |
| Med Trawler | 250 | 4,499 | 328[1/] | 356[1/] | 80[1/] | 58[1/] | 26[1/] |
| Lrg Trawler | 2,959 | 690 | 6,494[2/] | 6,514[2/] | 5,078[2/] | 3,448[2/] | 1,569[2/] |
| Longliner | 49 | 86 | 100 | 116 | 75 | 59 | 16 |
| TOTAL | 4,547 | 7,397 | 10,770 | 10,344 | 7,156 | 5,007 | 2,494 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 570 | 1,065 | 1,239[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 570 | 1,065 | 1,239 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 4 | 5 | 30[2/] | 49[2/] | -- | -- | 14[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 4 | 5 | 30 | 49 | -- | -- | 14 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 253 | 109 | 11 | 7 |
| Lrg Trawler | 3,049 | 809 | 389[2/] | 1,528[2/] | 723[2/] | 395[2/] | 84 |
| Longliner | -- | 16 | 19 | 3 | TR | 2 | -- |
| TOTAL | 3,049 | 825 | 408 | 1,531 | 831 | 408 | 91 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 423 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 33 | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 456 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6e Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Sablefish

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 101 | 154 | 287 | 222 | 194 | 121 | 49 |
| Med Trawler | 27 | 266 | 134[1/] | 86[1/] | 41[1/] | 45[1/] | 31[1/] |
| Lrg Trawler | 226 | 51 | 314[2/] | 359[2/] | 181[2/] | 170[2/] | 28[2/] |
| Longliner | 6,104 | 5,448 | 4,096 | 6,244 | 4,505 | 3,998 | 740 |
| TOTAL | 6,458 | 5,919 | 4,831 | 6,911 | 4,921 | 4,334 | 848 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 4 | 152 | 416[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 4 | 152 | 416 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | -- | -- | 4[2/] | -- | -- | 8[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | -- | -- | 4 | -- | -- | 8 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 33 | 11 | 28 | 10 |
| Lrg Trawler | 26 | 8 | 271[2/] | 184[2/] | 115[2/] | 149[2/] | 246[2/] |
| Longliner | 239 | 751 | 621 | 845 | 598 | 454 | -- |
| TOTAL | 265 | 759 | 892 | 1,062 | 724 | 631 | 256 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 40 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 15 | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 55 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6f Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Atka mackerel

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 246 | 263 | 667 | 811 | 758 | 455 | 250 |
| Med Trawler | 94 | 169 | 959[1/] | 1,089[1/] | 354[1/] | 239[1/] | 76[1/] |
| Lrg Trawler | 790 | 126 | 262[2/] | 1,735[2/] | 973[2/] | 2,109[2/] | 205[2/] |
| Longliner | 5 | 9 | 7 | 1 | 2 | 3 | 1 |
| TOTAL | 1,135 | 567 | 1,895 | 3,636 | 2,087 | 2,806 | 532 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 18,386 | 10,264 | 10,474[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 18,386 | 10,264 | 10,474 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | TR | 57[2/] | 279[2/] | -- | -- | TR[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | TR | 57 | 279 | -- | -- | TR |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 2,526 | 498 | 809 | 1 |
| Lrg Trawler | 63 | 81 | 736[2/] | 12,258[2/] | 4,174[2/] | 7,855[2/] | 3[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 63 | 81 | 736 | 14,784 | 4,672 | 8,664 | 4 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 34 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 3 | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 37 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6g Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Other rockfish

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 339 | 396 | 686 | 698 | 174 | 230 | 70 |
| Med Trawler | 29 | 618 | 36[1/] | 117[1/] | 21[1/] | 33[1/] | 15[1/] |
| Lrg Trawler | 718 | 665 | 1,986[2/] | 1,218[2/] | 1,007[2/] | 846[2/] | 280[2/] |
| Longliner | 191 | 14 | 79 | 113 | 82 | 83 | 11 |
| TOTAL | 1,277 | 1,093 | 2,787 | 2,146 | 1,284 | 1,195 | 376 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 1 | 122 | 7[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 1 | 122 | 7 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 9 | 19 | 4[2/] | 16[2/] | -- | -- | 1[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 9 | 19 | 4 | 16 | -- | -- | 1 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 383 | 63 | 35 | 1 |
| Lrg Trawler | 609 | 182 | 52[2/] | 1,796[2/] | 345[2/] | 486[2/] | 36[2/] |
| Longliner | -- | 3 | -- | -- | -- | -- | -- |
| TOTAL | 609 | 185 | 52 | 2,179 | 408 | 521 | 37 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 6 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 1 | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 7 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6h Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Thornyhead

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | -- | -- | 326 | 442 | 195 | 354 | 92 |
| Med Trawler | -- | -- | 14[1/] | 38[1/] | 6[1/] | 13[1/] | 5[1/] |
| Lrg Trawler | -- | -- | 507[2/] | 359[2/] | 247[2/] | 152[2/] | 48[2/] |
| Longliner | -- | -- | 369 | 282 | 210 | 161 | 14 |
| TOTAL | -- | -- | 1,216 | 1,121 | 658 | 680 | 159 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | -- | 3[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | -- | 3 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | -- | -- | -- | -- | -- | 1[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | -- | -- | -- | -- | -- | 1 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 27 | 3 | 1 | TR |
| Lrg Trawler | -- | -- | 4[2/] | 138[2/] | 22[2/] | 7[2/] | 5[2/] |
| Longliner | -- | -- | 128 | 56 | 104 | 30 | -- |
| TOTAL | -- | -- | 132 | 221 | 129 | 38 | 5 |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6i Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Squid

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 47 | 66 | 241 | 384 | 78 | 161 | 57 |
| Med Trawler | 47 | 188 | 11[1/] | 38[1/] | 19[1/] | 23[1/] | 33[1/] |
| Lrg Trawler | 92 | 11 | 443[2/] | 131[2/] | 105[2/] | 68[2/] | 10[2/] |
| Longliner | -- | TR | 2 | -- | TR | -- | TR |
| TOTAL | 186 | 265 | 897 | 553 | 202 | 252 | 100 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 1 | 1 | 39[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 1 | 1 | 39 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 1 | 9 | TR[2/] | 19[2/] | -- | -- | 3[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 1 | 9 | TR | 19 | -- | -- | 3 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 42 | 8 | TR | TR |
| Lrg Trawler | 133 | 143 | 107[2/] | 520[2/] | 68[2/] | 15[2/] | 17[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 133 | 143 | 107 | 562 | 76 | 15 | 17 |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

Table 5.6j Gulf of Alaska Foreign Landings of Groundfish by Vessel Type and Species in Metric Tons 1978 through 1984 Best Blend Estimates.

Species: Other fish

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| JAPAN | | | | | | | |
| Sm Trawler | 1,236 | 589 | 819 | 875 | 323 | 451 | 99 |
| Med Trawler | 119 | 806 | 487[1/] | 366[1/] | 116[1/] | 86[1/] | 75[1/] |
| Lrg Trawler | -- | 276 | 1,099[2/] | 336[2/] | 219[2/] | 213[2/] | 50[2/] |
| Longliner | 1,699 | 600 | 2,970 | 509 | 343 | 486 | 243 |
| TOTAL | 3,054 | 2,271 | 5,375 | 2,086 | 1,001 | 7,236 | 467 |
| USSR | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | 381 | 939 | 1,326[2/] | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | 381 | 939 | 1,326 | -- | -- | -- | -- |
| POLAND | | | | | | | |
| Sm Trawler | -- | -- | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | 14 | 44[2/] | 678[2/] | -- | -- | 21[2/] |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 14 | 44 | 678 | -- | -- | 21 |
| KOREA | | | | | | | |
| Sm Trawler | -- | -- | -- | 487 | 56 | 31 | 2 |
| Lrg Trawler | 1,687 | 736 | 1,449[2/] | 3,837[2/] | 986[2/] | 981[2/] | 85[2/] |
| Longliner | -- | 22 | -- | 25 | 6 | 8 | -- |
| TOTAL | 1,687 | 758 | 1,449 | 4,349 | 1,048 | 1,020 | 87 |
| MEXICO | | | | | | | |
| Sm Trawler | -- | 101 | -- | -- | -- | -- | -- |
| Lrg Trawler | -- | -- | -- | -- | -- | -- | -- |
| Longliner | -- | -- | -- | -- | -- | -- | -- |
| TOTAL | -- | 101 | -- | -- | -- | -- | -- |

TR (trace) = less than 1 metric ton
1/ Surimi trawler
2/ large freezer trawler
Source: Summaries of Provisional Foreign and Joint Venture Groundfish Catches in the Northeast Pacific Ocean and Bering Sea 1978 through 1985 Annual Reports.

A characteristic feature of the Soviet fishery is a greater reliance on support vessels than by Japan. This appears to be mainly because the catches are not processed to as great an extent aboard Soviet vessels as on Japanese vessels. The more highly processed Japanese products occupy less space aboard the catcher vessels, which means they do not have to unload as frequently as Soviet vessels; hence, there is less need for refrigerator transports.

5.2.2.2.2 Catch and Effort Trends

The Soviet fishery in the Gulf of Alaska has been a classic example of pulse fishing in which massive fishing effort is generated on local stocks with an early buildup in catches, followed by declining yields as abundance quickly falls off, and a shift of effort to other species or grounds. This pattern of fishing was followed by the U.S.S.R. on Pacific ocean perch throughout its range in the Gulf, starting in the west around the Shumagin Islands and ending in the eastern area of southeastern Alaska. The Soviet fishery peaked early in the Gulf with total groundfish catches reaching an estimated level of over 200,000 metric tons in 1963 and over 300,000 tons in 1965, then falling to 83,000 tons in 1966 and to an all-time low of 9,000 tons in 1970. There was some recovery in Soviet catches after 1970 to about 95,000 tons in 1975. This was accomplished, however, only by diverting the fleets from Pacific ocean perch, the target of the earlier fishery, to other less heavily exploited species of groundfish such as pollock, Atka mackerel, and flounders. The Soviet fishery decreased from approximately 70,000 tons to approximately 31,000 tons during the periods 1976-1979. In 1980 the catch increased to about 54,000 tons. The Soviet Union was excluded from the Gulf of Alaska in 1981 for political reasons.

The relative importance of the Soviet fishery for groundfish in the Gulf of Alaska compared to its fisheries in the Bering Sea and Washington-California area has diminished greatly with time. During the initial fishing period in 1962-1965 when Pacific ocean perch were still present in large concentrations, the catch from the Gulf of Alaska comprised 60% of the total Soviet harvest of groundfish (excluding herring) from all Pacific waters off the United States and Canada. The comparable figure for the Gulf of Alaska during the period 1970-74 was less than 9% of the groundfish total. In 1978 the Soviet Union caught 6% of the total foreign POP catch. The Soviet catch of POP increased to 11% and then decreased to 9% for 1979 and 1980, respectively. The contribution of POP to the total Soviet harvest from the Gulf of Alaska, from 1978-1980 represented only 1% to 3%. The reduction in the relative importance of the Gulf of Alaska to the U.S.S.R. has occurred despite efforts by the Soviets to maintain their catches by diverting to other target species besides Pacific ocean perch (see Table 5.2b).

It is impossible to quantitatively assess the improvement in the efficiency of Soviet fishing effort as a result of increased knowledge of the fish and fishing grounds and improvements in fishing gear, navigation, and fish-finding equipment. However, it is possible to examine changes that have occurred within the fleet regarding the numbers and gross tonnages of the different kinds of catcher vessels employed. This has been done in Table 5.7 for all waters off Alaska, but it is generally representative of what has occurred in the Gulf of Alaska.

A great increase in Soviet fishing power off Alaska is shown by the shift within the side trawler class from the use of small SRTs to large SRTMs and the increasing deployment of large factory stern trawlers. Factory stern trawlers now comprise over one-third of the Soviet catcher fleet off Alaska compared to only about 9% of the fleet in 1963-65. The gross tonnages for the combined classes of vessels are better measures of the fishing power than just the number of vessels. As can be seen from Table 5.7, the gross tonnage, and hence, relative fishing power of the Soviet fleet increased from an average level of 160,000 gross tons in 1963-65 to an average level of 514,000 gross tons in 1972-74.

Table 5.7 Number and equivalent gross registered tonnage of different Soviet catcher vessels sighted off Alaska, 1963-1980. Sightings were by NMFS personnel and do not include repeated sightings of the same vessels. Observations were not extensive enough to provide comparative numbers from 1959-1962.

| Year | Side Trawlers | | | | | Factory Stern Trawlers | | | Equivalent Gross Tons |
|---|---|---|---|---|---|---|---|---|---|
| | SRT | SRTR | SRTM | SRTK[1/] | Total | BMRT | RTM | Total | All Classes |
| 1963 | 155 | 7 | -- | -- | 162 | 10 | 1 | 11 | 79,000 |
| 1964 | 237 | 9 | 12 | -- | 258 | 28 | 1 | 29 | 167,000 |
| 1965 | 330 | 11 | 25 | -- | 366 | 36 | 3 | 39 | 233,000 |
| 1966 | 248 | 9 | 44 | -- | 301 | 42 | 4 | 46 | 245,000 |
| 1967 | 191 | 7 | 66 | | 264 | 53 | 4 | 57 | 279,000 |
| 1968 | 97 | 5 | 90 | -- | 192 | 71 | 3 | 74 | 324,000 |
| 1969 | 66 | 9 | 127 | -- | 202 | 79 | 6 | 85 | 377,000 |
| 1970 | 65 | 11 | 144 | -- | 220 | 97 | 6 | 103 | 447,000 |
| 1971 | 92 | 7 | 102 | 2 | 203 | 102 | 5 | 107 | 438,000 |
| 1972 | 111 | 6 | 161 | 7 | 285 | 100 | 11 | 111 | 497,000 |
| 1973 | 25 | 7 | 155 | 9 | 196 | 105 | 15 | 120 | 498,000 |
| 1974 | 25 | 7 | 174 | 8 | 214 | 117 | 14 | 131 | 546,000 |
| 1975 | 6 | 11 | 104 | -- | 121 | 86 | 18 | 104 | NA |
| 1976 | 15 | 8 | 126 | -- | 149 | 113 | 10 | 123 | NA |
| 1977 | -- | -- | -- | -- | -- | NA | NA | 67 | NA |
| 1978 | -- | -- | -- | -- | -- | NA | NA | 71 | NA |
| 1979 | -- | -- | -- | -- | -- | NA | NA | 72 | NA |
| 1980 | -- | -- | -- | -- | -- | NA | NA | 39 | NA |

1/ Medium stern trawler, approximately 750 gross tons.

5.2.2.3 Japan

The earliest reported fishing by Japanese vessels off Alaska resulted from an order issued by the Secretary of Commerce in April 1918 which suspended the law forbidding the landing of catches by foreign vessels in U.S. ports. The suspension was to encourage the importation of fish in order to compensate for reduced food supplies caused by World War I and was terminated in July 1921. During the time the suspension was in effect, Japanese vessels landed 4.5 million dry-salted cod and 80 mt of stockfish (dried, unsalted cod) at San Francisco and Puget Sound ports (Cobb, 1927). Although most of this cod was from around the Kurile Islands and Ohkotsk Sea, in a few instances the Japanese vessels caught their fish off Alaska. Neither the amount nor the area of origin (Bering Sea or Gulf of Alaska) of catches off Alaska can be determined now.

The first significant effort by Japan in the Gulf of Alaska began in 1960 when several small trawlers were diverted there from the Bering Sea to carry out exploratory operations. Exploratory probes continued in the Gulf through 1962, and commercial operations by Japan commenced with the assignment of several large independent trawlers there in 1963 (Chitwood, 1969). To some degree the initiation by Japan of a full-scale fishery for groundfish in the Gulf of Alaska in 1963 was precipitated by the start of a fishery there by the U.S.S.R. in 1962. Japan had shown prior constraint in pursuing a fishery in the Gulf of Alaska, at least partly in consideration for the potential impact on halibut--a subject of discussions between the Governments of Japan, Canada and the United States. The fleet of Japanese trawlers and area of operations in the Gulf were expanded rapidly after 1963.

Since its inception, the Japanese Gulf of Alaska trawl fishery has targeted principally on Pacific ocean perch, although recently with declines in the POP resource and full domestic utilization of this resource, substantial amounts of other groundfish are taken, i.e., pollock, Pacific cod, and flounder.

In addition to their trawl fisheries, Japan has had a fishery for sablefish in the Gulf since 1963. Although the sablefish fishery is licensed by Japan under the North Pacific Longline-Gillnet Fishery, gill nets (sunken types) were only used during 1963. Since then the Japanese have used hook and longline gear in this fishery. Japanese longline vessels also harvest Pacific cod and in 1978 made cod their primary target in response to foreign fleets being phased out of the sablefish fishery due to declines in the resource and expanding domestic utilization.

From the standpoint of size of catch as well as kind of fishing operations, Japan's fishery for groundfish is much less extensive in the Gulf of Alaska than in the Bering Sea. During the period 1970-74, Japan's harvest of groundfish from the Gulf of Alaska averaged only 99,000 mt compared to 1,706,000 mt from the Bering Sea. The Bering Sea harvest is taken by four kinds of fishing operations: a mothership fishery, North Pacific trawl fishery, landbased dragnet fishery, and North Pacific longline-gillnet fishery. In the Gulf of Alaska, Japan has had only two kinds of fishing operations, a North Pacific trawl fishery and a sablefish/cod longline fishery. Recent Japanese Gulf of Alaska groundfish harvests are presented in Tables 5.6a-j, according to species and vessel type.

5.2.2.3.1 North Pacific Trawl Fishery

5.2.2.3.1.1 Vessels and Gear

The North Pacific Trawl Fishery is now entirely carried out by factory stern trawlers operating independently of motherships and either offloading their processed catches to refrigerator transports or delivering the catches to Japan themselves. This is in contrast to the earliest period of the fishery when some side trawlers were employed as well as vessels which served as motherships to receive and process the catches. Since 1967 Japan has limited by license to 42 the number of vessels that can participate at any one time in the North Pacific trawl fishery; they may fish in waters north of 10°N. latitude and east of 170°E. longitude. This fishing area includes the Bering Sea, Aleutian Islands, Gulf of Alaska, and waters to the south off Canada and the remainder of the United States. However, most of the catch by the North Pacific trawl fishery is from the Bering Sea.

5.2.2.3.1.2 Catch and Effort Trends

The annual groundfish catch in Japan's Gulf of Alaska trawl fishery rose rapidly and by 1966 was approximately 85,000 mt. Between 1966 and 1974 the catch averaged about 79,000 mt. Peak catches of 91,000 and 92,000 mt were made in 1973 and 1974. From 1970-74, the Gulf of Alaska's trawl catch represented 14% of Japan's total groundfish catch. The average annual catch by this fishery was 484,000 mt from the Bering Sea and Aleutian Islands region compared to 77,000 mt from the Gulf of Alaska. The percentage of the total Japanese groundfish catch attributed to the Gulf area decreased over the next four years and represented 5% in 1978. From 1978-1983 the average annual percentage of the total groundfish catch attributed to the Gulf of Alaska was approximately 6%. The Gulf of Alaska represented 7% (66,231 mt) of Japan's total catch (9,262,012 mt) in 1983. Since then, Japan groundfish catches in the Gulf of Alaska have been reduced as a result of the expanding domestic fishery.

Pacific ocean perch has been the principal component of Japan's historical groundfish catches. The maximum catch of this species (65,200 mt) occurred in 1966, but since then the annual catch has gradually declined, reaching a figure of 4,948 mt in 1983 (see Table 5.6d). Between 1968 and 1982 most of the Japanese ocean perch catch was obtained from the INPFC areas of Kodiak, Yakutat, and Southeastern.

By 1978 pollock had replaced Pacific ocean perch as the predominant target of Japan's trawl fishing operations. Catches peaked at 55,047 mt in 1982 and have since declined as U.S. and joint venture operations increased their harvest of the available resource.

A significant feature of Japan's operations in the Gulf of Alaska has been the increase in fishing efficiency over the years. Some of the increase is a natural consequence of the fishermen learning more about the distribution and abundance of the fish and thereby being better able to anticipate where and when to find them in fishable concentrations. There also has been a major upgrading in efficiency of the fishing fleet, in terms of vessel size, horsepower, efficiency of fishing gear, navigation equipment, and fish-finding devices. Between 1967 and 1975 the average size of factory trawlers employed in the North Pacific trawl fishery increased from about 1,500 gross tons to over 2,500 tons and has remained approximately the same during the period 1976-1983. The result of this upgrading has been a marked increase in the fishing power of the fleet which is not apparent when one considers just the number of vessels employed. On June 1, 1982 Amendment 10 to the Gulf of Alaska FMP was adopted which closed the area east of 140°W. to all foreign fishing and permitted foreign mid-water trawling only year-round between 140° and 147°W.

5.2.2.3.2 Sablefish Setline Fishery

5.2.2.3.2.1 Vessels and Gear

Vessels employed in Japan's sablefish fishery in the Gulf of Alaska now use hook and longline gear. In 1963, bottom gillnets were used, but this method of fishing was soon discontinued. From 1975 to 1977 sablefish catches decreased from 22,000 mt to 14,400 mt, respectively. During the period 1978-1984 the average annual catch was approximately 4,900 mt and ranged from 6,911 mt in 1981 to 848 mt in 1984 (see Table 5.6e). This reduction was due in part to a decline in the sablefish resource. By 1985 the domestic fishery had expanded to harvest the available resource.

5.2.2.3.2.2 Catch and Effort Trends

According to estimates by NMFS law enforcement personnel, the annual average catch of sablefish by Japanese longline vessels in the Gulf during the years 1964-67 was about 2,700 mt[1/] During the subsequent period, 1968-1974, the annual average catch of sablefish by this fleet was 18,788 mt. The annual average longline catch of sablefish by Japan in INPFC Area Southeastern during 1968-1974 was 6,843 mt, or a little more than one-third of Japan's total longline catch from the Gulf. The relatively large catches taken off Southeast Alaska were particularly significant since that was the primary location for the domestic sablefish fishery.

Following passage of the MFCMA in 1976, catch quotas were implemented and waters off Southeast Alaska were closed to foreign longlining in 1981. The Gulf catch of sablefish in the Japanese longline fleet averaged 5,065 mt during 1978-83. By 1984 the harvest dropped to 735 mt taken, caught incidentally in the longline cod fishery, the only foreign fishery now allowed in the Gulf of Alaska.

5.2.2.4 Republic of Korea (ROK)

ROK vessels first began fishing for groundfish in the Gulf of Alaska in 1972, some five years after their Bering Sea operations had begun. They targeted on a variety of groundfish species, i.e., pollock, Pacific cod, flounder, sablefish, Atka mackerel, and to a lesser extent, Pacific ocean perch, rockfish and squid using longline and trawler vessels. By 1978 Korean fishing operations relied almost exclusively on trawl gear with pollock being the primary target species. As a result of expanding domestic harvesting capability, Korea has not received a directed fishing allocation in the Gulf of Alaska since 1985.

5.2.2.4.1 Vessels and Gear

ROK vessels used longline gear similar to that of Japanese longliners for capturing sablefish when participating in that fishery. Small trawler vessels (vessels less than 1,500 gross tons) began fishing in

5.2.2.4.2 Catch and Effort Trends

The year 1975 was the first for which ROK provided fishery statistics on their Gulf of Alaska operations. From surveillance of their fisheries, NMFS law enforcement personnel have estimated their catches of sablefish as 1,300 mt in 1972, 1,700 mt in 1973, and 2,800 mt in 1974. In 1975, ROK reported a sablefish catch of almost 2,200 mt of which 50% was obtained from the Southeastern area.

From 1976 to 1983 the average annual catch of sablefish by ROK longline vessels was approximately 9,950 mt and ranged from 3,700 mt in 1976 to 239 mt in 1978. In 1983 ROK landed about 454 mt of sablefish. In 1981, Amendment 10 to the Gulf of Alaska FMP was adopted which prohibited ROK and other foreign countries from fishing east of 140°W.

During the period 1981-83 small trawlers accounted for an average annual percentage of 11% of the total Gulf of Alaska trawl catch; large freezer trawlers (vessels greater than 1,500 gross tons producing frozen whole fish and fillet products) accounted for the remaining 89%. In 1983 small and large freezer trawlers caught 5,126 mt and 43,146 mt, respectively.

5.2.2.5 Poland

Polish vessels carried out exploratory fishing probes into the Gulf of Alaska in 1973 and conducted small fisheries on groundfish in 1974 and 1975. The reported catches were less than 100 mt in 1974 and about 2,000 mt in 1975; the catches were mostly pollock, Atka mackerel, and rockfish. Poland began targeting on pollock in 1977. The catch of pollock increased from approximately 1,230 mt in 1978 to approximately 39,900 mt in 1981. During this five-year period the average annual catch of pollock was about 12,300 mt. Atka mackerel and rockfish average annual catches were less than 85 mt and 12 mt, respectively. In 1984 a limited operation was conducted harvesting only 2,800 mt of pollock. Poland has not received a directed fishing allocation since 1985.

5.2.2.5.1 Vessels and Gear

Poland uses only factory stern trawlers for catcher vessels and its fishing operation is closely patterned after that of the U.S.S.R. Polish shipyards are among the major suppliers of vessels for the worldwide Soviet fishing fleet; the technology so gained has been put to good use by Poland in developing its own distant-water fisheries off the United States and in other parts of the world. Recent Polish Gulf of Alaska groundfish catches are presented in Tables 5.6a-j by species and vessel type.

5.2.2.6 Other Nations

A Taiwanese longliner began fishing in the Gulf in 1975 and was soon apprehended for violating the U.S. contiguous fishing zone. As of July 1976, three Taiwanese longliners and one factory stern trawler had been observed fishing in the Gulf. The following year Taiwan discontinued fishing within the Gulf of Alaska.

In 1979 Mexico harvested approximately 10,400 mt of groundfish from the Gulf of Alaska. Pollock represented 84% of Mexico's total catch. Catches of pollock and other groundfish are presented in Tables 5.6a-j according to species and vessel type.

## 5.3 Socioeconomic Characteristics of the Resource

The groundfish fishery in the Northeast Pacific has historically been a foreign dominated fishery, (Table 5.8). Prior to 1976 the majority of the harvest was taken by Japan and the Soviet Union. Because the fishery took place outside of U.S. territorial waters, very little authoritative information on total landings is available for this period.

With the advent of the Magnuson Fishery Conservation and Management Act of 1976 (MFCMA), the exploitation and management of the fisheries resources of the Northeast Pacific began to change; slowly at first, but with ever increasing speed. For example, between 1981 and 1985 the total groundfish harvest from the U.S. Fishery Conservation Zone (subsequently redefined as the Exclusive Economic Zone or EEZ) off Alaska ranged from approximately 1.7 million metric tons (mt) to just over 2 million mt per year, or 3.5 to 4.5 billion pounds annually. In 1981, the total groundfish catch was 1.6 million mt. U.S. domestic harvest in that year was about 114,405 mt, or approximately 7% of the total groundfish landings, (Table 5.9). By 1985, the domestic catch of groundfish had grown to 998,225 mt, accounting for 48% of the 2.07 million mt harvest, (Table 5.10). By 1986, U.S. domestic harvest topped 1.38 million mt, or 73.8% of total groundfish landings from these areas, (Table 5.11)[1] This dramatic change is reflective of the policy position advocated by the U.S. government, i.e., to take full economic advantage and control of the fisheries resources within the U.S. EEZ.

The movement towards domestic development, or "Americanization", of the resource has been most pronounced in the fisheries of the Gulf of Alaska (Gulf), where in 1986 there was, for the first time since enactment of the MFCMA, no directed foreign groundfish trawl fishery.[2] The majority of the 1986 groundfish harvest in the Gulf was expected to be taken by joint venture operations (JVP), although increasing growth in both the harvesting and processing capacity of the wholly domestic (DAP) sector of the industry was anticipated. The initial 1986 groundfish apportionments for the Gulf of Alaska were as follows: the total OY was set at 308,586 mt, DAP was apportioned 124,817 mt, JVP apportionment was 139,261 mt, and reserves were set at 28,398 mt. Actual JVP groundfish landings in the Gulf in 1986 were 61,364 mt. DAP landings data for 1986 show a catch of 43,507 mt, but remain preliminary owing to a decision by the State of Alaska to discontinue collection, editing, and compilation of groundfish catch data for groundfish after October 1, 1986. These data, nonetheless, demonstrate how far the domestic sector of this industry has come, and suggest how rapidly the fishery may be expected to evolve in the future.

[1] Annual performance data are available from Pacific Fishery Information Network (PacFIN).

[2] In 1986 there was a directed foreign longline fishery in the Gulf. This fishery had been given an initial TALFF of 16,110 mt, 15,520 mt of which was Pacific cod. Total TALFF groundfish landings were actually 15,529 mt for the Gulf in 1986.

Table 5.8 Historical groundfish catches off Alaska.

| Year | Japan | USSR | Korea | Poland | Taiwan | Mexico | West Germany | Total |
|---|---|---|---|---|---|---|---|---|
| 1970 | 1,564,235 | 241,053 | 4,620 | | | | | 1,809,908 |
| 1971 | 1,882,231 | 427,847 | 10,000 | | | | | 2,320,078 |
| 1972 | 2,019,377 | 480,967 | 13,222 | | | | | 2,513,566 |
| 1973 | 1,865,089 | 407,191 | 7,697 | | | | | 2,279,977 |
| 1974 | 1,639,207 | 512,934 | 39,800 | | | | | 2,191,941 |
| 1975 | 1,393,476 | 433,730 | 18,755 | 2,132 | 450 | | | 1,848,543 |
| 1976 | 1,310,544 | 359,244 | 127,369 | | | | | 1,797,157 |
| 1977 | 1,197,306 | 168,673 | 85,751 | 1,465 | 1,101 | | | 1,454,296 |
| 1978 | 1,157,408 | 277,515 | 103,328 | 1,268 | 3,226 | | | 1,542,745 |
| 1979 | 1,089,701 | 176,104 | 127,895 | 38,028 | 2,013 | 10,396 | | 1,444,137 |
| 1980 | 1,156,546 | 57,732 | 208,134 | 61,350 | 5,469 | | 6,675 | 1,495,906 |

Table 5.9 Commercial groundfish landed catch (in metric tons) for 1981 for all water off Alaska.

| SPECIES | ADFG | WDF | DAP | JVP | DAH | W.Germany | Japan | Korea | Poland | Taiwan | Foreign | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arrowtooth Flounder | 3.0 | - | 3.0 | 24.1 | 27.1 | 13.1 | 21253.2 | 7640.3 | 21.7 | | 28928.3 | 28955.4 |
| Kamchatka Flounder | - | - | - | - | - | 3.1 | 286.2 | 33.4 | 3.2 | | 325.9 | 325.9 |
| ___Turbots | 3.0 | - | 3.0 | 24.1 | 27.1 | 16.2 | 21539.4 | 7673.7 | 24.9 | | 29254.2 | 29281.3 |
| Dover Sole | - | - | - | - | - | - | 407.9 | 65.9 | 0.6 | | 474.4 | 474.4 |
| English Sole | TR | 0.2 | 0.2 | 21.3 | 21.5 | - | 0.5 | - | - | | 0.5 | 21.9 |
| Greenland Turbot | - | - | - | 0.1 | 0.1 | TR | 63676.4 | 811.7 | 73.5 | | 64561.6 | 64561.7 |
| Petrale Sole | - | - | - | - | - | - | 16.9 | 40.8 | - | | 57.6 | 57.6 |
| Rex Sole | - | - | - | 2.0 | 2.0 | 0.1 | 378.5 | 154.4 | 0.5 | | 533.6 | 535.6 |
| Rock Sole | 0.4 | - | 0.4 | 7530.4 | 7530.8 | 1.1 | 2145.0 | 2302.9 | 0.5 | | 4449.4 | 11980.2 |
| Starry Flounder | 100.4 | 226.8 | 327.2 | 64.4 | 391.7 | - | 64.1 | 7.2 | - | | 71.2 | 462.9 |
| Yellowfin Sole | - | - | - | 13862.6 | 13862.2 | - | 55512.8 | 17501.0 | 0.2 | | 73014.0 | 86876.5 |
| Other Flatfish | - | - | - | 468.0 | 468.0 | 5.4 | 11182.9 | 1851.7 | 7.4 | | 13047.5 | 13515.4 |
| Unsp. Flatfish | 72.2 | - | 72.2 | 78.8 | 151.0 | - | 599.4 | 24.2 | - | 1512 | 2135.8 | 2268.8 |
| ___All Flatfish | 176.0 | 227.0 | 403.0 | 22051.8 | 22454.7 | 22.9 | 155523.6 | 30433.4 | 107.6 | 1512 | 187599.8 | 210054.5 |
| Black Rockfish | - | - | - | - | - | - | 12.1 | 1.7 | TR | | 13.8 | 13.8 |
| Bocaccio | - | - | - | - | - | - | 1.4 | - | - | | 1.4 | 1.4 |
| Canary Rockfish | - | - | - | - | - | - | 0.3 | - | - | | 0.3 | 0.3 |
| Darkblothched Rockfish | - | - | - | - | - | - | 64.2 | 25.4 | TR | | 89.6 | 89.6 |
| Northern Rockfish | - | - | - | - | - | - | 1209.3 | 380.8 | TR | | 1590.1 | 1590.1 |
| Redstripe Rockfish | - | - | - | - | - | - | 1179.1 | 164.8 | - | | 1343.9 | 1343.9 |
| Rougheye Rockfish | - | - | - | - | - | 1.1 | 1351.1 | 20.6 | 37.0 | | 1410.3 | 1410.3 |
| Sharpchin Rockfish | - | - | - | - | - | - | 243.3 | - | - | | 234.3 | 234.3 |
| Shortraker Rockfish | - | - | - | - | - | TR | 3053.4 | 268.2 | 5.9 | | 3327.4 | 3327.4 |
| Silvergrey Rockfish | - | - | - | - | - | - | 200.7 | TR | - | | 200.8 | 200.8 |
| Splitnose Rockfish | - | - | - | - | - | - | 5.4 | - | - | | 5.4 | 5.4 |
| Yellowmouth Rockfish | - | - | - | - | - | - | 248.1 | - | - | | 248.1 | 248.1 |
| Yellowtail Rockfish | - | - | - | - | - | - | 3.9 | - | - | | 3.9 | 3.9 |
| Other Rockfish | - | - | - | TR | TR | 6.9 | 1350.2 | 325.8 | 6.7 | | 1689.6 | 1689.6 |
| Pacific Ocean Perch | 7.4 | - | 7.4 | 1.4 | 8.7 | 4.9 | 9876.8 | 3472.0 | 161.8 | | 13515.5 | 13524.2 |
| Shortbelly Rockfish | - | - | - | - | - | - | 0.4 | - | - | | 0.4 | 0.4 |
| Thornyheads | - | - | - | - | - | - | 802.7 | 120.7 | - | | 923.4 | 923.4 |
| Widow Rockfish | - | - | - | - | - | - | 31.4 | 12.3 | - | | 43.8 | 43.8 |
| Unsp. Rockfish | 355.8 | 15.2 | 371.0 | 7.7 | 378.7 | - | 402.8 | 107.4 | 6.8 | 44 | 561.9 | 940.6 |
| ___ All Rockfish | 363.2 | 15.2 | 378.4 | 9.1 | 387.4 | 13.0 | 20028.1 | 4899.8 | 218.2 | 44 | 25204.0 | 25591.4 |

Table 5.9 continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atka Mackerel | - | - | - | 1633.0 | 1633.0 | 38.0 | 9251.2 | 27196.1 | 297.2 | | 36782.5 | 38415.4 |
| Lingcod | 27.0 | 0.4 | 27.4 | - | 27.4 | - | - | - | - | | - | 27.4 |
| Pacific Cod | 7607.4 | 7589.7 | 15197.2 | 9216.3 | 24413.5 | 1152.9 | 57764.2 | 13688.6 | 628.5 | 847 | 74081.2 | 98494.7 |
| Sablefish | 1740.9 | 201.5 | 1942.4 | 180.5 | 2122.9 | 34.1 | 9321.5 | 1456.4 | 16.6 | 102 | 10930.8 | 13053.7 |
| Wallleye Pollock | 562.8 | 234.3 | 797.1 | 58939.3 | 59736.4 | 10304.6 | 855157.0 | 154567.7 | 93870.5 | 3366 | 1117266.5 | 1177002.9 |
| Other Roundfish | 0.8 | - | 0.8 | - | 0.8 | - | - | - | - | | - | 0.8 |
| Unsp. Roundfish | TR | - | TR | - | TR | - | - | - | - | | - | TR |
| ___ All Roundfish | 9938.9 | 8025.9 | 17964.8 | 69969.1 | 87933.9 | 11529.6 | 93149.0 | 196908.8 | 94812.8 | 4315 | 1239061.0 | 1326994.9 |
| | | | | | | | | | | | | |
| Spiny Dogfish | TR | - | TR | - | TR | - | - | - | - | | - | TR |
| Unsp. Groundfish | 157.2 | - | 157.2 | 3471.6 | 3628.7 | 307.3 | 41467.1 | 10741.6 | 952.1 | 105 | 53573.9 | 57202.6 |
| ___ Misc. Groundfish | 157.2 | - | 157.2 | 3471.6 | 3628.7 | 307.3 | 41467.1 | 10741.6 | 952.1 | 105 | 53573.9 | 57202.6 |
| | | | | | | | | | | | | |
| All Groundfish | 10635.2 | 8268.1 | 18903.3 | 95501.4 | 114404.7 | 11872.8 | 1148512.8 | 242983.6 | 96090.7 | 5978 | 1505438.6 | 1619843.4 |

This report includes only data for North Pacific Council INPFC Areas

TR = Landed catch less than 0.05 metric tons, or metric tons per unit of effort less than 0.005

Table 5.10 continued

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Spiny Dogfish | TR | - | TR | - | TR | - | - | - | - | | TR |
| Unsp. Squid | - | - | - | 37.6 | 37.6 | 1474.0 | 16.7 | 103.1 | 0.7 | 1594 | 1632.1 |
| Unsp. Groundfish | 712.5 | - | 712.5 | 8589.2 | 9301.7 | 4862.7 | 1478.1 | 5.2 | 33.8 | 6379 | 15681.6 |
| ___ Misc. Grdfish | 712.6 | - | 712.6 | 8626.8 | 9339.4 | 6336.7 | 1494.8 | 108.4 | 34.6 | 7974 | 17313.8 |
| All Groundfish | 105677.5 | 8980.2 | 114657.7 | 883567.3 | 998225.0 | 806101.6 | 225436.2 | 32218.9 | 10652.2 | 10744082 | 072633.9 |

This report includes only data for North Pacific Council INPFC Areas
TR = Landed catch less than 0.05 metric tons, or metric tons per unit of effort less than 0.005

Table 5.12 Commercial groundfish landed catch (in metric tons) for 1986 for all water off Alaska.

| SPECIES | ADFG | NMFS/AKR | WDF | DAP | JVP | DAH | China | Japan | Korea | Poland | Foreign | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arrowtooth Flounder | 6.5 | - | 91.2 | 97.6 | - | 97.6 | - | - | - | | - | 97.6 |
| Unspecified Turbots | - | 63.0 | - | 63.0 | 3608.4 | 3671.4 | 9.6 | 2630.4 | 855.0 | 0 | 3495.5 | 7166.9 |
| ___Turbots | 6.5 | 63.0 | 91.2 | 160.6 | 3608.4 | 3769.0 | 9.6 | 2630.4 | 855.0 | 0 | 3495.5 | 7264.5 |
| Dover Sole | 163.3 | - | - | 163.3 | - | 163.3 | - | - | - | | - | 163.3 |
| English Sole | 1.5 | - | - | 1.5 | - | 1.5 | - | - | - | | - | 1.5 |
| Greenland Turbot | 1357.9 | 1597.2 | - | 2995.1 | 35.7 | 2990.8 | - | 6928.2 | 14.2 | | 6942.4 | 9933.2 |
| Rex Sole | 64.9 | - | 7.2 | 72.1 | - | 72.1 | - | - | - | | - | 72.1 |
| Rock Sole | 3421.7 | 1148.5 | 73.0 | 4643.2 | - | 4643.2 | - | - | - | | - | 4643.2 |
| Starry Flounder | 12.4 | - | - | 12.4 | - | 12.4 | - | - | - | | - | 12.4 |
| Yellowfin Sole | 0.5 | 1.1 | - | 1.6 | 151410.6 | 151412.2 | 246.8 | 49318.0 | 7632.0 | | 57196.96 | 208609.0 |
| Other Flatfish | 131.3 | - | 19.2 | 150.5 | - | 150.5 | - | - | - | | - | 150.5 |
| Unsp. Flatfish | 316.9 | 193.7 | - | 510.6 | 63135.7 | 63646.3 | 107.0 | 8094.9 | 2291.4 | 3 | 10497.1 | 74143.4 |
| ___All Flatfish | 5476.9 | 3003.5 | 190.6 | 8670.9 | 218190.4 | 226861.3 | 363.4 | 66971.6 | 10972.5 | 4 | 78131.8 | 304993.2 |
| Black Rockfish | 51.7 | - | - | 51.7 | - | 51.7 | - | - | - | | - | 51.7 |
| Canary Rockfish | 9.0 | - | - | 9.0 | - | 9.0 | - | - | - | | - | 9.0 |
| Darkblothched Rockfish | 8.2 | - | - | 8.2 | - | 8.2 | - | - | - | | - | 8.2 |
| Silvergrey Rockfish | 0.8 | - | - | 0.8 | - | 0.8 | - | - | - | | - | 0.8 |
| Yelloweye Rockfish | 611.9 | - | - | 611.9 | - | 611.9 | - | - | - | | - | 611.9 |
| Yellowtail Rockfish | TR | - | - | TR | - | TR | - | - | - | | - | TR |
| Other Rockfish | 384.0 | - | - | 384.0 | - | 384.0 | - | - | - | | - | 384.0 |
| Pacific Ocean Perch | 645.1 | 3069.0 | 0.7 | 3714.8 | - | 3714.8 | - | - | - | | - | 3714.8 |
| Unsp. Pop Rock | - | - | - | - | 302.1 | 302.1 | - | 14.6 | 3.4 | 0 | 18.2 | 320.3 |
| Thornyheads | 423.8 | 396.5 | - | 820.3 | 1.1 | 821.4 | - | - | - | | - | 821.4 |
| Unsp. Rockfish | 807.3 | 1234.3 | 9.3 | 2050.9 | 307.5 | 2358.4 | 0.4 | 17.5 | 3.8 | 0 | 21.9 | 2380.3 |
| ___ All Rockfish | 2941.9 | 4699.8 | 10.2 | 7651.7 | 610.7 | 8262.4 | 0.4 | 32.1 | 7.2 | 0 | 40.1 | 8302.5 |
| Atka Mackerel | 3.8 | 1.0 | - | 4.8 | 31988.6 | 31993.4 | - | 1.1 | 1.1 | 0 | 2.3 | 31995.7 |
| Lingcod | 145.0 | - | 1.2 | 146.2 | - | 146.2 | - | - | - | | - | 146.2 |
| Pacific Cod | 33726.2 | 4669.5 | 3958.6 | 42354.2 | 66329.1 | 108683.4 | 182.5 | 51097.7 | 4041.6 | 8 | 55330.0 | 164013.6 |
| Sablefish | 23102.6 | 3145.9 | 285.2 | 26533.7 | 481.7 | 27015.5 | 0.1 | 74.5 | 33.9 | | 108.5 | 27124.0 |
| Wallleye Pollock | 33359.2 | 24106.5 | 762.2 | 58228.0 | 917853.4 | 976081.3 | 1433.1 | 262849.1 | 81632.4 | 6759 | 352684.5 | 1328765.8 |
| ___ All Roundfish | 90336.8 | 31922.9 | 5007.2 | 127266.9 | 1016652.9 | 1143919.7 | 1625.7 | 314022.4 | 85709.1 | 6768 | 408125.5 | 1552045.2 |
| Unsp. Squid | - | 3.9 | - | 3.9 | 41.6 | 45.5 | - | 836.6 | 3.7 | 7 | 847.7 | 893.2 |
| Other Groundfish | - | - | 0.9 | 0.9 | - | 0.9 | - | - | - | | - | 0.9 |
| Unsp. Groundfish | 358.3 | 279.5 | - | 637.8 | 7848.4 | 8486.2 | 12.2 | 3386.8 | 805.1 | 1 | 4205.3 | 12691.5 |
| ___ Misc. Groundfish | 358.3 | 283.4 | 0.9 | 642.6 | 7890.0 | 8532.6 | 12.2 | 4223.5 | 808.8 | 8 | 5053.0 | 13585.6 |
| All Groundfish | 99113.8 | 39909.6 | 5208.6 | 144232.0 | 1243344.0 | 1387576.0 | 2001.7 | 385249.6 | 97317.5 | 6781 | 491350.5 | 1878926.4 |

This report includes only data for North Pacific Council INPFC Areas. TR = Landed catch less than 0.05 metric tons, or metric tons per unit of effort less than 0.005

The economic and socioeconomic data required for management of the developing Gulf groundfish fishery will be more extensive than those required for regulation of an established domestic fishery. Regulation of an evolving fishery requires not only information on the existing effective physical capacity of both the harvesting and processing sectors, output characteristics, factor and product markets, but also the available potential capacity, as well as the economic and socioeconomic factors which will influence, and be influenced by growth. Additional data requirements may include:

(1) Domestic and international marketing conditions and demand trends.

(2) Information on industry plans for entry into or expansion within the Gulf groundfish fisheries and approximate time tables for such investment.

(3) Information concerning the economic and social conditions which prevail in communities which may be directly or indirectly affected by growth in this domestic industry.

5.3.1 Output Characteristics of the Subject Domestic Fishery

The groundfish complex which supports the commercial fisheries of the Gulf of Alaska is composed of a wide variety of demersal, semi-demersal, and pelagic species. The Alaska Department of Fish and Game (ADF&G) fish ticket serves as the legal document of commercial exvessel sale for wholly domestic groundfish catch in the EEZ.[3] That fish ticket explicitly lists 24 species of groundfish, as well as two general or unspecified categories. In addition, space is provided for recording landings of species other than those explicitly listed. The list includes:

Sablefish
Soles and Flounders (including)
Flathead sole
Rock sole
Dover sole
Rex sole
Yellowfin sole
Starry flounder
Alaska plaice
Flounder-unspecified
Pacific Cod
Pollock
Pacific Ocean Perch

Rockfishes (including)
Black rockfish
Idiot rockfish
Red Snapper - Yelloweye
Canary rockfish
Quillback rockfish
China rockfish
Rosethorn rockfish
Dusky rockfish
Red rockfish unspecified and Rockfish unspecified

[3] While the State of Alaska has determined not to continue to maintain its groundfish fish ticket system after October 1, 1986, or until additional funding can be attained, ADF&G fish tickets are still required by law to be filed for all DAP sales of groundfish. U.S. Dept. of Commerce - NMFS intends to negotiate a contract with the State of Alaska, and pay ADF&G to reinstitute its former system of editing and compiling DAP groundfish catch data.

In addition, Lingcod, Sculpin, Skates, and Sharks are explicitly listed. The ADF&G Groundfish Fish Ticket Database Species Codes, which are used to more precisely record reported landings composition, includes 59 species or species categories of groundfish.

5.3.1.1 Description and Value of Product (wholesale)

The wholly domestic groundfish fishing industry, operating in the Gulf of Alaska, is responsible for a wide variety of products bound for both U.S. and foreign markets. While product form is highly variable, depending upon the level of primary and/or secondary processing undertaken and the intended market, in general, most of the output of the domestic groundfish fishery in the mid-1980s remains in frozen product form, i.e., blocks, fillets, headed and gutted, etc. While exceptions do exist, for example, in the case of the expanding "fresh" market for some flatfishes and rockfishes, and the newly developing "surimi" market, the traditional groundfish product forms remain the mainstay of DAP output at this point in time.

As examples, frozen dressed halibut and sablefish are an intermediate product form. They are exported from Alaska to undergo further processing into final market products, primarily steaks and fillets. The Japanese market has emerged as the principal outlet for sablefish, while halibut (a species not managed under this FMP) is widely delivered to both domestic and international markets. Domestic landings of Pacific cod have begun to make inroads into the highly competitive world whitefish fillet market. With continued emphasis on producing a high quality product, and declining catches of Atlantic cod from traditional sources, prospects for sustained growth in the world codfish market are good, (see, An Assessment Of Current World Cod Resources And Markets, With An Emphasis On Japan And The United States, Lewis E. Queirolo and Joseph Terry, NWAFC Technical Memorandum, 1987). Domestic production of Alaska pollock has also shown a strong growth potential. Output is primarily composed of fillets, blocks, and "formed" products, although as noted, surimi-base and analog products have attracted considerable recent attention.

The domestic groundfish catch from the Gulf of Alaska is also used in the "industrial" products area--specifically as a source of bait for various line and pot fisheries. Information on species composition and quantity is not readily available. However, total volumes are assumed to be relatively small when compared to the food fish harvest.

5.3.1.2 Markets

The following excerpt is taken from, "A Strategy for the Americanization of the Groundfish Fisheries of the Northeast Pacific", Volume 2, Technical Report, NOAA Cooperative Agreement #NA84-ABH-00065, December 1985.

> The processors and brokers of groundfish landed in Pacific coast states have had great difficulty in competing with imported frozen block and fillet products. Thus, very little of the fillets prepared from flounders, cod, rockfishes, etc., is frozen as blocks or portion packed. Instead, those marketing the product ship fresh fillets or headed and gutted product, directly or through brokers to fish markets, chain stores, institutional buyers and restaurants. The exception to this strategy is the marketing of frozen halibut which moves to national and international buyers. In recent years, however, marketers have had some success in selling frozen fillets of Pacific cod and pollock in competition with Canadian and European products. These sales are limited to high quality fish which are caught and processed at sea within a few hours of capture and command premium price.
>
> A small quantity of headed and gutted sablefish fillets (sic) and other bottomfish species have also been targeted for Japanese markets. This marketing channel is likely to increase as foreign fishing opportunities dwindle during the next several years. Sablefish bound for U.S. markets may be smoked or sold as fresh or frozen product.
>
> Until very recently Pacific coast strategy has been to sell in the small "window" provided by the fresh fish market or what is left over after imported whitefish products such as fillets, breaded fish,

fish sticks, etc., reach consumers. Whitefish products from the Pacific region generally have not been competitive either on a national scale or in the international arena. Some signs are evident, however, that this may now be changing.

Processed product sales from Pacific area whitefish, however, are small scale compared with that of over-the-side sales of groundfish which are subsequently processed and marketed by foreigners in a variety of world markets including the U.S.

The competition for U.S. whitefish markets has traditionally come from Canada, Iceland, Norway and Denmark. These countries have generally flooded the U.S. with Atlantic cod, pollock and other whitefish. Most enter the U.S. in the form of frozen blocks or fillets, although increasing quantities of fresh fish are also moving to U.S. markets from Canada. In addition to traditional European and Canadian competitors, South American, South Korean, Polish and Japanese exports of blocks and analog fish products are on the increase. The latter shows significant growth in the U.S. in the past several years.

Domestic Supply and Consumption

Based upon preliminary data, 1985 U.S. civilian consumption of commercial fish and shellfish exceeded 3.43 billion pounds. This was up from the 1984 total of just under 3.22 billion pounds. These figures represent the pounds of edible meat consumed from domestically caught and imported fish and shellfish supplies, and do not include recreational or subsistence fish consumption. On a per capita basis, Americans consumed approximately 14.5 pounds of commercially supplied edible fish and shellfish in 1985. With respect to commercially supplied fillets, steaks, sticks, and portions, the per capita U.S. consumption was estimated to be 5.0 pounds in 1985; up again over the 1984 level of 4.83 pounds per capita.

Data on U.S. supplies of groundfish fillets and steaks suggest that domestic production accounted for approximately 21.7% of the available supply of product in 1985, with imports making up the remaining 78.3%. Total volume was 390.42 million pounds, of which 305.7 million pounds were imported and 84.7 million pounds were domestically produced. These same data suggest that while U.S. per capita consumption of fillets and steaks increased by just under 8.5% between 1985 and 1986, per capita consumption of sticks and portions actually declined by almost 4% over the same period.

While a single year's decline in consumption of sticks and portions does not demonstrate a trend, it is consistent with the generally held opinion that the U.S. consumer is becoming more quality conscious with respect to seafood in general, and more discriminating with respect to specific product forms demanded. This is a tendency which, if confirmed, could work to the advantage of the domestic groundfish fishery, considering that in both 1984 and 1985 U.S. supplies of regular and minced blocks (the raw material from which sticks and portions are produced) were composed of 99.2% imported product and only .8% U.S. product. In fact, between 1975 and 1985 U.S. production of regular and minced block never represented more than a fraction over 1% of the total U.S. supply of this commodity.

It should be emphasized that there will likely remain a substantial market for groundfish blocks in this country for the foreseeable future, given that more than 336.6 million pounds of this product were supplied to the U.S. market in 1985. This does not include the rapidly growing market for surimi analog, which would seem to represent an excellent development opportunity for the domestic groundfish industry. These data do suggest, however, that this is an area of the domestic groundfish market which bears watching in the coming years.

Commercial landings by U.S. fishermen at ports in the 50 states were reported to have been 6.3 billion pounds in 1985, reflecting a decrease of 180.1 million pounds from 1984 levels, although landings of Alaska pollock, salmon, and herring actually increased. Joint venture catches by U.S. fishermen delivering to foreign processing vessels increased by 37% over 1984 levels, reaching 2.0 billion pounds. The major species were flounders, Atka mackerel, and Alaska pollock. The combined catch, both foreign and

domestic, from the U.S. EEZ in 1985 was estimated to be 2.8 million mt. This reflects a 5% increase over 1984 catches, with the U.S. share rising by 9% to fully 59% of the total harvest, (Fisheries of the United States, 1985).

Import Supplies

It has been speculated that imports of groundfish blocks and fillets will not be sufficient to meet U.S. consumption needs in the future. Fishing restrictions and catch quotas imposed on some of the major historical producing nations have reduced inventories available for export. Worldwide demand for groundfish products, as for example the increases observed in the Northern European countries, has reduced the supplies that might be offered to U.S. buyers.

The foreign catch of fish and shellfish from the U.S. EEZ was nearly 1.2 million mt in 1985, 14% below 1984 levels. The foreign catch in the Pacific U.S. EEZ was 1.1 million mt, 203.6 thousand mt less than 1984. Over 91% of this harvest was made in the Bering Sea; 5% off California, Oregon, and Washington; and 4% from the Gulf of Alaska. Alaska pollock reportedly comprised 73% of the total foreign harvest; Pacific flounders, 13%; Pacific cod, 6%; and other fish and shellfish the remainder.

According to Dr. Lee Alverson, Natural Resources Consultants, "Although it is widely believed that considerable quantities of the fish harvested by foreign vessels in the FCZ end up in the U.S. market, the fact is most of the products are sold in foreign markets. Soviet caught hake, rockfish, flounder and pollock are mostly marketed in the Soviet Union and eastern block countries."

"The Japanese, on the other hand, consume almost all of the pollock surimi in their own country where it is made into a variety of kamoboko products, fish sausages, chikuwa, etc. These products are sold in small and large food markets throughout Japan and are estimated to have an annual retail value of $1.5 billion. Most of the other groundfish products from Japanese vessels are also used domestically. Headed and gutted Pacific ocean perch, sablefish and flounders are currently exported from U.S. fisheries to Japan."

"Although it has been noted that most of the Japanese harvest of groundfish from the FCZ off the west coast of the U.S. is destined for (Japanese) markets, in recent years Japan has had considerable success selling surimi-based crab analogs in the U.S., United Kingdom, Australia, New Zealand and western Europe. In 1983 almost 14,000 mt were exported to U.S. markets and it is estimated that the total for 1984 will approach 30,000 mt."

Alverson goes on to report, "South Korean harvests from the FCZ off Alaska are utilized in markets in the U.S., Japan and South Korea. It is apparent that considerable quantities of catches by South Korean vessels and by joint venture operations are exported back to the U.S. in the form of blocks, fillets, steaks, etc."

"Other markets for fish taken off Alaska include exports of pollock blocks to the U.S. markets by Polish vessels, sale of pollock fillets in West Germany from German vessels operating in the Bering Sea, and Taiwanese sale of groundfish in home ports and Japan."

5.3.1.3 Impact on Domestic Groundfish Fishery Development

All of these sources of groundfish supply, extracted from the U.S. EEZ, have an effect upon the availability and price of fishery products at the U.S. consumer level. They also influence, in a potentially significant way, the economic development and performance of the U.S. domestic groundfish fishing industry. As noted above, imports of fish block and whitefish fillet products from Canada, Iceland, and Northern European countries will most probably remain below historic levels for sometime. Because U.S. consumers depend so heavily upon imports for their supplies of these groundfish products, the U.S. domestic market is vulnerable to shortages of some commodities. Indications are that shortages of traditional groundfish products, such as Atlantic cod fillets and blocks, have begun to appear in the major world groundfish markets, with accompanying upward pressure on prices. This situation presents U.S.

producers with potentially new marketing opportunities, for both traditional and nontraditional species and product forms. It will, however, simultaneously open U.S. market opportunities to groundfish suppliers who have not historically sold into the U.S. market, as well as potentially expand access by other traditional suppliers. The resulting direct competition between these foreign suppliers and the developing U.S. domestic groundfish fishing industry, particularly in the North Pacific and Bering Sea, will be a challenging obstacle to overcome enroute to full domestic utilization of the groundfish resource in the EEZ.

5.3.2 Domestic Commercial Fleet Characteristics

The domestic groundfish fleet can be segmented into two major groupings, i.e., wholly domestic operations (DAP) and joint venture (JVP) operations. Janet Smoker, Alaska Region, NMFS, reported of the 1985 JVP fishery, "Over-the-side joint ventures for groundfish off Alaska, which began in 1978, showed a doubling of catch amounts five years in a row. Reasons for this phenomenal expansion included a Magnuson Act amendment which links foreign directed fishery allocations to joint venture participation, and the decline of high-valued Alaska shellfish resources which resulted in the conversion of many U.S. vessels to trawling. The rate of growth finally slowed in 1984, with a total catch of 584,000 mt compared to 352,000 mt in 1983. The total 1985 deliveries were almost 882,000 mt, indicating a slightly lower rate of growth than that of the previous year. The 1985 season was marked by an increase in joint venture partnerships (26 compared to 22 in 1984), and of U.S. vessels (101 compared to 78 in 1984). Other highlights of the 1985 season included expanded catches of species other than pollock (traditionally the bulk of the catch). Catches of Atka mackerel exceeded 38,000 mt. Deliveries of flatfish including yellowfin sole reached 179,000 mt, more than triple 1984's catch of 53,000 mt. Total exvessel value of the 1985 deliveries (of JVPs) is estimated at $98.6 million, compared to $64.5 million in 1984."

"The 1985 joint venture trawl fleet was a heterogeneous group of about 100 U.S. vessels from 98 to 220 net tons, (actual reported range is between 55 and 220 net tons) most in the 120-140 ton range. Many of these trawlers have fished for several years with only one or two foreign partners, and operate in groups of four to thirty, rotating with their sister ships through the season. Others appear to be more opportunistic, working with several different companies over the course of a year. Also in 1985 the first longline vessels delivered turbot to a Taiwanese processor."

"Of the 101 participants in 1985, 26 vessels listed an Alaska port as 'home' (an increase from 20 in 1984); 5 were from California, 18 from Oregon, and 52 from the State of Washington, with the greatest number (41) listing Seattle as home port. Twenty-nine of these vessels fished in their first Alaska joint venture in 1985 (six which fished in 1984 did not return in 1985). Two joint venture trawlers, the ALERT and the ALEUTIAN HARVESTER were lost at sea in 1985."

Of the 1986 "over-the-side" joint venture fishery, she reported, "Deliveries of Alaskan groundfish by U.S. catcher-boats to foreign processing vessels exceeded 1 million mt in 1986. This was the first year that the domestic catch of groundfish exceeded the foreign directed fishery catch. The total deliveries of over 1,218,000 mt represented an increase of more than a third over 1985's tonnage of 882,000 mt. The total exvessel value of the 1986 harvest is estimated at $143.7 million, compared to $98.6 million in 1985."

"Partnerships were formed between twenty U.S. companies and 32 foreign companies: fourteen Korean, eleven Japanese, three Chinese and three Polish. A proposed Taiwanese joint venture did not materialize."

"Total catches of pollock reached 904,000 mt, less than 64,000 mt of which was in the Gulf of Alaska. The yellowfin sole and flatfish fisheries caught 216,000 mt, well over 1985's catch of 179,000 mt despite closures of prime areas because of crab bycatch problems. The Atka mackerel catch was reduced from 1985's catch of 38,000 mt to less than 32,000 mt because of reduced resource availability."

"In 1986 a second attempt was made at a longline joint venture. Unlike 1985's venture, where several U.S. longliners delivered turbot to a Taiwanese processor in the Bering Sea, the 1986 operation involved six boats delivering Pacific cod to a Japanese processor in the Gulf of Alaska."

"The 1986 joint venture trawl fleet was a heterogeneous group of 108 vessels, ranging from 58 to 135 feet: 25 were 120 feet or over, 35 were between 100-119 feet, 40 were between 80-99 feet, and eight below 80 feet. Many of these trawlers have fished for several years with only one or two foreign partners, and operated in groups of four to thirty, rotating with their sister ships throughout the season (which began in late January and ended in the last week of December, with peak activity occurring in mid August). Seventeen of the trawlers and all six of the longliners fished in their first Alaskan joint venture in 1986. Nine trawlers which participated in 1985 joint ventures did not return in 1986."

"Of the 114 participants, 35 indicated a homeport in Alaska (an increase from 26 in 1985); 6 were from California, 13 from Oregon, and 60 from Washington, with the greatest number (53) listing Seattle as home port. One Seattle-based trawler, the KARINA EXPLORER was lost with all hands early in the year."

Total joint venture sales of groundfish in 1985, from waters adjacent to Alaska exceeded, 1.919 billion pounds, i.e., 870.3 thousand mt, with an estimated exvessel value of approximately $98.5 million. In 1986, JVP landings exceeded 2.687 billion pounds, or 1.22 million mt, with an estimated exvessel value of more than $143.6 million, (Table 5.12). The total groundfish production of JVPs in the Gulf in 1985 was 539.1 million pounds, or 244.5 thousand mt, with an estimated exvessel value of $23.9 million. In 1986, the landings dropped to 145.8 million pounds with an estimated exvessel value of $7.2 million, due to the sharp reduction in the pollock quota for the Gulf.

In addition to the domestic capacity associated with the JVP groundfish fisheries, a significant and expanding portion of the domestic harvesting sector is represented by the wholly domestic or DAP component of DAH. In 1985, the DAP groundfish sector operating in the EEZ and internal waters off Alaska included perhaps as many as 1,392 vessels, (Source, ADF&G, August 1986). Total DAP landings of groundfish in that year were 109,250 mt, of which 46,152 mt were processed at sea by "catcher/processors", and 63,098 mt were processed by "shorebased" facilities, (Table 5.13).

In 1985, DAP groundfish catches in the Gulf accounted for approximately 29% of the total DAP harvest in that year, or 31,581 mt. Catches from "internal waters" made up roughly 2%, and landings recorded by ADF&G as "unknown area" represented about 2.5% of the total, i.e., 2,320 mt and 2,729 mt, respectively. The remaining 66.5% of DAP came from the Bering Sea and Aleutian Islands management area.

Estimates place the exvessel value of the Gulf DAP harvest at approximately $15.2 million, in 1985. Total DAP exvessel value for groundfish harvested in the EEZ off Alaska in that year was approximately $41.8 million, (PacFIN Report #212, May 1986). Equivalent catch and earnings data for the 1986 DAP fishery are unavailable owing to the decision by ADF&G to end its tabulation of groundfish fish tickets effective October 1, 1986.

Based upon Vessel Registration Files, compiled by the Alaska Region, NMFS, a total of 1,091 DAP vessels were registered to fish for groundfish in the EEZ off Alaska, in 1986. Those registered in the Gulf numbered 1,063. (Some vessels registered in the Gulf may have fished other areas, as well, and vessels that operated exclusively in internal waters of the state were not included in these totals.) Vessel length categories and gear configurations are summarized below, from the same source, (Table 5.14).

Table 5.12 Annual report joint venture sales; distance from shore version.

| 1986 BERING/ALEUT (in 1000's) | 3 to 12 miles (lbs) | 3 to 12 miles ($) | 12 to 200 miles (lbs) | 12 to 200 miles ($) | Total (lbs) | Total ($) | Wt. Av. Price |
|---|---|---|---|---|---|---|---|
| POLLOCK | 0 | 0 | 1,852,845 | 88,572 | 1,852,845 | 88,572 | 0.048 |
| YELLOWFIN SOLE | 167,891 | 10,176 | 167,891 | 10,176 | 335,782 | 20,352 | 0.061 |
| FLOUNDERS | 68,874 | 4,186 | 68,874 | 4,186 | 137,748 | 8,372 | 0.061 |
| PACIFIC COD | 71,204 | 7,070 | 71,204 | 7,070 | 142,408 | 14,140 | 0.099 |
| ATKA MACKEREL | 70,514 | 4,827 | 0 | 0 | 70,514 | 4,827 | 0.068 |
| P.O. PERCH | 591 | 71 | 11 | 1 | 602 | 72 | 0.120 |
| ROCKFISH | 474 | 57 | 0 | 0 | 474 | 57 | 0.120 |
| SABLEFISH | 941 | 135 | 15 | 2 | 956 | 137 | 0.144 |
| TOTALS | 380,489 | 26,522 | 2,160,840 | 110,007 | 2,541,329 | 136,529 | 0.054 |

| 1986 GULF OF AK (in 1000's) | 3 to 12 miles (lbs) | 3 to 12 miles ($) | 12 to 200 miles (lbs) | 12 to 200 miles ($) | Total (lbs) | Total ($) | Wt. Av. Price |
|---|---|---|---|---|---|---|---|
| POLLOCK | 89,791 | 4,300 | 50,567 | 2,422 | 140,358 | 6,722 | 0.043 |
| FLOUNDERS | 1,098 | 56 | 1,296 | 67 | 2,394 | 123 | 0.070 |
| PACIFIC COD | 2,853 | 282 | 276 | 27 | 3,129 | 309 | 0.120 |
| ATKA MACKEREL | 13 | 1 | 0 | 0 | 13 | 1 | 0.070 |
| TOTALS | 93,755 | 4,639 | 52,139 | 2,516 | 145,894 | 7,155 | 0.049 |

| 1986 ALL ALASKA (in 1000's) | 3 to 12 miles (lbs) | 3 to 12 miles ($) | 12 to 200 miles (lbs) | 12 to 200 miles ($) | Total (lbs) | Total ($) | Wt. Av. Price |
|---|---|---|---|---|---|---|---|
| POLLOCK | 89,791 | 4,300 | 1,903,412 | 90,994 | 1,993,203 | 95,294 | 0.048 |
| YELLOWFIN SOLE | 167,891 | 10,176 | 167,891 | 10,176 | 335,782 | 20,352 | 0.061 |
| FLOUNDERS | 69,972 | 4,242 | 70,170 | 4,253 | 140,142 | 8,495 | 0.061 |
| PACIFIC COD | 74,057 | 7,352 | 71,480 | 7,097 | 145,537 | 14,449 | 0.099 |
| ATKA MACKEREL | 70,527 | 4,828 | 0 | 0 | 70,527 | 4,828 | 0.068 |
| P.O. PERCH | 591 | 71 | 11 | 1 | 602 | 72 | 0.120 |
| ROCKFISH | 474 | 57 | 0 | 0 | 474 | 57 | 0.120 |
| SABLEFISH | 941 | 135 | 15 | 2 | 956 | 137 | 0.144 |
| TOTALS | 474,244 | 31,161 | 2,212,979 | 112,523 | 2,687,223 | 143,684 | 0.053 |

Table 5.13 DAP output, all species, by area for 1985 (in metric tons).

| | Shorebased | Catcher-Processor | Total |
|---|---|---|---|
| SE/SE Yakutat | 2,364 | 1,085 | 3,449 |
| West Yakutat | 2,202 | 639 | 2,841 |
| Central Gulf | 10,039 | 3,165 | 13,204 |
| Western Gulf | 10,832 | 1,255 | 12,087 |
| Bering Sea | 35,084 | 35,513 | 70,567 |
| Aleutians | 239 | 1,813 | 2,052 |
| Internal Waters | 2,267 | 54 | 2,320 |
| Unknown Area | 102 | 2,628 | 2,729 |
| TOTAL | 63,098 | 46,152 | 109,250 |

Source: ADF&G, 1985 Alaska Domestic Groundfish Catch

Table 5.14 Number of Vessels Registered to Fish Groundfish in the EEZ off Alaska, By Length, By Gear Type, 1986.

| Vessel Length (ft) | All EEZ Areas | Gulf of Alaska |
|---|---|---|
| 50 | 765 | 746 |
| 51 - 75 | 218 | 217 |
| 76 - 100 | 68 | 64 |
| 101 - 125 | 16 | 15 |
| 126 | 24 | 21 |
| TOTAL | 1,091 | 1,063 |
| | | |
| Gear Type | | |
| Longline | 926 | 943 |
| Pots | 30 | 28 |
| Trawl | 45 | 40 |
| Longline/pots | 16 | 16 |
| Longline/trawl | 4 | 4 |
| Longline/pots/trawl | 1 | 1 |
| Other* | 33 | 31 |
| TOTAL | 1,091 | 1,063 |

*Other gear types include dredges, gillnets, jigs, and troll.
Source: National Marine Fisheries Service, Alaska Region, 1987.

### 5.3.3 Recreational Fishing Characteristics

In most areas of the state, groundfish, except halibut and rockfish, are not highly regarded as sportfish. Relatively minor recreational fisheries for flounder, Pacific cod, greenling, etc., 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 ADF&G Sport Fish Division data, it appears that recreational use of "groundfish", which would include primarily halibut and rockfishes, accounted for 30.4%, 33.8% and 34.1% of all saltwater finfish sport landings in Alaska in 1983, 1984, and 1985, respectively. Statewide landings of rockfish were estimated to have been 67,610 fish in 1985, the latest data currently available. In that same year, halibut sport landings, statewide, were estimated at 127,634 fish, (ADF&G Statewide Harvest Report, Vol. 27, July 1, 1985 - June 30, 1986).

While recreational use of groundfish has been on the increase, virtually all of the sport catch is taken in the Southeastern and Southcentral regions of the state, and is associated with the larger population centers. Sport "bottomfish fishing", as a recreational category, precludes the separation of effort targeting halibut, a species not managed under this FMP, from effort aimed at the capture of rockfishes, other flatfishes, Pacific cod, etc., which are managed herein. However, it is clear that "bottomfish" as a sport fish resource, is growing in importance, despite the fact that the volume of total harvest of groundfish in the recreational fishery is quite small in comparison to the directed commercial catch.

### 5.3.4 Subsistence Fishing Characteristics

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, is considerably less than during the period prior to the establishment of local retail stores and easily accessible packaged foods. Of the groundfish species, halibut is the most extensively preferred and utilized, statewide. Clark (1974) has noted the continued use of cod and greenling in the Aleutians. Flounders and sculpins are occasionally speared in shallow lagoons of the Kodiak area, and in Southeast Alaska, the native people continue to subsist on the traditional species.

The commercial fishermen of Alaska reportedly utilize, to varying degrees, the groundfish taken incidentally to their target species. The extent of this use is difficult to measure with any accuracy, but is believed to be extensive.

### 5.3.5 Native Treaty Fishing Characteristics

Two coastal Native reservations, Annette Island and Karluk, are on the Alaska coast. These reservations extend 3,000 feet seaward from land, and are therefore well within State waters. While the Native residents generally abide by State laws and regulations (with the notable exception of Annette Island's salmon traps), the Secretary of the Interior has the authority to regulate the fisheries within the reservation boundaries.

5.3.6 Area Community Characteristics

Profiles of over 100 Alaska coastal communities are available for reference through the following agencies: North Pacific Fishery Management Council (Anchorage, AK); National Marine Fisheries Service, Alaska Region (Juneau, AK), Northwest Region (Seattle, WA), and Northwest and Alaska Fisheries Center (Seattle, WA); and Alaska Department of Fish and Game (Juneau, AK).

5.4.1 Domestic Fisheries

5.4.1.1. Regulatory Measures

Fishery restrictions on U.S. nationals are those established by the State of Alaska, the U.S. Department of Commerce, and those promulgated by the International Pacific Halibut Commission (IPHC) for the taking of Pacific halibut. The State of Alaska requires all commercial fishermen landing any species of fish or shellfish in Alaska to possess a commercial fishing license, and the captain or owner of all fishing vessels are required to license their vessels and the fishing gear employed. Buyers are required to keep records of each purchase and show the number and name of the vessel, the State license number of the vessel, date of landing, pounds purchased of each species, statistical area in which the fish were caught, and the kind of gear used in taking the fish. Federal regulations pertaining specifically to groundfish include the specification of legal gear, quotas, time/area restrictions, and bycatch limits. The most substantive regulations on groundfish fishing in the Gulf of Alaska are for sablefish where a catch quota, specific gear allocations, area restrictions, and time restrictions are in effect.

Restrictions by the IPHC on the taking of Pacific halibut pertain to licenses, gear, size limits, seasons, and catch quotas. Licenses issued by the IPHC are required for all commercial vessels fishing for halibut, including charter boats carrying recreational fishermen. Prior to 1984 only vessels five net tons or larger that fished with hook and longline gear required a commercial license. In regard to both commercial and sport gear, only hook and line gear is authorized by the IPHC for the taking of halibut.

5.4.1.2 Purpose of Regulatory Measures

The limited number of groundfish regulations currently in effect by the State of Alaska, excepting the southeast Alaska sablefish regulations, are designed for the protection of other fish (salmon, herring, juvenile halibut) and shellfish species, e.g., the pot gear definitions and gill netting, otter trawling, and seining restrictions. They are published annually by the Alaska Department of Fish and Game.

The State's sablefish quota which applies to the northern, inside districts of Southeastern was established upon request of the fishermen in an attempt to reduce the decline of the inshore sablefish stocks. Since abundance and fishing mortality data were not available for inside waters, historical catch data were examined; and the quota was set as a temporary conservation measure. For the most part, gear and season restrictions for the sablefish fishery are based on economic and social considerations. Most sablefish fishermen are engaged in other fisheries during the summer. Therefore, the season in the traditional, northern grounds is delayed until September. Furthermore, the flesh quality is superior in the fall after the fish have recovered from spawning during the spring. For the closing date it was the consensus of opinion that if the sablefish quota could not be taken by November 1 the season should close. The deteriorating weather conditions during the fall also had influence on this decision.

Regulations by IPHC successfully helped rebuild the halibut stocks to levels which will produce the maximum sustained yield. Current regulations are designed to maintain the stock at abundance levels compatible with optimum sustainable yield. Regulations for the halibut fishery are published annually by the IPHC.

Federal fishery regulations have governed foreign and domestic groundfish fisheries through this FMP since 1978. The purpose of the management measures was to meet the MFCMA National Standards, achieve the goals and objectives of this plan, and encourage development of the domestic groundfish fishery.

Regulations governing the fishery are published annually by the National Marine Fisheries Service (NMFS).

### 5.4.2 Foreign Fisheries

#### 5.4.2.1 Regulatory Measures

The three kinds of restrictions placed on foreign nations have been:

(1) U.S. law establishing a 12-mile contiguous fishing zone (CFZ) within which all foreign fishing and activities in support of fishing are prohibited. This law was approved on October 14, 1966. Enforcement of the CFZ and territorial waters is accepted by other fishing nations as a U.S. right and responsibility.

(2) Provisions contained in bilateral and other agreements signed by foreign nations with the U.S. These provisions usually have been agreed upon through a negotiating process in which concessions have been made by foreign governments to U.S. fishery interests in exchange for concessions granted by the U.S. to the fishery interests of the other nations. Concessions granted by the U.S. have been in the nature of permission to fish or carry out activities in support of fishing at certain times and places within the CFZ. Concessions granted by foreign nations have been in the form of agreement not to fish at certain times and places on the high seas outside the CFZ, not to target on certain species, and not to exceed certain levels of catch (catch quotas).

(3) U.S. law establishing a 200-mile exclusive economic zone (EEZ) within which all fishery resources which dwell on or near the continental shelf, including highly migratory species and anadromous species which spawn in U.S. rivers or estuaries, will be harvested, protected, and managed in compliance with the National Standards described in the MFCMA. This law was approved in April 1976 and has been amended several times since. Foreign fisheries are prohibited in the EEZ unless a foreign quota allocation has been provided under the procedures described in fishery management plans.

Enforcement of the provisions of bilateral and other agreements has been the responsibility of the individual nations. For example, the Japan has been responsible for enforcing and imposing penalties on its own nationals for violations relating to fishing activities on the high seas, outside the U.S. EEZ.

Within the EEZ several restrictions on foreign nations in the form of catch quotas and time-area closures have been used in the Gulf of Alaska groundfish fisheries in recent years. Current regulations pertaining to the foreign fisheries are found in 50 CFR 611(g).

#### 5.4.2.2 Purpose of Regulatory Measures

The earliest restrictions placed on foreign fishermen were primarily to prevent conflicts between foreign mobile gear (trawls) and domestic fixed gear (crab pots and halibut setlines). In the early 1970s, when halibut production was low, at least partly because of the incidental catch by foreign trawlers, winter trawl closures in the central and western Gulf of Alaska (time and area of known halibut concentrations on the trawl grounds) were negotiated. Finally, beginning in 1973 when certain major groundfish stocks clearly began to deteriorate, national catch quotas were also negotiated. With implementation of the MFCMA, foreign groundfish quotas have been annually determined by the Council.

### 5.4.3 Effectiveness of Management Measures (Foreign and Domestic)

Regulations aimed at reducing gear conflicts have been, without question, successful. Loss of U.S. fixed gear declined to a low level with recent losses occurring only in areas not covered by trawl or pot closures.

Regulations designed to mitigate conservation problems, however, have had mixed success, as witnessed by the fact that halibut and sablefish stocks have recovered from previous low levels while Pacific ocean perch have remained depressed. This is, in part, due to the fact that halibut and sablefish have relatively short lifecycles and faster growth rates as compared to Pacific ocean perch and other rockfish. Aging studies have shown that halibut and sablefish live to about 30 and 20 years, respectively, compared to rockfish where ages of 70-105 years are not uncommon. Both halibut and sablefish recruit into the fishery at an early age due to their high rates of growth. Results of management increases designed to rebuild these stocks will be observed first with the short-lived/fast-growing species. Rockfish stocks which may experience only one successful year class every 20 years will take much longer to rebuild due to their longevity and slow rate of growth.

In the case of the halibut fishery, continual and substantial restrictions imposed on North American setline fishermen by IPHC, coupled with reduced incidental catches by foreign fisheries and better natural production have increased halibut abundance. Winter trawl closures and restrictions on the use of bottom trawls were partially responsible for reducing incidental catches. Bycatch limits for the domestic fishery have probably not been a factor to date in reducing incidental halibut catches, but without continued implementation of bycatch controls, future increases in the domestic groundfish fishery would cause serious loss of halibut productivity.

5.4.4 History of Research

Investigations of the groundfish resources of the Gulf of Alaska have been conducted by the U.S., Canada, Japan, and U.S.S.R. Research efforts by the U.S. have been of the longest duration (1880 to present) and were initiated to assist the development of U.S. cod and halibut fisheries in the latter part of the 19th century. Canada began cooperative research with the U.S. on the halibut stocks of the Gulf of Alaska in the 1920s under the authority of the Halibut Conservation Treaty. This cooperative research continues to the present day under the direction of the International Pacific Halibut Commission. Research by Japan and the U.S.S.R. in the Gulf coincided with the development of their trawl fisheries in the Gulf of Alaska in the early 1960s and cooperative research has continued. A major cooperative trawl survey with Japan occurred in 1984 in the Central and Western Gulf. A cooperative longline survey with Japan for sablefish and cod has been conducted annually since 1979 and has become a key stock assessment tool for sablefish in the Gulf of Alaska.

5.4.4.1 United States (see also 5.4.4.5)

The earliest investigations of the bottomfish and shellfish of the northeastern Pacific and Bering Sea were those of the U.S. Fish Commission's steamer, Albatross, during the years 1889 through 1921. Included in these investigations were surveys of the cod and halibut banks of Alaskan waters.

In 1940 Congress provided funds authorizing the U.S. Fish and Wildlife Service to investigate the extent of the king crab resources off Alaska. Included in the king crab surveys of 1940 and 1941 was an assessment of groundfish potential in the western Gulf of Alaska and eastern Bering Sea. Sampling was conducted using standard commercial gear so that catch rates could be equated with those occurring in areas of established commercial fisheries. This was the first attempt to systematically examine the commercial potential of demersal fish and shellfish of Alaskan waters.

In 1953 assessment of Gulf of Alaska groundfish was resumed when the Bureau of Commercial Fisheries (BCF) vessel, John N. Cobb, conducted trawling off Yakutat. Since then the BCF (later the NMFS) carried out 19 cruises to examine the distribution, relative abundance, and biological characteristics of groundfish in various regions of the Gulf. Surveys conducted since 1973 have covered most of the Gulf of Alaska from Yakutat in the eastern Gulf to waters off Unalaska Island in the western Gulf. These surveys provided estimates of exploitable biomass of pollock and other major groundfish species for this extensive region. Trawl surveys conducted in 1981 and 1984 provided abundance estimates for major groundfish species in the Eastern, Central, and Western Regulatory Areas of the Gulf.

In addition to these trawl surveys of groundfish, NMFS scientists have studied the identification, distribution, and density of eggs and larvae of Gulf of Alaska groundfish. Icthyoplankton surveys began in the Kodiak region in 1972. Since then many surveys have been conducted Gulfwide. The surveys provide an index to the condition of a variety of groundfish stocks.

During the period 1964-1969 U.S. observers were allowed aboard Japanese trawlers in the Gulf to record the incidence of halibut. The observer program was resumed in 1975 and its objectives were expanded to include the collection of information on catch composition and biological data on the target species and recording the incidence of Tanner and king crab. In 1974 U.S. observers were allowed aboard U.S.S.R. trawlers in the Gulf. The passage of the FCMA in 1976 provided for increased observer coverage of all foreign fisheries off Alaska. The program was enlarged in the early 1980s to include the placement of observers on foreign vessels participating in joint venture fisheries. Legislation was also passed in the early 1980s which required 100% observer coverage by 1984. The observer program is presently an important research activity under the direction of NMFS.

From analyses of research data and of foreign fishery statistics, NMFS scientists prepare reports that assess the condition of specific groundfish resources as well as provide recommendations for resource use.

Scientists of the Alaska Department of Fish and Game compile and analyze catch and effort statistics from the domestic groundfish fisheries of the Gulf.

Observer programs for domestic fisheries have not yet been established. However, occasional observer trips have been conducted by the Alaska Department of Fish and Game on trawl and setline vessels. Catch composition and prohibited species catch data were typically collected.

In 1971 the NMFS initiated a sablefish tagging program to study the relationship between stocks (Thorsen and Shippen, 1975). Sablefish tagging was conducted in southeastern Alaskan waters in 1972 and 1973 using the U.S. research vessels, George B. Kiley and John N. Cobb. Until 1980 the tagging study was a cooperative endeavor between the fishery agencies of California and Oregon, and those of U.S.S.R. and the Republic of Korea.

With the closure of the waters off southeastern Alaska to the Japanese longline fishery in 1978, catch per unit effort data from the foreign observer program was no longer available to follow trends in abundance. The NWAFC initiated a sablefish trap survey off southeastern Alaska in 1978 which has been conducted annually to assess abundance and release tagged fish.

The Alaska Department of Fish and Game conducted a sablefish tagging program in southern southeast inside waters during 1979-1983 and voted a size related pattern in the direction of recoveries.

A cooperative longline survey with Japan for sablefish and cod has been conducted annually since 1979 and has become a key source of stock assessment information for sablefish in the Gulf, as well as provides Gulfwide releases of tagged sablefish.

A cooperative sablefish tag analysis effort developed a common data base of the release and recovery information on sablefish in the Northeastern Pacific for the years 1978-1983. The data results largely from tagging conducted by the Canadian Department of Fisheries and Oceans, the Far Seas Fisheries Research Laboratory of Japan, NWAFC, and the Alaska Department of Fish and Game.

5.4.4.2 Canada

For Canadian research conducted under the auspices of the International Pacific Halibut Commission see Section 3.4.5.

During the period 1963-1966, the Fisheries Research Board of Canada investigated the rockfish of the Gulf of Alaska. A trawl and echo-sounder survey was conducted using the research vessel G.B. Reed.

Objectives of the survey were to examine the distribution, abundance, and biology of rockfish with primary emphasis on Pacific ocean perch (Westrheim, 1970). In 1970 further studies on rockfish of southeastern Alaskan waters were pursued using the G.B. Reed.

5.4.4.3 Japan

Japanese research in the Gulf arose over concern by U.S. and Canadian scientists of the bycatch of halibut in the Japanese trawl fishery for Pacific ocean perch. Through the International North Pacific Fisheries Commission cooperative research was initiated in 1963 to determine the effect of Japanese trawl fisheries on halibut stocks.

Japan conducted experimental trawling to measure the incidence of halibut in trawl catches. U.S. observers were allowed aboard Japanese vessels to record the bycatch of halibut in the perch fishery. This arrangement continued until 1969. Also in 1963 Japanese exploratory trawlers were involved in the tagging of halibut in the western Gulf of Alaska. Tagging of halibut continued in 1964 and in various years from 1965 to 1970.

The first survey of groundfish resources by Japan of any magnitude occurred in 1965 when the biological characteristics and availability of groundfish were investigated. Tagging of both halibut and cod was conducted with some fishery experiments to measure the incidence of halibut in trawl catches. Research vessel surveys resumed in 1970 and continued until 1974 and were limited to the western Gulf of Alaska. Principal resources surveyed were those of pollock, Pacific ocean perch, and sablefish. During some of these surveys, investigations concerning the distribution of ocean perch were pursued. In 1984 the U.S. and Japan conducted a cooperative trawl survey of the Central and Western Gulf. Sablefish have also been tagged throughout the Gulf during the U.S.-Japan cooperative longline survey which has been conducted annually since 1979. This data has contributed significantly to a reevaluation of earlier conclusions on sablefish stock structure in the Gulf of Alaska. Since 1963 Japan has reported to INPFC the incidence of halibut in their trawl fisheries of the Gulf and detailed statistics on their groundfish fisheries including length frequency data on some of the principal species. Beginning in 1970 information on the age composition of some of the principal species in the fisheries has also been collected.

Japanese scientists have also submitted reports on the condition of Pacific ocean perch and sablefish stocks based on research vessel findings and fishery statistics.

5.4.4.4 U.S.S.R.

Soviet groundfish research in the Gulf of Alaska began in 1960 and was directed principally on rockfish, mainly Pacific ocean perch (Lyubimova, 1961 and 1962). Surveys were conducted to determine the extent of the resources, the behavior and movement of schools, and biological characteristics. Ichthyoplankton surveys were also conducted. In recent years U.S.S.R. research in the Gulf has shifted to ichthyoplankton surveys of pollock and Atka mackerel.

5.4.4.5 International Pacific Halibut Commission (IPHC)

Investigations by IPHC on the halibut resource have been conducted since 1925. One of the Commission's first major undertakings was a tagging program to determine the extent of migration of halibut between the various fishing banks in the northeastern Pacific and arrive at estimates of mortality. There had been earlier studies before the Commission was formed on the life history of halibut and management of the fishery (Thompson, 1916 a, b and 1917). Studies of the biology of halibut continued in the early 1930's and were concerned with the early life history, embryonic and larval development, location of spawning areas, the transport of eggs and larvae, and the environment of halibut (Thompson and Van Cleve, 1936).

By the early 1930s the halibut stocks had declined to a low level of abundance, but through careful management by IPHC the stocks increased and began producing high catches in the Gulf of Alaska by the late 1950s.

Anticipating the eventual growth of foreign trawl fisheries in the Gulf of Alaska, IPHC completed a Gulfwide and season survey of groundfish in 1961-63 to obtain information on the possible effects of such fisheries on the halibut stocks, and in turn, upon the Canadian and U.S. halibut setline fishery of this region (IPHC, 1964).

Later in the mid-1960s, IPHC resumed halibut tagging studies in the Gulf of Alaska and, in 1967, initiated an annual trawl survey of juvenile halibut as a means of measuring both the strength of year classes before their entry into the fishery and the impact of the trawl fisheries on the juvenile halibut population. In 1976 IPHC began an annual survey with setline gear to assess the adult portion of the halibut population in the northern Gulf of Alaska (Portlock and Albatross fishing grounds). The survey provides measures of stock density, recruitment, mortality, and growth, and halibut are tagged and released.

In the late 1970s and early 1980s, IPHC conducted extensive tagging studies designed to quantify movements of juvenile and adult halibut between U.S. and Canadian waters. During 1982-85, experiments were conducted to investigate differences in fishing power (catch and CPUE) between: (1) conventional and snap setline gear; (2) "J" hooks and circle hooks; and (3) various hook spacings on setline gear.

## 5.5 Interaction Between and Among User Groups

### 5.5.1 Domestics

The potential for conflicts between domestic users will be increased both directly and indirectly with the advent of an extensive groundfish trawl fishery. Presently within the Gulf of Alaska shellfish fisheries there exist gear conflicts between the users of mobile and stationary gear, specifically between the shrimp trawlers and king and Tanner crab fishermen. Because of the relatively restricted inshore distribution of commercially harvestable shrimp stocks and the timing of the shrimp and crab seasons, user groups can choose alternate grounds and thereby reduce confrontations between user groups. However, with a groundfish fishery dragging within a wide range of depths and habitat types, voluntary actions on the part of the fishermen may no longer present a workable solution to the problem.

Conflicts between different types of stationary gear will also occur. The use of pots in the sablefish fishery has led to significant gear conflicts since the heavy pot longlines, when placed on the very light hook and longlines, prevent the light gear from being retrieved without entanglement or breakage. The use of pot gear along a relatively narrow depth range found productive for harvesting sablefish often leads to preemption of those grounds in favor of pot gear. In the past, domestic fishermen have avoided these grounds to prevent gear conflicts. In 1985 management measures were implemented to phase out pot gear in favor of hook and longline gear as the primary gear type for use in harvesting sablefish. Trawl gear is permitted in the sablefish fishery but its share of the directed sablefish quota is limited with most of the sablefish intended for bycatch purposes.

Indirect competition involving the capture and destruction of incidentally caught species, especially high valued crab, sablefish, halibut, and salmon fisheries, presents another conflict among domestic fisherman. Legal-sized male, juvenile and female crabs, juvenile and adult sablefish and halibut, and migrating salmon are distributed over vast areas of the Continental Shelf. From National Marine Fisheries Service surveys, it is known that groundfish and crab distributions overlap to a substantial degree. Further study is necessary to delineate potential groundfish fishing grounds with respect to shellfish, sablefish, halibut, and salmon distributions and thereby determine the extent of potential conflict.

The prohibited species concept, which had its origins in the salmon abstention provisions of the original International Convention for the High Seas Fisheries of the North Pacific Ocean and in the old bilateral fisheries arrangements, is an important element for managing fisheries under terms of the MFCMA. In 1981 federal regulations specified that there could be no directed foreign fishery for prohibited species and that any prohibited species that are taken incidentally in target fisheries must be returned to the sea immediately, dead or alive, and with minimum injury (NPFMC Document #13). Presently in the Gulf of Alaska, halibut, king crab, Tanner crab, and Pacific salmon are defined as prohibited species to both

foreign and domestic groundfish fisherman. Prohibited species catch limits are often used to place a cap on incidental harvests.

Historically, it has been difficult to effectively measure the adverse effects of incidental catch on domestic king and Tanner crab, salmon and halibut fisheries because of the limited availability of accurate data. However, since 1977 the NMFS has systematically dispatched fisheries observers to the foreign and joint venture flees operating off the Northwest coast of the U.S. to collect data which allows the U.S. to estimate the foreign commercial catch and ensure adherence to quotas, to determine the incidental catch of prohibited species, to provide information needed to assess the biological status of various stocks of fish, and to report suspected violations (NPFMC Document #13). The foreign and joint venture observer program provides reasonable estimates of prohibited species caught in the Gulf of Alaska foreign groundfish fishery. Unfortunately, the current NMFS observer program does not include domestic vessels, but plans are being made to include domestic vessels as foreign fleets are displaced by the expanding domestic industry.

Although the State of Alaska's domestic fisheries observer program has been in existence since 1977, catches of prohibited species are not extensively sampled. Since the target specie catch in the domestic groundfish fishery has been insignificant compared to catches in the foreign and joint venture fisheries, the impact of the prohibited species catch in the domestic groundfish fishery is also assumed to be small (NPFMC Document #21).

It is difficult to accurately estimate domestic king and Tanner crab, salmon and halibut economic losses due to the incidental catches of prohibited species because of the lack of information concerning natural fishing mortality rates. Estimated natural mortality rates are based upon may interrelated factors such as life cycles, predator/prey relationships, and habitat requirements. Estimated incidental fishing mortality rates of prohibited species are based upon a limited number of tag and release studies which indicate that the rates depend on the species and gear type involved and may range from 25% to 100%.

5.5.2 Impacts on halibut from other Fisheries

The halibut fishery in the Gulf of Alaska is affected by domestic fisheries for shrimp, crab, and groundfish (primarily flounders), and by foreign and joint venture fisheries for groundfish. The kinds of impacts include destruction of gear, preemption of fishing grounds, and a reduction in abundance that results from the incidental capture of halibut.

The effect of domestic fisheries on halibut have been less than by foreign fisheries. Gear conflicts between domestic fisheries have been minimal, but the annual incidental halibut catch by domestic shrimp and crab fisheries, although not precisely known, has averaged about 1,500 mt west of Cape Spencer to Unimak Pass (IPHC Area 3) during 1980-84. This would represent about 13% of the catch by the halibut fishery in this area during the same period. Incidental catches in the domestic trawl fishery has grown and developed. However, estimates of the incidental catch by domestic trawlers are unavailable due to the lack of observer data. A major impact on the halibut fishery could occur as effort toward groundfish increases. An incidental catch of about 1,200 mt now occurs annually in the Canadian trawl fishery for groundfish off British Columbia (IPHC unpublished). Incidental catch probably occurs in the domestic setline fishery for sablefish, but is likely low due to the different distribution of the two species when the fishery takes place. Several observer trips were conducted by ADF&G in 1984 and halibut comprised less than 1% of the total catch by weight.

Regarding foreign fisheries, reports by halibut fishermen of gear conflicts or preemption of fishing grounds are rare at the present time. During the 1970s it was no unusual for conflicts of this type to occur. With the decline in foreign fishing and the shortening of the commercial halibut season to a few days in length in recent years, the likelihood of such conflicts has become minimal. However, if such a conflict were to occur today, the impact on the halibut fishermen would be severe, as the loss of a two-day fishing period could eliminate on-half of the available fishing time, based on 1986 IPHC Area 3 fishing seasons. The more important effect of foreign fishing is that of incidental catches. Although foreign vessels target on

species other than halibut, halibut are taken incidentally in substantial numbers. Regulations require that halibut caught incidentally be released, but most die from injuries received during capture (IPHC, pers. comm.). Hoag and French (1976) used data collected by observers to estimate the annual incidental catch by foreign trawlers in the Gulf of Alaska (including the British Columbia coast). Their estimates show that the catch peaked in 1965 at about 9,000 mt (1,500,000 fish) and declined to about 4,000 mt in 1974. By 1984, the incidental catch by foreign trawlers was about 500 mt (IPHC unpublished). The majority of these halibut were 3 to 7 years old and less than 10 pound. Total (foreign plus domestic) incidental trawl catch in recent years, therefore, has averaged about 1,700 mt, with and additional 1,500 mt taken incidentally by domestic fisheries for crab and shrimp. Incidental catch in the foreign setline fisheries has increased from less than 100 mt in 1978 to almost 2,000 mt in 1983. Since then, halibut bycatch has declined, probably due to the domestic takeover of the sablefish fishery in 1983-84. While no information is available as to the halibut bycatch in the domestic setline fishery, it is assumed that in the sablefish fishery, similar incidental catches of halibut will occur.

Incidental catches from all sources are shown in Table 5.15.

Table 5.15 Estimated incidental catch of halibut in the Gulf of Alaska (IPHC Areas 2 and 3, not including the Pacific coast) for 1978-1986. Figures are in metric tons, round weight (IPHC unpublished).

| | | | | | Domestic | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Foreign | | Joint | Shrimp | Fish Trawl | | | Crab | |
| Year | Trawl | Setline | Venture | Trawl | B.C. | S.E. | Gulf | Pot | Total |
| 1978 | 1,217 | 72 | 0 | 121 | 1,774 | 0 | 15 | 2,110 | 5,309 |
| 1979 | 2,365 | 210 | 21 | 84 | 2,234 | 2 | 44 | 2,309 | 7,269 |
| 1980 | 2,087 | 1,119 | 48 | 92 | 1,656 | Trace | 25 | 2,566 | 7,593 |
| 1981 | 1,192 | 1,307 | 5 | 46 | 1,433 | 10 | 51 | 2,243 | 6,287 |
| 1982 | 1,175 | 1,515 | 4 | 30 | 1,046 | NA | NA | 1,691 | 5,474 |
| 1983 | 772 | 2,463 | 356 | 14 | 1,137 | NA | NA | 1,084 | 5,826 |
| 1984 | 517 | 989 | 590 | 11 | 1,296 | NA | NA | 808 | 4,283 |
| 1985 | 24 | 217 | 300 | 8 | 1,375 | NA | NA | 785 | 2,709 |
| 1986 | 0 | 341 | 81 | 10 | 1,327 | NA | NA | 663 | 2,422 |

Joint venture fisheries for groundfish (primarily pollock) began in the Gulf of Alaska in 1978. NMFS observer are placed aboard the mothership processor to monitor the species composition of the groundfish catch and the catch of prohibited species. Incidental catches of halibut were relatively low through 1982, generally less than 50 mt annually. The development of fisheries for flounders dramatically increased incidental halibut catches to about 600 mt in 1984 (NMFS unpublished).

Hoag (pers. comm.) used estimate of the incidental halibut catch (excluding the catch by the domestic shrimp and crab fisheries) and assessed the effect of trawling on the North American setline fishery for halibut. The results showed that trawling reduced the survival of juvenile halibut and, therefore, recruitment to the setline fishery. The estimated yield loss to the setline fishery was substantial, averaging about 5,000 mt annually during 1967-1974 and representing nearly 50% of the setline catch west of Cape Spencer during that time.

Measures to protect the halibut stocks from the effect of trawling and to reduce incidental catches by trawlers have generally consisted of combinations of time and area closures. In addition, domestic trawling has been limited by a PSC (Prohibited Species Catch) cap of 81 mt of incidentally caught halibut. Neither

strategy proved effective in controlling incidental catches of halibut, as concentrations of halibut occur throughout the Gulf of Alaska and closing one area resulted in a shift of effort to another area where halibut concentrations were nearly as high. In the case of the domestic trawl fishery, the PSC limit unnecessarily hampered the development and expansion of the fishery. In 1985 the Council adopted a flexible PSC strategy, whereby annual PSC limits would be set, which would be dependent upon the bycatch needs of the trawl fishery and the conditions of the halibut resource. For 1986, PSC limits of 1,885 mt for domestic bottom trawlers and 322 mt for joint venture fishermen were set.

The incidental catch of halibut in the Gulf varies with fishery, area, and season. The incidence of halibut observed in the foreign trawl, foreign setline, and joint venture fisheries during 1977-1982 is shown by month and area in Table 5.16 (NMFS unpublished). Data were not available for all month-area blocks, but some difference were apparent. Incidence rates tend to be highest on foreign setline operations fishing less than 500 m, with rates greater than 10 halibut per metric ton of total catch generally observed. Rates on foreign trawlers were highest during spring and early summer months, approaching 8 halibut per metric ton, but were usually less than 3 halibut per metric ton at other times of the year. Foreign setline operations fishing greater than 500 mt typically target on sablefish and rates in this fishery were highest in the early winter, as halibut tend to be in deeper water for spawning and resulting in an overlap of halibut and sablefish distributions. Joint venture operations in the winter target on mid-water concentrations of pollock and extremely low rates are found in this fishery. Joint venture bottom trawl fisheries for flounders, cod, and pollock are conducted in the summer months, but incidence rates are quite variable, ranging from 0.0 to almost 18 halibut per metric ton. Rates in the joint venture summer operation tend to be higher than those observed in the foreign trawl summer fisheries.

Gear modifications offer an opportunity to save halibut without seriously affecting operations for other fisheries. Properly fished pelagic trawls do not catch halibut. In 1976, gear experiments were conducted to test the effects of off-bottom versus on-bottom trawls (Pereyra et al., unpublished document submitted to INPFC in 1976). Data were collected on Japanese stern trawlers fishing for pollock with two types of trawls: an on-bottom net that is commonly used in the Japanese pollock fishery, and an experimental off-bottom net that was similar in construction to the on-bottom net except that dropper chains of up to 2 m were placed between the bobbins and footrope. The average incidence was 1.9 halibut per metric ton of groundfish in the on-bottom net compared to 0.7 per metric ton in the off-bottom net. Another important result was that trawlers apparently can successfully harvest pollock with the off-bottom net; in fact, the groundfish catch was actually higher with the experimental off-bottom trawls, 9.5 mt per hour compared to 8.9 mt per hour in the on-bottom nets. Similar results were collected from modified nets tested by IPHC, NMFS, and the Japan Fishery Resources Research Center during 1982-84.

### 5.5.3 Trawl vs. Salmon

During the mid-1970s Japan and the U.S.S.R. permitted U.S. scientific observers aboard their trawler fishing in the northeastern Pacific to sample the catch. One of the observers' duties was to determine the incidence of salmon in the daily trawl landings. Although sampling was limited and did not occur in all areas each month, salmon were observed in trawl catches in each of the major statistical areas from Shumagin Area to Vancouver Area.

Since then, U.S. observers have been placed on numerous foreign harvesting and processing vessels to continue monitoring both directed and incidental catches. Salmon are usually only found in trawls in trace quantities since their trawl operations are conducted in areas or time of year when salmon are not abundant. In the fall of 1984, 72,000 salmon were captured incidentally in mid-water trawls directed at pollock and around Kodiak Island. This bycatch was considered unacceptable and voluntary measures were agreed by the fishing industry to reduce incidental salmon catches. In 1985 the incidental catch was reduced to 15,000 salmon, in part due to the self-imposed bycatch limits.

Salmon taken by trawlers in the northeastern Pacific have been primarily chinook salmon (Oncorhynchus tschawytscha) with occasional sockeye (O. nerka), silver (O. kisutch), and chum salmon (O. keta) observed in the catches.

**Table 5.16** The average incidence of halibut (number per mt of groundfish) in foreign and joint venture fisheries in the Gulf of Alaska, by month, area, and fishery, 1977-1982 (Wall, French, Nelson, Hennick, and Berger, NMFS, unpublished documents).

| | MONTH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fishery & Area | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
| **Foreign Trawl** | | | | | | | | | | | | |
| Shumagin | 0.000 | 5.544 | -- | 5.649 | 5.648 | 1.847 | 0.645 | 0.489 | 0.423 | 1.615 | 0.846 | 1.068 |
| Chirikof | 0.015 | 6.510 | -- | 1.204 | 2.513 | 1.268 | 1.365 | 0.943 | 0.394 | 0.678 | 0.959 | 0.010 |
| Kodiak | -- | 7.845 | -- | -- | 3.222 | 0.986 | 1.196 | 1.110 | 1.494 | 2.101 | 14.951 | -- 1/ |
| Yakutat | -- | 6.399 | 3.867 | 3.020 | 2.048 | 1.583 | 1.024 | 2.686 | 2.808 | 2.220 | 2.654 | -- |
| Southeastern | -- | 5.415 | -- | 1.391 | 0.904 | 0.856 | 0.852 | 0.702 | 0.790 | 1.885 | 4.222 | -- |
| **Foreign Setline ( 500 m)** | | | | | | | | | | | | |
| Shumagin | 15.417 | 7.175 | 9.508 | 8.993 | 40.102 | 39.101 | 3.547 | 13.026 | 6.705 | 3.660 | 4.376 | 5.394 |
| Chirikof | 11.031 | 10.483 | 16.590 | 18.851 | 14.046 | 5.469 | 2.660 | 6.606 | 9.080 | 6.903 | 9.919 | 11.364 |
| Kodiak | 169.388 | 34.202 | -- | 23.647 | 27.649 | -- | -- | 12.038 | 8.916 | 43.797 | 18.557 | 26.530 |
| Yakutat | -- | -- | -- | -- | 112.000 | -- | -- | -- | 24.660 | -- | -- | -- |
| Southeastern | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Foreign Setline ( 500 m)** | | | | | | | | | | | | |
| Shumagin | -- | -- | 0.000 | 0.000 | 0.253 | 0.363 | 0.000 | 0.000 | 0.014 | 0.250 | 0.330 | 13.596 |
| Chirikof | 0.000 | -- | 2.084 | 0.617 | 0.000 | 0.000 | 0.627 | 0.000 | 0.000 | 0.000 | 2.688 | 5.414 |
| Kodiak | 0.000 | 17.910 | 4.590 | 0.301 | 0.086 | 0.000 | 0.000 | 14.000 | 0.000 | 0.990 | 1.543 | 3.547 |
| Yakutat | 0.000 | -- | 0.507 | 0.704 | 4.283 | 0.056 | 0.251 | 0.000 | 0.073 | 3.055 | 3.525 | 0.051 |
| Southeastern | -- | -- | -- | -- | -- | -- | -- | -- | 0.000 | 0.000 | -- | -- |
| **Joint Venture** | | | | | | | | | | | | |
| Shumagin | -- | -- | -- | 8.734 | 4.975 | -- | 2.251 | -- | -- | -- | -- | -- |
| Chirikof | 0.014 | 0.002 | 0.008 | 3.039 | 2/ | 10.866 | -- | 0.000 | -- | -- | -- | --- |
| Kodiak | -- | -- | -- | 0.157 | 2.712 | 17.977 | -- | -- | -- | -- | -- | -- |
| Yakutat | -- | -- | -- | 19.277 | 0.248 | -- | -- | 0.000 | -- | -- | -- | -- |
| Southeastern | -- | -- | -- | -- | -- | -- | -- | 0.581 | -- | -- | -- | -- |

1/ Two unusually high values (78.462 for Japanese small trawlers in 1979, and 85.185 for Korean small trawlers in 1982) are included. Average incidence rate without these values is 3.156.

2/ One unusually high value (15.189); without it, average incidence is 0.002.

5.5.4 Trawl vs. Crab Fisheries

Trawling in the waters near Kodiak Island has resulted in significant crab bycatches, loss of fixed crab gear and also in preemption of grounds, because crab fishermen avoid areas where trawling occurs. With the dramatic decline in the king crab resource in the early 1980s, incidental catches of king crab by bottom trawl gear has been a major issue within the fishing industry. Both state and federal agencies have instituted management measures to rebuild the king crab resources around Kodiak Island. However, with the development of domestic trawl fisheries, king crab bycatches have increased which can undermine rebuilding efforts. In comparison, crab bycatch in joint venture and foreign trawl fisheries has been reduced in part as a result of time/area closures restricting these fisheries. Loss of gear results in economic loss not only due to the value of the gear lost, but also due to the amount of fishing time lost when crab fishermen must return to port to secure tags for replacement pots. The threat of this economic loss has resulted in preemption of grounds, because crab fishermen are understandably reluctant to place gear in areas where foreign and domestic trawling occurs.

5.6 Relationship of this Management Plan to Existing Laws and Policies

5.6.1 Other Fishery Management Plans Proposed by a Council or the Secretary

This management plan can be considered an extension of the Preliminary Fishery Management Plan (PFMP) for the Gulf of Alaska Trawl Fishery and portions of the PFMP for the Sablefish Setline/Trap Fishery, both prepared and implemented by the Secretary of Commerce, and which are superceded by this plan.

There is also an implicit relationship to North Pacific Council management plans for the king and Tanner crab fishery, and the salmon fishery. Management programs for the halibut fishery, the scallop fishery, and the shrimp fishery must also be considered. This plan recognizes the need for possible emergency action to prevent conflicts with, or a conservation crisis in, those other managed fisheries (see Section 8.3.1.1).

5.6.2 Federal Law and Policies

5.6.2.1 Treaties and Conventions

The U.S. is party to the following international conventions which directly or indirectly address conservation and management needs of groundfish in the Gulf of Alaska: the International Convention for the High Seas Fisheries of the North Pacific Ocean (INPFC), and the Convention Between the United States of America and Canada for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea (IPHC).

There are no Indian treaty fishing rights for groundfish in the fishery conservation zone in the Gulf of Alaska.

5.6.2.2 Federal Programs Addressing Habitat of Gulf of Alaska Groundfish Stocks

Habitat Protection: Existing Programs

This section describes (a) general legislative program, portions of which are particularly directed or related to the protection, maintenance, or restoration of the habitat of living marine resources; and (b) specific actions taken within the Gulf of Alaska area for the same purpose.

Federal legislative programs and responsibilities related to habitat. The Department of Commerce, through NOAA, is responsible for, or involved in, protecting living marine resources and their habitats under a number of Congressional authorities that call for varying degrees of interagency participation, consultation, or review. Those having direct effect on Council responsibilities are identified with an asterisk. A

potential for further Council participation exists wherever federal review is required or encouraged. In some cases, state agencies may share the federal responsibility.

* (a) Magnuson Fishery Conservation and Management Act (Magnuson Act). This Act provides for the conservation and management of U.S. fishery resources within the 200-mile fishery conservation zone, and is the primary authority for Council action. Conservation and management is defined as referring to "all of the rules, regulations, conditions, methods, and other measures which are required to rebuild, restore, or maintain, and which are useful in rebuilding, restoring, or maintaining, any fishery resource and the marine environment, and which are designed to assure that irreversible or long-term adverse effects on fishery resources and the marine environment are avoided." Fishery resource is defined to include habitat of fish. The North Pacific Council is charged with developing FMPs, FMP amendments, and regulations for the fisheries needing conservation and management within its geographical area of authority. FMPs are developed in consideration of habitat-related problems and other factors relating to resource productivity. After approval of FMPs or FMP amendments, NMFS is charged with their implementation. See sectopm 5.10 for more information concerning essential fish habitat for FMP managed species.

(b) Fish and Wildlife Coordination Act of 1958 (FWCA). The FWCA provides the primary expression of federal policy for fish and wildlife habitat. It requires interagency consultation to assure that fish and wildlife are given equal consideration when a federal or federally-authorized project is proposed which controls, modifies, or develops the Nation's waters. For example, NMFS is a consulting resources agency in processing Department of the Army permits for dredge and fill construction projects in navigable waters, Environmental Protection Agency (EPA) ocean dumping permits, Federal Energy Regulatory Commission hydroelectric power project proposals, and Department of the Interior (DOI) Outer Continental Shelf (OCS) mineral leasing activities, among others.

* (c) National Environmental Policy Act of 1969 (NEPA). NEPA requires that the effects of Federal activities on the environment be assessed. Its purpose is to ensure that federal officials weigh and give appropriate consideration to environmental values in policy formulation, decision-making and administrative actions, and that the public is provided adequate opportunity to review and comment on the major federal actions. NEPA requires preparation of an Environmental Impact Statement (EIS) for major federal actions that significantly affect the quality of the human environment, and consultation with the agencies having legal jurisdiction or expertise for the affected resources. NMFS reviews EISs and provides recommendations to mitigate any expected impacts to living marine resources and habitats. An EIS or environmental assessment for a finding of no significant impact is prepared for FMPs and their amendments.

(d) Clean Water Act (CWA). The purpose of the CWA, which amends the Federal Water Pollution Control Act, is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters; to eliminate the discharge of pollutants into navigable waters; and to prohibit the discharge of toxic pollutants in toxic amounts. Discharge of oil or hazardous substances into or upon navigable waters, contiguous zone and ocean is prohibited. NMFS reviews and comments on Section 404 permits for deposition of fill or dredged materials into U.S. waters, and on EPA National Pollutant Discharge Elimination System permits for point source discharges.

(e) River and Harbor Act of 1899. Section 10 of this Act prohibits the unauthorized obstruction or alternation of any navigable water of the United States, the excavation from or deposition of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such water. Authority was later extended to artificial islands and fixed structures located on the Outer Continental Shelf. The Act authorizes the Department of the Army to regulate all construction and dredge and fill activities in navigable water to mean high water shoreline. NMFS reviews and comments on Public Notices the Corps of Engineers circulates for proposed projects.

* (f) Endangered Species Act of 1973 (ESA). The ESA provides for the conservation of endangered and threatened species of fish, wildlife, and plants. The program is administered jointly by DOI (terrestrial, freshwater, and some marine species such as walrus) and DOC (marine fish, and some marine mammals

including the great whales). Federal actions that may affect an endangered or threatened species are resolved by a consultation process between the project agency and DOC or DOI, as appropriate. For actions related to FMPs, NMFS provided biological assessments and Section 7 consultations if the federal action may affect endangered or threatened species or cause destruction or adverse modification of any designated critical habitat.

* (g) Coastal Zone Management Act of 1972 (CZMA). The principal objective of the CZMA is to encourage and assist states in developing coastal zone management programs, to coordinate state activities, and to safeguard the regional and national interests in the coastal zone. Section 307(c) requires that any federal activity directly affecting the coastal zone management program to the maximum extent practicable. Under present policy, FMPS undergo consistency review. Alaska's coastal zone program contains a section on Resources and habitats. Following a January 1984 U.S. Supreme Court ruling, the sales of OCS oil and gas leases no longer requires a consistency review; such a review is triggered at the exploratory drilling stage.

* (h) Marine Protection, Research and Sanctuaries Act (MPRSA). Title I of the MPRSA establishes a system to regulate dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect "human health, welfare or amenities or the marine environment, ecological systems, or economic potentialities." NMFS may provide comments to EPA on proposed sites of ocean dumping if the marine environment or ecological systems may be adversely affected. Title III of the MPRSA authorizes the Secretary of Commerce (NOAA) to designate as marine sanctuaries areas of the marine environment that have been identified as having special national significance due to their resource or human-use values. The Marine Sanctuaries Amendments of 1984 amend this Title to include, as consultative agencies in determining whether the proposal meets the sanctuary designation standards, the Councils affected by the proposed designation. The Amendments also provide the Council affected with the opportunity to prepare draft regulations, consistent with the Magnuson Act national standards, for fishing within the FCZ as it may deem necessary to implement a proposed designation.

(i) Outer Continental Shelf Lands Act of 1953, as amended (OCSLA). The OCSLA authorizes the Department of Interior's Minerals Management Service (MMS) to lease lands seaward of state marine boundaries, design and oversee environmental studies, prepare environmental impact statements, enforce special lease stipulations, and issue pipeline rights-of-way. It specifies that no exploratory drilling permit can be issued unless MMS determines that "such exploration will not be unduly harmful to aquatic life in the area, result in pollution, create hazardous or unsafe conditions, unreasonably interfere with the other uses of the area, or disturb any site, structure or object of historical or archaeological significance." Drilling and production discharges related to OCS exploration and development are subject to EPA NPDES permit regulations under the CWA. Sharing responsibility for the protection of fish and wildlife resources and their habitats, NOAA/NMFS, FWS, EPA and the states act in an advisory capacity in the formulation of OCS leasing stipulations that MMS develops for conditions or resources that are believed to warrant special regulation or protection. Some of these stipulations address protection of biological resources and their habitats. Interagency Regional Biological Task Forces and Technical Working Groups have been established by NMS to offer advise on various aspects of leasing, transport, and environmental studies. NMFS is represented on both groups in Alaska.

The Secretary of the Interior is required to maintain an oil and gas leasing program that "consists of a schedule of proposed lease sales indicating, as precisely as possible, the size, timing, and location of leasing activity" that will best meet national energy needs for a 5-year period following its approval or reapproval. In developing the schedule of proposed lease, the Secretary is required to take into account the potential impacts of oil and gas exploration on other offshore resources, including the marine, coastal, and human environments.

Once a lease is awarded, before exploratory drilling can begin in any location, the lessee must submit an exploration plan to the Minerals Management Service (MMS) for approval. An oilspill contingency plan must be contained within the exploration plan. If approved by MMS and having obtained other necessary

permits, the lessee may conduct exploratory drilling and testing in keeping with lease sale stipulations and MMS Operating Orders.

If discoveries are made, before development and production can begin in a frontier lease area, a development plan must be submitted and a second EIS process begun. At this time, a somewhat better understanding of the location, magnitude, and nature of activity can be expected, and resource concerns may once again be addressed before development can be permitted to proceed.

* (j) National Fishing Enhancement Act of 1984. Title II of this Act authorizes the Secretary of Commerce (NOAA) to develop and publish a National Artificial Reef Plan in consultation with specified public agencies, including the Councils, for the purpose of enhancing fishery resources. Permits for the siting, construction, and monitoring of such reefs are to be issued by the Department of the Army under Section 10 of the River and Harbor Act, Shelf Lands Act, in consultation with appropriate federal agencies, states, local governments and other interested parties. NMFS will be included in this Consultation process.

(k) The Northwest Power Act of 1980 (NPA). The NPA includes extensive and unprecedented fish and wildlife, particularly anadromous fish, in making decisions about hydroelectric projects. Under the NPA, a detailed Fish and Wildlife Program has been established to protect, mitigate, and enhance fish and wildlife in the Columbia River Basin. In addition, general fish and wildlife criteria for hydroelectric development throughout the region have been established in the Regional Energy Plan developed under the Act. NMFS has a statutory role in the development of the Program and the Plan and encourages their implementation by federal agencies such as the Federal Energy Regulatory Commission, the Corps of Engineers, and the Bureau of Reclamation.

(l) Alaska National Interest Lands Conservation Act of 1980. The purpose of this Act is to provide for the designation and conservation of certain public lands in Alaska. The Department of Agriculture Forest Service has authority to manage surface resources on National Forest Lands in Alaska. Under Title V of this Act, any regulations for this purpose must take into consideration existing laws and regulations to maintain the habitats, to the maximum extent feasible, of anadromous fish and other foodfish, and to maintain the present and continued productivity of such habitat when they are affected by mining activities. For example, mining operations in the vicinity of the Ouartz Hill area in the Tongass National Forest must be conducted in accordance with an approved operations plan developed in consultation with NMFS; consultation continues through the monitoring and altering of operations through an annual review of the operations plan. Title XII of the Act establishes an Alaska Land Use Council to advise federal agencies, the state, local governments and Native Corporations with respect to land and resource uses in Alaska. NOAA is named as a member of this Council.

* (m) Marine Mammal Protection Act (MMPA). The Marine Mammal Protection Act establishes a moratorium on the taking of marine mammals and a ban on the importation of marine mammal products with certain exceptions. Responsibility is divided between DOC (whales, porpoises, seals, and sea lions) and DOI (other marine mammals) to issue permits and to waive the moratorium for specified purposes, including incidental taking during commercial fishing operations. The Magnuson Act amended the MMPA to extend its jurisdiction to the FCZ. If the FMP has effect on marine mammal populations, certain information must be included in the EIS, and the FMP should indicate whether permits are available for any incidental takings.

5.6.3 State Laws and Policies

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 its 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.

5.6.4 Other

This plan has a most significant relationship to the management of the Pacific halibut fishery which continues to be vested in the International Pacific Halibut Commission. Many of the management measures contained herein are for the expressed purpose of controlling impacts on the domestic halibut fishery by recognizing a situation in which other fisheries could contribute to a decline in halibut abundance.

The Council and NMFS, with authority in this plan, have taken specific actions related to habitat and the Gulf groundfish fisheries. They are:

- Gear limitations that Act to protect habitat or critical life stages. Section 611.16 of the foreign fishing regulations prohibits discard of fishing gear and other debris by foreign fishing vessels.

- Seasonal restrictions that Act to protect habitat or critical life stages. Section 611.92 of the foreign fishing regulations prohibits foreign trawling during specific periods in the West Yakutat area to provide protection against a possible directed fishery on spawning halibut and prevent disturbance of the spawning grounds.

- Recommendations to permitting agencies regarding lease sales. Recommendations have been made to permitting agencies on all past proposed lease sales on the Alaska OCS, in the interests of protecting or maintaining the marine environment. These recommendations have ranged from calling for delay or postponement of certain scheduled sales such as in Bristol Bay and Kodiak, requesting deletions from sales of certain areas such as in Shelikof Strait, identifying the need for additional environmental studies and for protective measures such as burial of pipelines, seasonal drilling limitations, and oilspill countermeasure planning.

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 affect on habitats of species in the Gulf of Alaska 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 MMS regarding upcoming oil and gas lease areas affecting the Gulf of Alaska/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 base is 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.

## 5.7 Enforcement Requirements

The existing and projected joint Coast Guard-NMFS fisheries enforcement patrols are geared to policing the wide range of foreign and domestic fisheries throughout the Alaska Region. In so doing, the individual patrols are seldom devoted to enforcement of a single management plan but rather monitor compliance with all plans and other statutory responsibilities pertinent to the area covered by that patrol. Enforcement of this plan is somewhat unique because the plan encompasses all the permitted foreign fishing in the Gulf of Alaska, all the restrictions against foreign retention of prohibited species, i.e., salmon, halibut, crab, and a significant portion of the U.S. fisheries in the Gulf of Alaska. Therefore, the major share of the multi-mission patrol in the Gulf of Alaska can be prorated to enforcement of this plan.

Since the implementation of this fishery management plan, the domestic fisheries in the Gulf of Alaska have expanded rapidly and have displaced the large foreign fisheries that occurred in the 1970s and early 1980s. Based on current foreign and domestic fisheries in the Gulf of Alaska, it is estimated that the Coast Guard will devote about 936 aircraft-hours and 252 ship-days toward enforcement of this plan. Following long established procedures, these patrols will, whenever possible, be accompanied by NMFS fisheries enforcement specialists. The majority of this enforcement effort will be directed at domestic fisheries and will utilize smaller Coast Guard cutters and predominately helicopters for aerial surveillance. These patrol units operate at a lesser cost than the larger cutters and fixed wing aircraft that were predominately used previously for foreign fisheries enforcement. The type of domestic regulations employed in the future will have a significant impact on enforcement requirements. Time area closures and gear restrictions will require at-sea enforcement. Also, if domestic vessels expand their at-sea processing capability, an enforcement presence will be required at sea to monitor catch levels of targets species as well as potential retention of prohibited species by those vessels.

## 5.8 Financing Requirements

### 5.8.1 Management and Enforcement Costs

ESTIMATED MANAGEMENT COSTS
(in thousands of dollars)

| | |
|---|---|
| 40 man-months of foreign fishery observers | 112 |
| 25% of North Pacific Council FY'86 budget (Less contracts) | 246 |
| NMFS Alaska Region Fishery Operations Branch | 60 |
| 20 man-months of domestic fishery observers | 50 |
| Research activities, e.g., stock assessment, by NWAFC | - |
| Computerized data analyses - NMFS | 5 |
| Improve State of Alaska statistical system | 124 |

ESTIMATED ENFORCEMENT COSTS
(in thousands of dollars)

| | |
|---|---|
| 252 Coast Guard ship patrol days | 333 |
| 936 Coast Guard aerial patrol hours | 377 |
| NMFS Alaska Region Law Enforcement Branch | 157 |
| NMFS/NOAA administration of civil penalties | 8 |
| U.S. Attorney administration of criminal penalties | 2 |
| Computerized data analyses - NMFS | 8 |
| Domestic enforcement by small Coast Guard vessels or by an "Enforcement contract" with State of Alaska, or by a combination of the two. | Unknown |

5.8.2 Federal and State Revenues Derived From Fishery

Federal revenues are based on charges placed on foreign fisheries, while state (Alaska) revenues are based on fees and taxes placed on the domestic fishery.

5.8.2.1 Federal Revenues

Revenues accrue to the federal government from charges placed on foreign fisheries (TALFF). In 1986 total revenues of $25.3 million were received by the federal government from poundage fees associated with foreign groundfish fisheries operating in the EEZ adjacent to Alaska. Most of this revenue was generated from TALFF occurring in the Bering Sea/Aleutian Islands management area.

Confidentiality constraints prevent the disclosure of Gulf of Alaska data for 1986, when only a single foreign nation participated in a TALFF groundfish fishery.

In addition to poundage fees, income accrues to the federal government from vessel license fees. In 1986 approximately $133,600 were paid by vessel operators to obtain federal permits to fish in the groundfish fisheries of the Gulf and Bering Sea.

Finally, the federal government obtains reimbursement for costs associated with U.S. observer coverage of the foreign fishing vessels and foreign processors participating in joint ventures. In 1986 the federal government collected $188,000 in reimbursable costs for observers in the groundfish fisheries in the EEZ off Alaska. An additional $156,000 was paid by foreign fishermen to U.S. private sector companies to supply approved observer coverage in these fisheries. In 1985 these same reimbursable costs totaled $382,000 and $262,000 for federal and U.S. private sector observer coverage, respectively (source: NWAFC, NMFS, Seattle, WA).

5.8.2.2 State Revenues

5.8.3 Expected State and Federal Revenues, Taxes, Fees

Federal revenue expected in 1987 from charges placed on foreign fishing operations in the Gulf of Alaska is estimated to be near zero, a decline from approximately $1.9 million received in 1977. This decline is due to the displacement of the foreign fleet by the American fishery.

The projected 1987 domestic groundfish catch (excluding halibut) for shorebased processing in the Gulf of Alaska will be around 141,000 mt from which total state revenues generated by taxes and licenses will be roughly $1.5 million.

## 5.9 References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## 5.10 Essential Fish Habitat for GOA Groundfish

Summaries and assessments of habitat information for GOA groundfish are provided in the "Essential Fish Habitat Assessment Report for the Groundfish Resources of the Gulf of Alaska Region" dated April 1, 1998. Habitat descriptions and life history information was reviewed and the levels of information available for each life history stage was determined. The approach set forth in regulations at 50 CFR 600.815(a)(2) for gathering and organizing the data necessary to identify EFH was applied. In evaluating the level of knowledge available, a level 0 was defined as a subset of level 1. For life stages of GOA groundfish, it was determined that information at levels 0, 1, and 2 was available.

**Table 5.10.1. Levels of essential fish habitat information currently available for GOA groundfish, by life history stage.**

| Species | Eggs | Larvae | Early Juveniles | Late Juveniles | Adults |
|---|---|---|---|---|---|
| Pollock | 1 | 1 | 1 | 1 | 2 |
| Pacific cod | 0a | 0a | 0a | 1 | 2 |
| Shallow water flatfish | | | | | |
| Yellowfin sole | 0a | 0a | 0a | 1 | 2 |
| Rock sole | 0a | 0a | 0a | 1 | 2 |
| Deepwater flatfish | 0a | 0a | 0a | 0a | 1 |
| Arrowtooth flounder | 0a | 0a | 0a | 1 | 2 |
| Rex sole | 0a | 0a | 0a | 0a | 1 |
| Flathead sole | 0a | 0a | 0a | 1 | 2 |
| Sablefish | 0a | 0a | 0a | 1 | 2 |
| Pacific ocean perch | - | 0a | 0a | 1 | 1 |
| Northern rockfish | - | 0b | 0b | 1 | 1 |
| Shortraker rockfish | - | 0b | 0a-b | 0b | 1 |
| Rougheye rockfish | - | 0b | 0a-b | 1 | 1 |
| Yelloweye rockfish | - | 0b | 0a | 1 | 1 |
| Pelagic shelf rockfish | | | | | |
| Dusky rockfish | - | 0b | 0b | 0a | 1 |
| Thornyhead rockfish | 0a | 0a | 0a | 0a | 1 |
| Atka mackerel | 0a | 0a | 0a | 0a | 1 |
| Other species | | | | | |
| sculpins | 0a | 0a | 0a | 0a | 1 |
| skates | 0a | - | 0a | 0a | 1 |
| sharks | - | - | 0a | 0a | 0a |
| octopus | 0a | - | 0a | 0a | 0a |
| squid | 0a | - | 0a | 0a | 0a |
| Forage Fish species | | | | | |
| smelts | 0a | 0a | 0a | 0a | 0a |
| other forage fish[1,2] | 0 | 0 | 0 | 0 | 0 |

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

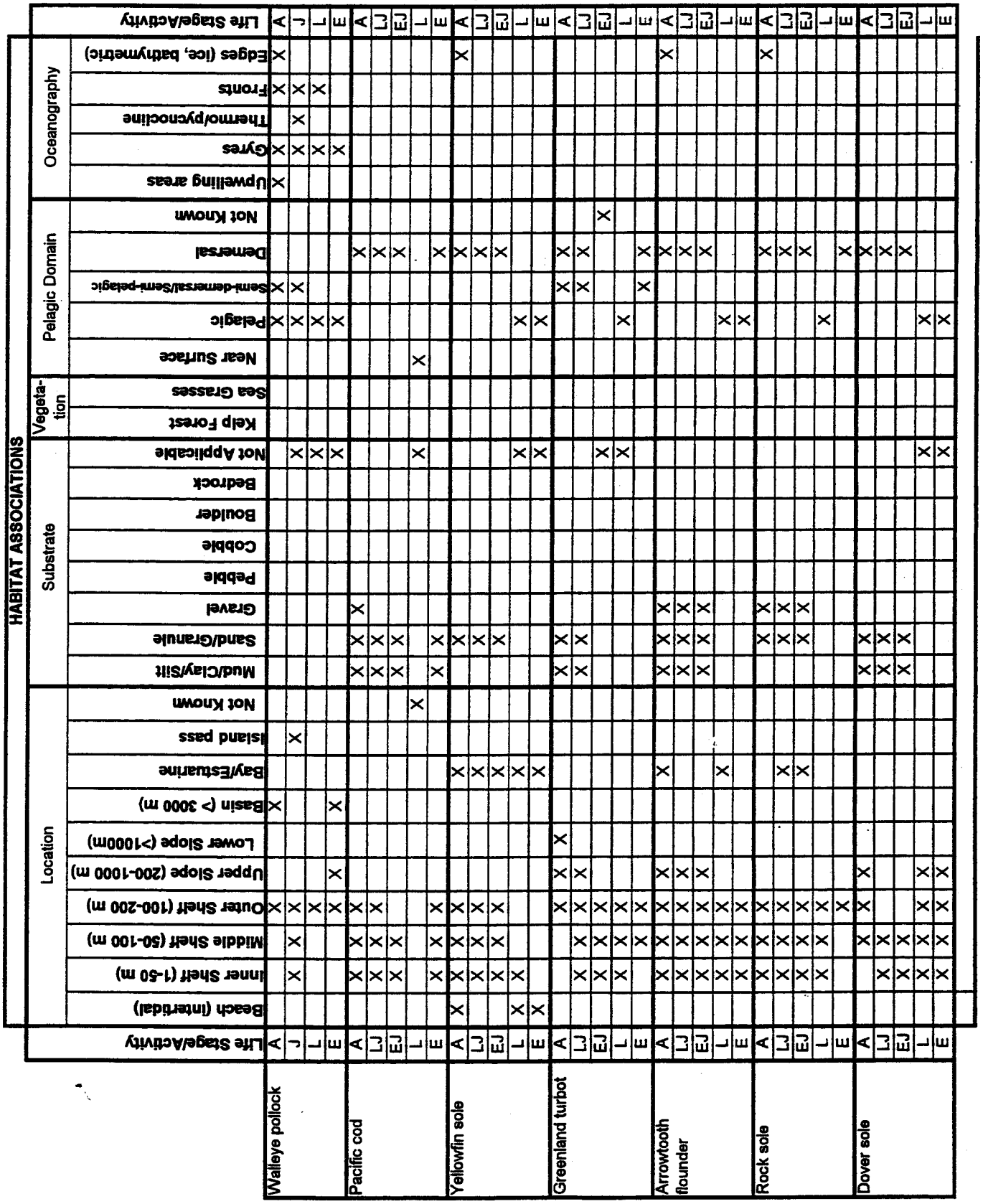
[1]Other forage fish includes all members of the lanternfish, deep sea smelt, sand lance, sandfish, gunnel, shanny, krill, bristlemouth families.

[2]For the egg and larvae stages for Myctophids, Bathylagids, Pholids, and Stichaeids, the larvae stage for Sandfish, and the egg, larvae and juvenile stages for gonostomids, information is insufficient to infer general distribution.

0a: Some information on a species' life stage upon which to infer general distribution.

0b: No information on the life stage, but some information on a similar species or adjacent life stage from which to infer general distribution.

Table 5.10.2. Summary of habitat associations for groundfish in the BSAI and GOA.

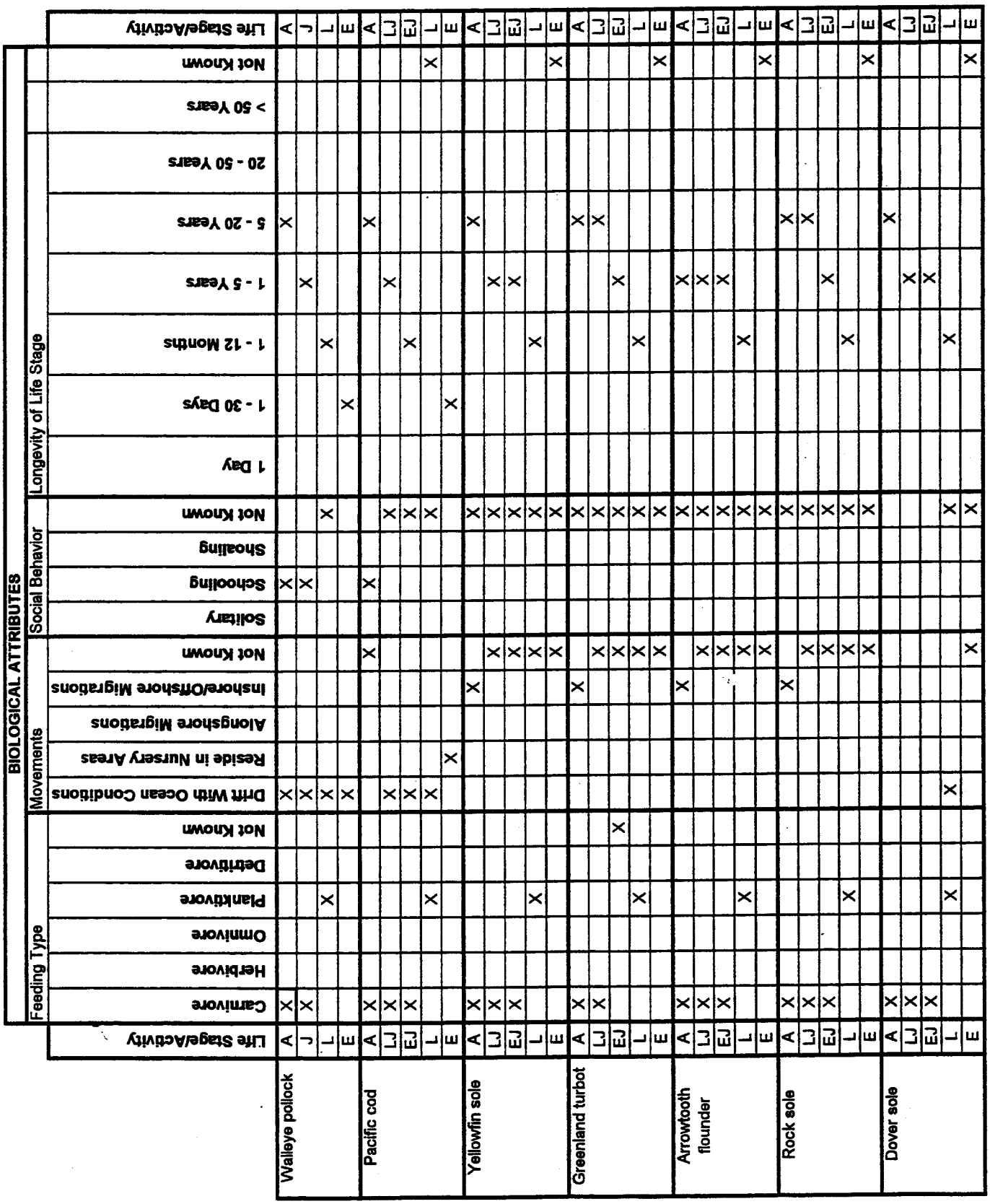


| | | HABITAT ASSOCIATIONS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Location | | | | | | | | | | Substrate | | | | | | | | Vegetation | | Pelagic Domain | | | | | Oceanography | | | | | |
| | Life Stage/Activity | Beach (intertidal) | Inner Shelf (1-50 m) | Middle Shelf (50-100 m) | Outer Shelf (100-200 m) | Upper Slope (200-1000 m) | Lower Slope (>1000m) | Basin (> 3000 m) | Bay/Estuarine | Island pass | Not Known | Mud/Clay/Silt | Sand/Granule | Gravel | Pebble | Cobble | Boulder | Bedrock | Not Applicable | Kelp Forest | Sea Grasses | Near Surface | Pelagic | Semi-demersal/Semi-pelagic | Demersal | Not Known | Upwelling areas | Gyres | Thermo/pycnocline | Fronts | Edges (ice, bathymetric) | Life Stage/Activity |
| Alaska plaice | A | | X | X | | | | | | | | X | X | | | | | | | | | | | | X | | | | | | | A |
| | J | | X | X | | | | | | | | X | X | | | | | | | | | | | | X | | | | | | | J |
| | L | | X | X | | | | | | | | | | | | | | | | | | | X | | | | | | | | | L |
| | E | | X | | X | | | | | | | | | | | | | | | | | | X | | | | | | | | | E |
| Rex sole | A | | | X | X | X | | | | | | X | X | X | | | | | | | | | | | X | | | | | | | A |
| | J | | X | X | X | | | | | | | X | X | X | | | | | | | | | | | X | | | | | | | J |
| | L | | X | X | X | | | | | | | | | | | | | | X | | | | X | | | | | | | | | L |
| | E | | X | X | X | | | | | | | | | | | | | | X | | | | X | | | | | | | | | E |
| Flathead sole | A | | X | X | X | | | | | | | X | X | | | | | | | | | | | | X | | | | | | X | A |
| | LJ | | X | X | X | | | | | | | X | X | | | | | | | | | | | | X | | | | | | | LJ |
| | EJ | | X | X | X | | | | | | | X | X | | | | | | | | | | | | X | | | | | | | EJ |
| | L | | X | X | X | | | | | | | | | | | | | | X | | | | X | | | | | | | | | L |
| | E | | X | X | X | | | | | | | | | | | | | | X | | | | X | | | | | | | | | E |
| Sablefish | A | | | | | X | X | | | | | X | X | X | | | | | | | | | | | X | | X | | | | | A |
| | LJ | | | | | X | X | | | | | | | | | | | | | | | | | | X | | X | | | | | LJ |
| | EJ | | X | X | X | | | | X | X | | | | | | | | | X | | | | X | X | X | | X | | | | | EJ |
| | L | | | X | X | X | X | X | | | | | | | | | | | X | | | X | | | | | X | | | | | L |
| | E | | | | | X | X | X | | | | | | | | | | | X | | | | X | | | | X | | | | | E |
| Pacific Ocean perch | A | | | | X | X | | | | | | | | X | X | X | | | | | | | | X | X | | X | | | | | A |
| | J | | X | X | X | X | | | | | | | | X | X | X | X | | | | | | X | X | | | X | | | | | J |
| | L | | X | X | X | X | X | X | | | | | | | | | | | X | | | | X | | | | X | | | | | L |
| Shortraker & Rougheye rockfish | A | | | | X | X | | | | | | X | X | X | X | X | X | X | | | | | | X | | | | | | | | A |
| | J | | | X | X | | | | | | | | | | | | | | | | | | | | | X | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | X | | | | | | | X | | | | | | L |
| Northern rockfish | A | | | | X | X | | | | | | | | | | X | X | | | | | | | X | | | | | | | | A |
| | J | | X | X | X | | | | | | | | | | | X | X | | | | | | | X | | | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | X | | | | X | | | | | | | | | L |
| Dusky rockfish | A | | | | X | X | | | | | | | | X | | X | X | X | | | | | | X | | | | | | | | A |
| | J | | X | X | X | | | | | | | | | X | | X | X | | | | | | | | | X | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | X | | | | X | | | | | | | | | L |

| | | HABITAT ASSOCIATIONS: Location | | | | | | | | | | Substrate | | | | | | | | Veg. | | Pelagic Domain | | | | | Oceanography | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Life Stage/Activity | Beach (intertidal) | Inner Shelf (1-50 m) | Middle Shelf (50-100 m) | Outer Shelf (100-200 m) | Upper Slope (200-1000 m) | Lower Slope (>1000m) | Basin (> 3000 m) | Bay/Estuarine | Island pass | Not Known | Mud/Clay/Silt | Sand/Granule | Gravel | Pebble | Cobble | Boulder | Bedrock | Not Applicable | Kelp Forest | Sea Grasses | Near Surface | Pelagic | Semi-demersal/Semi-pelagic | Demersal | Not Known | Upwelling areas | Gyres | Thermo/pycnocline | Fronts | Edges (ice, bathymetric | Life Stage/Activity |
| Yelloweye rockfish | A | | | X | X | X | | | X | X | | | | X | X | X | X | X | | | | | | | X | | | | | | | A |
| | J | | | X | X | X | | | X | X | | | | X | X | X | X | X | | | | | | | X | | | | | | | J |
| | L | | | | | | | | | | X | | | X | | X | | X | | | | | | | X | | | | | | | L |
| Thornyhead rockfish | A | | | X | X | X | X | | | | | X | X | X | X | X | X | X | | | | | | | X | | | | | | | A |
| | J | | | X | X | X | | | | | | X | X | X | X | X | X | X | | | | | | | X | | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | L |
| | E | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | E |
| Atka mackerel | A | | X | X | X | | | | | X | | | | X | X | X | | | | X | | | | X | | | | | | X | X | A |
| | J | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | | | | X | | | | | | | | | | L |
| | E | | X | | | | | | | X | | | | X | X | X | | | | X | | | | | X | | | | | | | E |
| Squid | A | | X | X | X | X | X | X | | | | | | | | | | | | | | | | X | | | X | | | X | | A |
| | J | | X | X | X | X | X | X | | | | | | | | | | | X | | | X | X | | | | X | | | X | | J |
| | E | | | | | X | X | | | | | X | X | | | | | | | | | | | | X | | | | | | | E |
| Capelin | A | X | X | X | X | | | | | | | | X | X | | | | | | | | | X | X | X | | | | | X | X | A |
| | J | | X | X | | | | | | | | | | | | | | | X | | | | X | | | | | | | X | X | J |
| | L | | X | X | | | | | | | | | | | | | | | X | | | X | X | | | | | | | | | L |
| | E | X | | | | | | | | | | | X | | | X | | | | | | | | | X | | | | | | | E |
| Eulachon | A | | | X | X | X | | | X | | | | X | | | X | | | | | | | X | | X | | | | | X | | A |
| | J | | | X | X | X | | | | | | | | | | | | | X | | | | X | | | | | | | X | | J |
| | L | | X | | | | | | | | | | | | | | | | X | | | | X | | | | | | | | | L |
| | E | | | | | | | | X | | | | X | | | X | | | | | | | | | X | | | | | | | E |
| Sculpins | A | X | X | X | X | X | | | | | | X | X | X | X | X | X | | | | | | | | X | | | | | | | A |
| | J | X | X | X | X | X | | | | | | X | X | X | | | | | | | | | | | X | | | | | | | J |
| | L | | X | X | X | X | | | | | | | | | | | | | X | | | X | X | | | | | | | | | L |
| | E | X | X | X | X | | | | | | | | | X | X | X | | | | | | | | | X | | | | | | | E |
| Sharks | A | | X | X | X | X | | | | | | X | X | X | X | | | | X | | | | X | | X | | | | | | | A |
| | J | | X | X | X | X | | | | | | | | | | | | | X | | | | X | | X | | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | X | | | | | | | | | | | | | L |
| Skates | A | | | X | X | X | | | | | | X | X | X | | | | | | | | | | | X | | | | | | | A |
| | J | | | X | X | X | | | | | | | | | | | | | | | | | | | X | | | | | | | J |
| | E | | | X | X | X | | | | | | | | | | | | | | | | | | | X | | | | | | | E |
| Octopus | A | | X | X | X | X | | | | | | X | X | X | | | | | | | | | | | X | | | | | | | A |
| | J | | X | X | X | X | | | | | X | | | | | | | | | | | | | X | | | | | | | | J |
| | E | | X | X | X | X | | | | | X | | | X | X | X | | | | | | | | | X | | | | | | | E |

| | | HABITAT ASSOCIATIONS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Location | | | | | | | | | | Substrate | | | | | | | | Vegetation | | Pelagic Domain | | | | | Oceanography | | | | | |
| | Life Stage/Activity | Beach (intertidal) | Inner Shelf (1-50 m) | Middle Shelf (50-100 m) | Outer Shelf (100-200 m) | Upper Slope (200-1000 m) | Lower Slope (>1000m) | Basin (> 3000 m) | Bay/Estuarine | Island pass | Not Known | Mud/Clay/Silt | Sand/Granule | Gravel | Pebble | Cobble | Boulder | Bedrock | Not Applicable | Kelp Forest | Sea Grasses | Near Surface | Pelagic | Semi-demersal/Semi-pelagic | Demersal | Not Known | Upwelling areas | Gyres | Thermo/pycnocline | Fronts | Edges (ice, bathymetric) | Life Stage/Activity |
| Eulachon | A | | | X | X | X | | | | | | | | | | | | | X | | | | X | | | | | | | | | A |
| | J | | | X | X | X | | | | | | | | | | | | | X | | | | X | | | | | | | | | J |
| | L | | X | | | | | | | | | | | | | | | | X | | | | X | | | | | | | | | L |
| | E | | | | | | | | | | | X | X | X | | | | | | | | | | | X | | | | | | | E |
| Capelin | A | X | X | X | X | | | | | | | | X | | | X | | | X | | | | X | | | | | | | X | X | A |
| | J | | X | X | | | | | | | | | | | | | | | X | | | | X | | | | | | | X | X | J |
| | L | | X | X | | | | | | | | | | | | | | | X | | | X | | | | | | | | | | L |
| | E | X | | | | | | | | | | | X | | | X | | | | | | | | | X | | | | | | | E |
| Sand lance | A | | X | X | | | | | | | | X | X | | | | | | | | | | | X | | | | | | | | A |
| | J | | X | X | | | | | | | | X | X | | | | | | | | | | | X | | | | | | | | J |
| | L | | X | | | | | | | | | | | | | | | | X | | | X | X | | | | | | | | | L |
| | E | | X | | | | | | | | | | X | X | | | | | | | | | | | X | | | | | | | E |
| Myctophids and Bathylagids | A | | | | | X | X | X | | | | | | | | | | | X | | | | | X | | | | | | | | A |
| | J | | | | | X | X | X | | | | | | | | | | | X | | | | | X | | | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | L |
| | E | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | E |
| Sand fish | A | | X | | | | | | | | | X | X | | | | | | | | | | | | X | | | | | | | A |
| | J | | X | | | | | | | | | X | X | | | | | | | | | | | | X | | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | L |
| | E | X | | | | | | | | | | | | | | X | X | | | | | | | | X | | | | | | | E |
| Euphausiids | A | | | | X | X | X | X | | | | | | | | | | | X | | | | X | | | | X | | | | X | A |
| | J | | | | X | X | X | X | | | | | | | | | | | X | | | | X | | | | X | | | | X | J |
| | L | | | | | | | | | | X | | | | | | | | | | | X | X | | | | | | | | | L |
| | E | | | | | | | | | | X | | | | | | | | | | | X | | | | | | | | | | E |
| Pholids and Stichaeids | A | X | | | | | | | | | | X | | | | | | | | X | X | | | | | | | | | | | A |
| | J | X | | | | | | | | | | X | | | | | | | | X | X | | | | | | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | L |
| | E | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | E |
| Gonostomatids | A | | | | | X | X | X | | | | | | | | | | | X | | | | X | | | | | | | | | A |
| | J | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | J |
| | L | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | L |
| | E | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | E |

Table 5.10.3. Summary of biological associations for groundfish in the BSAI and GOA.



| | | BIOLOGICAL ATTRIBUTES | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feeding Type | | | | | | Movements | | | | | Social Behavior | | | | Longevity of Life Stage | | | | | | | | |
| | Life Stage/Activity | Carnivore | Herbivore | Omnivore | Planktivore | Detritivore | Not Known | Drift With Ocean Conditions | Reside in Nursery Areas | Alongshore Migrations | Inshore/Offshore Migrations | Not Known | Solitary | Schooling | Shoaling | Not Known | 1 Day | 1 - 30 Days | 1 - 12 Months | 1 - 5 Years | 5 - 20 Years | 20 - 50 Years | > 50 Years | Not Known | Life Stage/Activity |
| Alaska plaice | A | X | | | | | | | | | | X | | | | X | | | | | X | | | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | | X | | | | J |
| | L | | | | X | | | | | | | X | | | | X | | | X | | | | | | L |
| | E | | | | | | | | | | | X | | | | X | | | | | | | | X | E |
| Rex sole | A | X | | | | | | | | | | X | | | | X | | | | X | | | | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | X | | | | | J |
| | L | | | | X | | | | | | | X | | | | X | | | | | | | | X | L |
| | E | | | | | | | | | | | X | | | | X | | | | | | | | X | E |
| Flathead sole | A | X | | | | | | | | | X | | | | | X | | | | | | | | X | A |
| | LJ | X | | | | | | | | | | X | | | | X | | | | | | | | X | LJ |
| | EJ | X | | | | | | | | | | X | | | | X | | | | | | | | X | EJ |
| | L | | | | X | | | X | | | | | | | | X | | | | | | | | X | L |
| | E | | | | | | | | | | | X | | | | X | | | | | | | | X | E |
| Sablefish | A | X | | | | | | | | | | X | | | | X | | | | | | X | | | A |
| | LJ | X | | | | | | | | | | X | | | | X | | | | X | | | | | LJ |
| | EJ | X | | | | | | | | | X | | | | | X | | | | X | | | | | EJ |
| | L | | | | X | | | X | | | | | | | | X | | | X | | | | | | L |
| | E | | | | | | | X | | | | | | | | X | | X | | | | | | | E |
| Pacific Ocean perch | A | X | | | | | | | | | X | | | X | | | | | | | | | X | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | | X | | | | J |
| | L | | | | X | | | | | | | X | | | | X | | | X | | | | | | L |
| Shortraker/rougheye rockfish | A | X | | | | | | | | | | X | | | | X | | | | | | | X | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| Northern rockfish | A | X | | | | | | | | | | X | | X | | | | | | | | | X | | A |
| | J | | | | | | X | | | | | X | | | | X | | | | | X | | | | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| Dusky rockfish | A | X | | | | | | | | | | X | | | | X | | | | | | X | | | A |
| | J | | | | | | X | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| Yelloweye rockfish | A | X | | | | | | | | | | X | X | | | | | | | | | | X | | A |
| | J | X | | | | | | | | | | X | X | | | | | | | | X | | | | J |
| | L | | | | X | | | | | | | X | | | | X | | | X | | | | | | L |
| Thornyhead rockfish | A | X | | | | | | | | | | X | | | | X | | | | | | | | X | A |
| | J | X | | | | | | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | X | | | | | | L |
| | E | | | | | | X | | | | | X | | | | X | | | | | | | | X | E |

## BIOLOGICAL ATTRIBUTES

| | | Feeding Type | | | | | | Movements | | | | | Social Behavior | | | | Longevity of Life Stage | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Life Stage/Activity | Carnivore | Herbivore | Omnivore | Planktivore | Detritivore | Not Known | Drift With Ocean Conditions | Reside in Nursery Areas | Alongshore Migrations | Inshore/Offshore Migrations | Not Known | Solitary | Schooling | Shoaling | Not Known | 1 Day | 1 - 30 Days | 1 - 12 Months | 1 - 5 Years | 5 - 20 Years | 20 - 50 Years | > 50 Years | Not Known | Life Stage/Activity |
| Atka mackerel | A | X | | | | | | | | | X | | | X | | | | | | X | | | | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | X | | | | | J |
| | L | X | | | | | | | | | | X | | | | X | | | X | | | | | | L |
| | E | | | | X | | | | | | | X | | | | X | | X | | | | | | | E |
| Squid | A | X | | | | | | | | | X | | | | | X | | | | X | | | | | A |
| | J | | | | X | | | | | | | X | | | | X | | | X | | | | | | J |
| | E | | | | | | X | | | | | X | | | | X | | | X | | | | | | E |
| Capelin | A | X | | | | | | | | | X | | | X | | | | | | X | | | | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | X | | | | | J |
| | L | | | | X | | | | | | | X | | | | X | | | X | | | | | | L |
| | E | | | | | | | | | | | X | | | | X | | X | | | | | | | E |
| Eulachon | A | X | | | | | | | | | X | | | X | | | | | | X | | | | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | X | | | | | J |
| | L | | | | X | | | | | | | X | | | | X | | | X | | | | | | L |
| | E | | | | | | | | | | | X | | | | X | | X | | | | | | | E |
| Sculpins | A | X | | | | | | | | | | X | | | | X | | | | | | | | X | A |
| | J | X | | | | | | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| | E | | | | | | X | | | | | X | | | | X | | | | | | | | X | E |
| Sharks | A | X | | | | | | | | | | X | | | | X | | | | | | | X | | A |
| | J | X | | | | | | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| | E | | | | | | X | | | | | X | | | | X | | | | | | | | X | E |
| Skates | A | X | | | | | | | | | | X | | | | X | | | | | | | | X | A |
| | J | X | | | | | | | | | | X | | | | X | | | | | | | | X | J |
| | E | | | | | | | | | | | X | | | | X | | | | | | | | X | E |
| Octopus | A | X | | | | | | | | | | X | | | | X | | | | X | | | | | A |
| | J | | | | X | | | | | | | X | | | | X | | | | | | | | X | J |
| | E | | | | | | | | | | | X | | | | X | | | | | | | | X | E |

| | | BIOLOGICAL ATTRIBUTES | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feeding Type | | | | | | Movements | | | | | Social Behavior | | | | Longevity of Life Stage | | | | | | | | |
| | Life Stage/Activity | Carnivore | Herbivore | Omnivore | Planktivore | Detritivore | Not Known | Drift With Ocean Conditions | Reside in Nursery Areas | Alongshore Migrations | Inshore/Offshore Migrations | Not Known | Solitary | Schooling | Shoaling | Not Known | 1 Day | 1 - 30 Days | 1 - 12 Months | 1 - 5 Years | 5 - 20 Years | 20 - 50 Years | > 50 Years | Not Known | Life Stage/Activity |
| Eulachon | A | | | | X | | | | | | X | | | X | | | | | | X | | | | | A |
| | J | | | | X | | | | | | | X | | X | | | | | | | | | | X | J |
| | L | | | | X | | | X | | | | | | | | X | | | | | | | | X | L |
| | E | | | | | | | | | | | | | | | | | X | | | | | | | E |
| Capelin | A | | | | X | | | | | | X | | | X | | | | | | X | | | | | A |
| | J | | | | X | | | | | | X | | | X | | | | | | | | | | X | J |
| | L | | | | X | | | X | | | | | | | | | | | | | | | | X | L |
| | E | | | | | | | | | | | | | | | | | X | | | | | | | E |
| Sand lance | A | | | X | | | | | | | | X | | | | X | | | | X | | | | | A |
| | J | | | X | | | | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| | E | | | | | | X | | | | | X | | | | X | | | | | | | | X | E |
| Myctophids and Bathylagids | A | | | | X | | | | | | | X | | | | X | | | | | | | | X | A |
| | J | | | | | | X | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| | E | | | | | | X | | | | | X | | | | X | | | | | | | | X | E |
| Sand fish | A | X | | | | | | | | | | X | | | | X | | | | | | | | X | A |
| | J | | | | | | X | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| | E | | | | | | X | | | | | X | | | | X | | | | | | | | X | E |
| Euphausiids | A | | | | X | | | X | | | | | | | X | | | | | | X | | | | A |
| | J | | | | X | | | X | | | | | | | X | | | | | | | | | X | J |
| | L | | | | X | | | X | | | | | | | | | | | | | | | | X | L |
| | E | | | | | | | | | | | | | | | | | | | | | | | X | E |
| Pholids and Stichaeids | A | | | X | | | | | | | | | X | | | | | | | | X | | | | A |
| | J | | | X | | | | | | | | | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | | | | | X | | | | | | | | X | L |
| | E | | | | | | X | | | | | | | | | X | | | | | | | | X | E |
| Gonostomatids | A | | | | | | X | | | | | X | | | | X | | | | | | | | X | A |
| | J | | | | | | X | | | | | X | | | | X | | | | | | | | X | J |
| | L | | | | | | X | | | | | X | | | | X | | | | | | | | X | L |
| | E | | | | | | X | | | | | X | | | | X | | | | | | | | X | E |

Table 5.10.4. Summary of reproductive traits for groundfish in the BSAI and GOA.

| Reproductive Traits | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Age at Maturity | | | | 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 yrs | | 4 yrs | | X | | | | | | X | | | | | X | | | | | | | | | |
| Pacific cod | 5 yrs | | 5 yrs | | X | | | | | X | | | | | | X | | | | | | X | X | | |
| Yellowfin sole | 10.5yrs. | | | | X | | | | | | X | | | | | | X | X | X | | | | | | |
| Greenland turbot | 5-10yrs. | | | | X | | | | | | X | | | | | | | | | X | X | X | X | | |
| Arrowtooth flounder | 5 yrs | | 4 yrs | | X | | | | | | | | | | | | | | | | | | | X | |
| Rock sole | 9yrs. | | | | X | | | | | X | | | | | | X | X | | | | | | X | | |
| Dover sole | 33cm | | | | X | | | | | | | | | | | X | X | | | | | X | X | | |
| Alaska plaice | 6-7yrs | | | | X | | | | | | | | | | | X | | | | | | | | | |
| Rex sole | 24cm | | 16cm | | X | | | | | | | | | | | X | X | X | | | | | X | | |
| Flathead sole | | | | | X | | | | | | | | | | | X | | | | | | | | | |
| Sablefish | 65cm | | 57cm | | X | | | | | | X | | | | | X | X | | | | | | | | |
| Pacific ocean perch | 10.5 yrs | | | | | X | | | X | | | | | | | | | | | | X | X | | | |
| Shortraker/Rougheye rockfish | 20 yrs | | 20 yrs | | | X | | | X | | | | | | | | X | X | | | | | | | |
| Northern rockfish | 12.8 yrs | | | | | X | | | X | | | | | | | | X | X | | | | | | | |
| Dusky rockfish | | | | | | X | | | X | | | | | | | | X | X | | | | | | | |
| Yelloweye rockfish | 22 yrs | | 22 yrs | | | X | | | X | | | | | | | | X | X | | | | | | | |
| Thornyhead rockfish | 12 yrs | | | | | | | | | X | | | | | | X | | | | | | | X | | |
| Atka mackerel | 3 yrs | | 3 yrs | | X | | | | | | | | X | X | | | | X | X | | | | | | |
| Squid | | | | | | X | | | | | | | | | | | | X | X | | | | | | |
| Capelin | 2 yrs | 4 yrs | 2 yrs | 4 yrs | X | | | | | | X | | | | | | X | X | X | | | | | | |
| Eulachon | 3 yrs | 5 yrs | 3 yrs | 5 yrs | X | | | | | X | | | | | | | X | | | | | | | | |
| Sculpins | | | | | X | X | | X | | | | | X | X | | | | | | | | X | X | | |
| Sharks | | | | | | X | | | | | | | | | | | | | | | | | | | |
| Skates | | | | | | X | X | | | | | X | | | | | | | | | | | | | X |
| Octopus | | | | | | X | | | | | | | | | | | | | | | | | | | X |

| | Reproductive Traits | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Age at Maturity | | | | 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 |
| Eulachon | 3 | | | | X | | X | | | X | | | | | | X | X | | | | | | | |
| Capelin | 2 | | | | X | | X | | | X | | | | | | X | X | X | X | X | | | | |
| Sand Lance | 2 | | | | | | | | | | | | | | | | | | | | | | | X |
| Myctophids & Bathylagids | | | | | | | | | | | | | | | | | | | | | | | | X |
| Sand fish | | | | | | | | | | | | | | | | | | | | | | | | X |
| Euphausiids | 1 | | | | X | | | | | | X | | | | | X | X | | | | | | | |
| Pholids and Stichaeids | 2-4 | | | | X | | | | | | | | | X | | X | X | | | | | X | X | |
| Gonostomatids | | | | | | | | | | | | | | | | | | | | | | | | X |

5.10.1 EFH Determination

**EFH definition for GOA Walleye Pollock**

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

**Larvae (duration 14-60 days)-Level 1**
Epipelagic waters of the water column along the middle and outer continental shelf in the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those that contain copepod, naupli and small euphausiids. Oceanographic features that larvae may be associated with are gyres and fronts.

**Juveniles (.4-4.5 years)- Level 1**
Pelagic waters along the inner, mid and outer continental shelf in the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those that contain pelagic crustaceans, copepods and euphausiids. Oceanographic features that juveniles may be associated with are fronts and the thermocline.

**Adults (4.5+ years)- Level 2**
Pelagic waters from 70-200m along the outer continental shelf and basin in the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those that contain pelagic crustaceans and fish. Oceanographic features that adults are associated with are fronts and upwelling. Spawning concentrations occur in Shelikof Strait, in the Shumagin Islands, 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 300m.

**EFH definition for GOA Pacific cod**

**Eggs (duration 15-20 days)-Level $0_a$**
Areas of mud, sandy mud, muddy sand and sand along the inner, middle and outer continental of the Gulf of Alaska from Dixon Entrance to 170°W in winter and spring.

**Larvae (duration unknown)-Level $0_a$**
Epipelagic waters of the Gulf of Alaska from Dixon Entrance to 170°W in winter and spring.

**Early Juveniles(up to 2 years)-Level $0_a$**
Areas of mud, sandy mud, muddy sand and sand along the inner and middle continental shelf and the lower portion of the water column of the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing 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 Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing pollock, flatfish, and crab.

**Adults(5+ years)- Level 2**
Areas of mud, sandy mud, muddy sand and sand along the inner, middle and outer continental shelf up to 500m and the lower portion of the water column of the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing pollock, flatfish, and crab. Spawning occurs in January-May.

**EFH definition for GOA Deep water flatfish, Dover sole**

**Eggs- Level $0_a$**
Pelagic waters along the inner, middle and outer continental shelf, during spring and summer, of the Gulf of Alaska from Dixon Entrance to 170°W.

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

**Early Juveniles (up to 3years)-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 Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing polychaetes, amphipods and annelids.

**Late Juveniles (3-5 years)-Level $0_a$**
Areas of sand and mud along the inner and middle continental slope and the lower portion of the water column of the Gulf of Alaska from Dixon Entrance to 170° W. Feeding areas are those containing polychaetes, amphipods and annelids.

**Adults (5+ years)-Level 1**
Areas of sand and mud along the middle to outer continental shelf and upper slope deeper than 300m and the lower portion of the water column of the Gulf of Alaska from Dixon Entrance to 170° W. 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 are those containing polychaetes, amphipods, annelids and mollusks.

**EFH Definition for GOA Shallow water complex, Yellowfin Sole**

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

**Larvae (duration 2-3 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 (known for the Bering Sea). Adult spawning areas known for the eastern Bering Sea (see Bering Sea EFH definition). 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 to the Alaskan Peninsula.

## EFH Definition for GOA Shallow water complex, Rock Sole

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

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

**Early Juveniles (to 3.5 years old) - Level $0_a$**
Inner, middle and outer portions of the continental shelf (down to 250 m) of the Gulf of Alaska and the lower portion of the water column from Dixon Entrance to 170°W. 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 and the lower portion of the water column within nearshore bays and on the inner, middle and outer portions of the continental shelf (down to 250 m) of the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas would be those containing polychaetes, bivalves, amphipods and crustaceans.

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

## EFH definition for GOA Rex sole

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

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

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

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

## EFH definition for GOA Flathead sole

**Eggs (duration unknown)-Level $0_a$**
Pelagic waters (January-April) along the inner, middle and outer continental shelf in the Gulf of Alaska from Dixon Entrance to 170°W.

**Larvae (duration unknown)-Level $0_a$**
Pelagic waters along the inner, middle and outer continental shelf in the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing phytoplankton and zooplankton.

**Juveniles (2-3 years)-Level 1**
Areas of sand and mud along the inner, middle and outer continental shelf and upper slope and the lower portion of the water column in the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing polychaetes, bivalves, ophiuroids, pollock and small tanner crab.

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

## EFH definition for GOA Arrowtooth flounder

**Eggs (duration unknown)-Level $0_a$**
Pelagic waters (November - March) along the inner, middle, and outer continental shelf in the Gulf of Alaska from Dixon Entrance to 170°W.

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

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

**Late Juveniles (1-4 yrs.)-Level 1**
Areas of gravel, mud, and sand along the inner, middle, and outer continental shelf and upper slope and the lower portion of the water column in the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those that contain euphausiids, crustaceans, amphipods and pollock.

**Adults (4+ years)-Level 2**
Areas of gravel, mud, and sand along the inner, middle, and outer continental shelf, upper slope and nearshore bays and the lower portion of the water column in the Gulf of Alaska from Dixon Entrance to 170°W. Summer feeding areas on the middle and outer shelf would be those containing gadids, euphausiids, and other fish. Spawning areas in winter are on the outer shelf and upper slope regions.

## EFH definition for GOA Sablefish

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

**Larvae (duration up to 3 months)-Level $0_a$**
Epipelagic waters of the middle to outer continental shelf, the slope and basin areas of the Gulf of Alaska from Dixon Entrance to 170°W 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 Gulf of Alaska from Dixon Entrance to 170°W. Areas of soft-bottom in nearshore bays and island passes in the demersal, semi-demersal regions, after the first summer till end of second summer.

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

**Adults (5+years)- Level 2**
Areas of soft bottom deeper than 200m (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 Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas would be those containing mesopelagic and benthic fishes, benthic invertebrates and jellyfish. A large portion of the adult diet is comprised of gadid fishes mainly pollock.

## EFH definition for GOA Slope rockfish, Pacific Ocean Perch

**Eggs (internal incubation, ~90days) No EFH definition determined.**
Infernal 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 to outer continental shelf, the upper and lower slope and the basin areas extending to the seaward boundary of the EEZ of the Gulf of Alaska from Dixon Entrance to 170°W, during the spring and summer months.

**Early Juveniles (larval stage to 3 years) - Level $0_a$**
Initially pelagic, then demersal in very rocky areas of the inner continental shelf of the Gulf of Alaska from Dixon Entrance to 170 degrees W.

**Late Juveniles (3 to 10 years) - Level 1**
Areas of cobble, gravel, mud, sandy mud and muddy sand along the inner, middle to outer continental shelf and upper slope areas, shallower than adults, middle to lower portion of the water column, of the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing euphausiids.

**Adults (10+ years)- Level 1**
Areas of cobble, gravel, mud, sandy mud or muddy sand along the outer continental shelf and upper slope areas from 180-420m (actual depths sampled) of the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing euphausiids. Areas of high concentrations tend to vary seasonally and

may be related to spawning behavior, in summer adults inhabit shallower depths (180-250m) and in the fall they migrate farther offshore (300-420m).

## EFH definition for GOA slope rockfish, Shortraker and Rougheye rockfish

**Eggs- No EFH definition determined.**
Internal fertilization and incubation.

**Larvae- Level $0_b$**
Pelagic waters of the inner, middle, and outer continental shelf, the upper and lower slope and the basin areas extending to the seaward boundary of the EEZ of the Gulf of Alaska from Dixon Entrance to 170°W, 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 Gulf of Alaska from Dixon Entrance to 170°W.

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

**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 third of the water column, of the outer continental shelf and the upper slope of the Gulf of Alaska from Dixon Entrance to 170°W. Fishery concentrations at 300-500m. Feeding areas would be those areas where shrimps, squid and myctophids occur.

## EFH definition for GOA slope rockfish, Northern rockfish

**Eggs- No EFH definition determined.**
Internal fertilization and incubation.

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

**Early juveniles (up to 25cm)-Level $0_b$**
Pelagic waters of the inner, middle to outer continental slope, of the Gulf of Alaska from Dixon Entrance to 170°W.

**Late Juveniles (greater than 25cm)-Level 1**
Areas of cobble and rock along the shallower regions (relative to adults) of the outer continental shelf and the middle and lower portions of the water column of the Gulf of Alaska from Dixon Entrance to 170°W.

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

**EFH definition for GOA Pelagic shelf rockfish, Dusky rockfish**

**Eggs- No EFH definition determined.**
Internal fertilization and incubation.

**Larvae- Level $0_b$**
Pelagic waters of the inner, middle to outer continental shelf, the upper and lower slope and the basin areas extending to the seaward boundary of the EEZ of the Gulf of Alaska from Dixon Entrance to 170°W, 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 Gulf of Alaska from Dixon Entrance to 170°W.

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

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

**EFH definition for GOA Demersal shelf rockfish, Yelloweye rockfish**

**Eggs- No EFH definition determined.**
Internal fertilization and incubation

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

**Early Juveniles (to 10yrs.)-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 Gulf of Alaska from Dixon Entrance to 170°W. Concentrations of young juveniles (2.5-10cm) have been observed in areas of high relief (such as vertical walls, cloud sponges, fjord-like areas).

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

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

## EFH definition for GOA Thornyhead rockfish

**Eggs- Level $0_a$**
Pelagic waters of the Gulf of Alaska from Dixon Entrance to 170°W during the late winter and early spring.

**Larvae (<15months)- Level $0_a$**
Pelagic waters extending to the seaward boundary of the EEZ of the Gulf of Alaska from Dixon Entrance to 170°W 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 Gulf of Alaska from Dixon Entrance to 170°W.

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

## EFH definition for GOA Atka mackerel

**Eggs (40-45 days)-Level $0_a$**
Areas of gravel, rock and kelp in shallow waters, island passes and the inner continental shelf of the Gulf of Alaska from Kodiak Island to 170°W.

**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 in the Gulf of Alaska from Kodiak Island to 170°W.

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

**Adults- Level 1**
Areas of gravel, rock and kelp on the inner, middle and outer continental shelf and the entire water column (to the surface) in the Gulf of Alaska from Kodiak Island to 170°W. Feeding areas are those containing copepods, euphausiids and meso-pelagic fish (myctophids). Spawning occurs in nearshore (inner shelf and in island passes) rocky areas and in kelp in shallow waters in summer and early. Move to offshore deeper areas nearby in winter. Perform diurnal/tidal movements between demersal and pelagic areas.

## EFH Definition for GOA Other species-Sculpins

**Eggs - Level $0_a$**
All substrate types on the inner, middle and outer continental shelf of the Gulf of Alaska from Dixon Entrance to 170°W. Some species deposit eggs in rocky shallow waters near shore.

**Larvae- Level $0_a$**
Pelagic waters of the inner, middle and outer continental shelf and slope of the Gulf of Alaska from Dixon Entrance to 170°W, predominately over the inner and middle shelf.

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

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

## EFH definition for GOA other species-Skates

**Eggs-Level $0_a$**
All bottom substrates of the upper slope and across the shelf throughout the Gulf of Alaska from Dixon Entrance to 170°W.

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

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

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

## EFH Definition for GOA Other Species -Sharks

**Eggs - No EFH definition determined.**
Not applicable (most are oviparous)

**Larvae - No EFH definition determined.**
Not applicable (most species are oviparous/ no larval stage)

**Juveniles and Adults-Level $0_a$**
All waters and substrate types in the inner, middle and outer continental shelf and slope of the Gulf of Alaska from Dixon Entrance to 170°W to the seaward edge of the EEZ.

## EFH Definition for GOA Other Species -Octopus

**Eggs-Level $0_a$**
All bottom substrates of the shelf throughout the Gulf of Alaska from Dixon Entrance to 170°W.

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

**Juveniles and Adults-Level $0_a$**
Broad range of substrate types (mostly rock, gravel, and sand) and the lower portion of the water column on the shelf and the upper slope of the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing crustaceans and molluscs.

## EFH Definition for GOA Squid - Red Squid

**Eggs-Level $0_a$**
Areas of mud and sand on the upper and lower slope Gulf of Alaska from Dixon Entrance to 170°W.

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

**Juveniles and Adults-Level $0_a$**
Pelagic waters of the shelf, slope and basin to the seaward edge of the EEZ in the Gulf of Alaska from Dixon Entrance to 170°W. Feeding areas are those containing euphausiids, shrimp, forage fish, and other cephalopods.

## EFH Definition for GOA 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 Gulf of Alaska from Dixon Entrance to 170°W.

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

**Adults (3+ years)- Level $0_a$**
Pelagic waters of the middle to outer continental shelf and upper slope throughout the Gulf of Alaska from Dixon Entrance to 170°W for non-spawning fishes (July-April). Feeding areas are those containing euphausiids and copepods. Rivers during spawning (April-June).

## EFH Definition for GOA Forage fish complex, Capelin

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

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

**Juveniles (1-2 yrs)- Level $0_a$**
Pelagic waters of the inner and middle continental shelf throughout the Gulf of Alaska from Dixon Entrance to 170°W. 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 Gulf of Alaska from Dixon Entrance to 170°W 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).

## EFH Definition for GOA Forage fish complex, Sand lance

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

**Larvae (100-131 days) - Level $0_a$**
Pelagic and neustonic waters along the inner continental shelf throughout the Gulf of Alaska from Dixon Entrance to 170°W.

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

## EFH Definition for GOA Forage fish complex, Myctophids and Bathylagids

**Eggs - Level $0_c$ - No EFH definition determined**
No information available at this time.

**Larvae - Level $0_c$ - No EFH definition determined**
No information available at this time.

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

## EFH Definition for GOA Forage fish complex, Sand fish

**Eggs - Level $0_a$**
Egg masses attached to rock in nearshore areas throughout the Gulf of Alaska from Dixon Entrance to 170°W.

**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 Gulf of Alaska from Dixon Entrance to 170°W.

**Adults- Level $0_a$**
Bottom substrates of mud and sand of the inner continental shelf throughout the Gulf of Alaska from Dixon Entrance to 170°W.

## EFH Definition for GOA Forage fish complex, Euphausiids

**Eggs - Level $0_a$**
Neustonic waters throughout the Gulf of Alaska from Dixon Entrance to 170°W and to the seaward extent of the EEZ in spring.
**Larvae - Level $0_a$**
Epipelagic waters throughout the Gulf of Alaska from Dixon Entrance to 170°W and to the seaward extent of the EEZ in spring.

**Juveniles - Level $0_a$**
Pelagic waters throughout the Gulf of Alaska from Dixon Entrance to 170°W 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 Gulf of Alaska from Dixon Entrance to 170°W 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.

## EFH Definition for GOA Forage fish complex, Pholids and Stichaeids

**Eggs - Level $0_c$ - No EFH definition determined**
No information available at this time.

**Larvae - Level $0_c$ - No EFH definition determined**
No information available at this time.

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

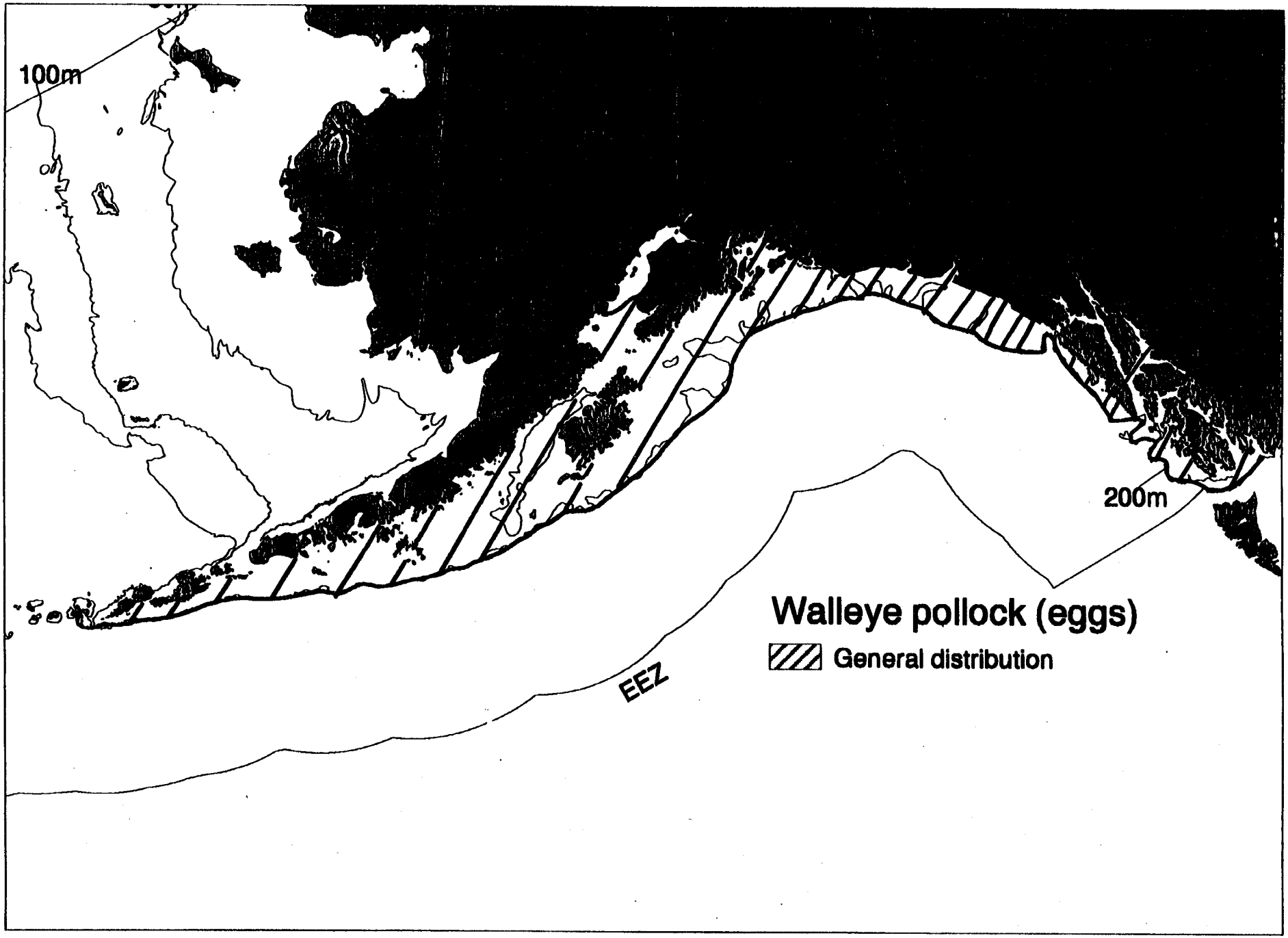
## EFH Definition for GOA Forage fish complex, Gonostomatids

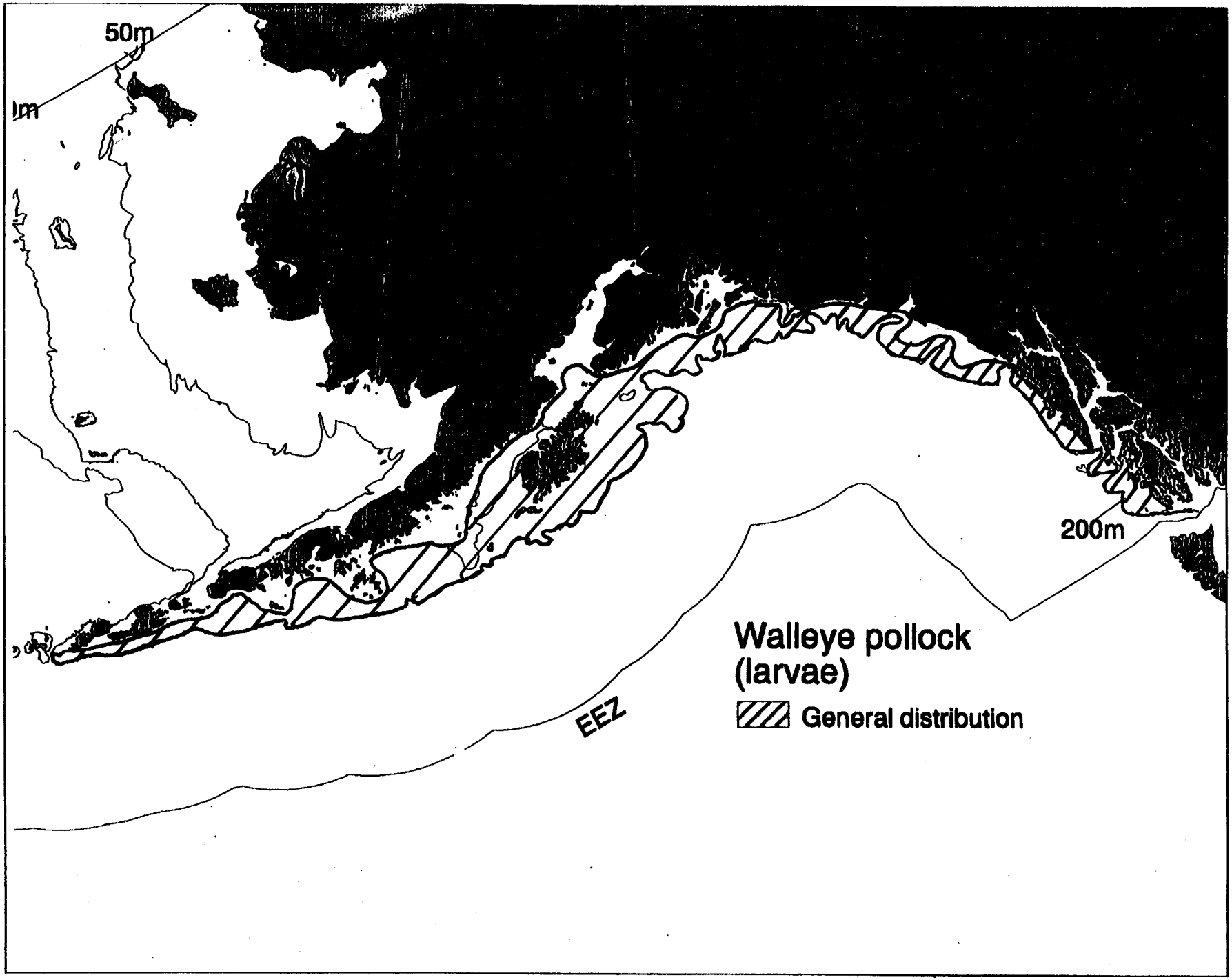
**Eggs - Level $0_c$ - No EFH definition determined**
No information is available at this time.

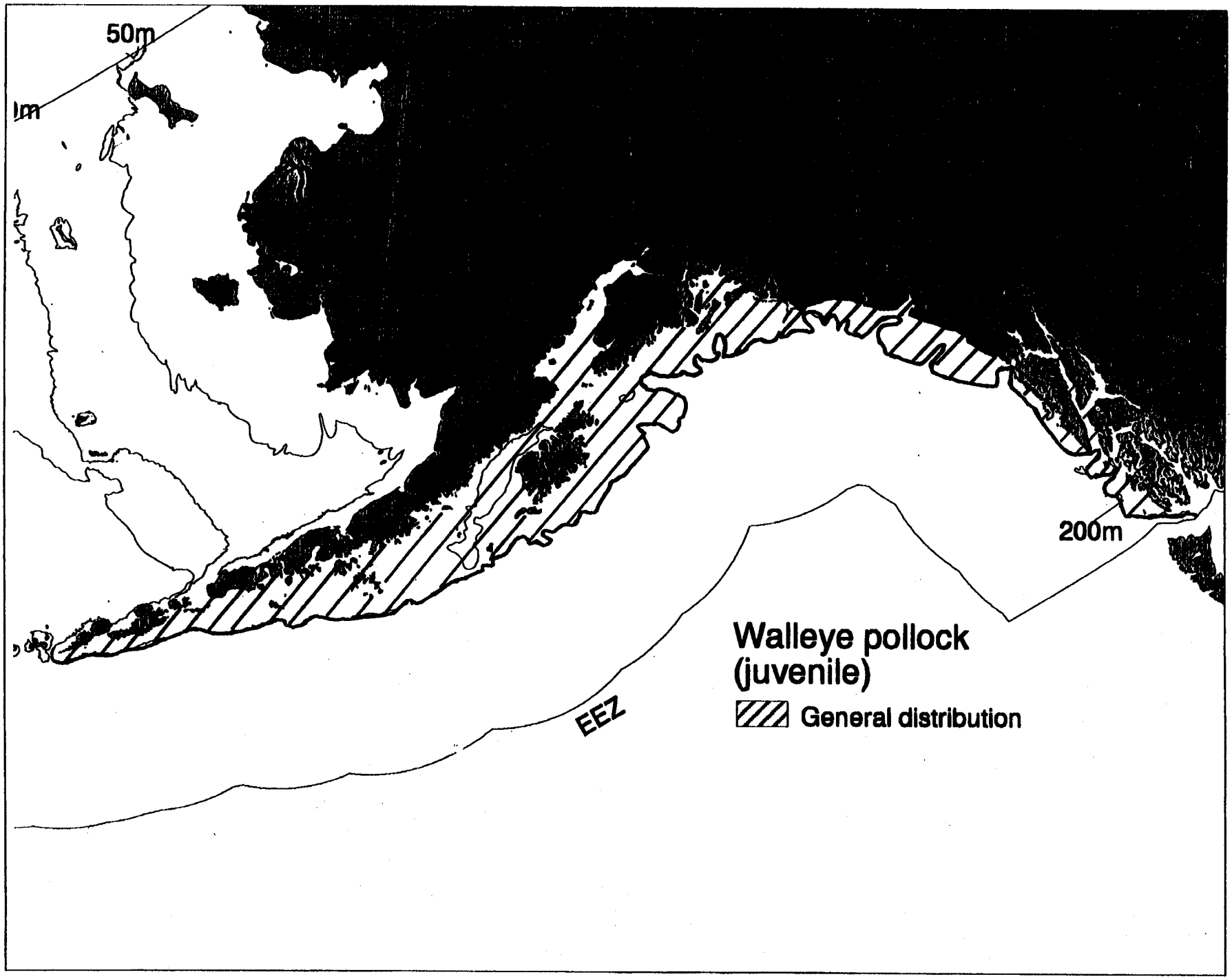
**Larvae - Level $0_c$ - No EFH definition determined**
No information is available at this time.

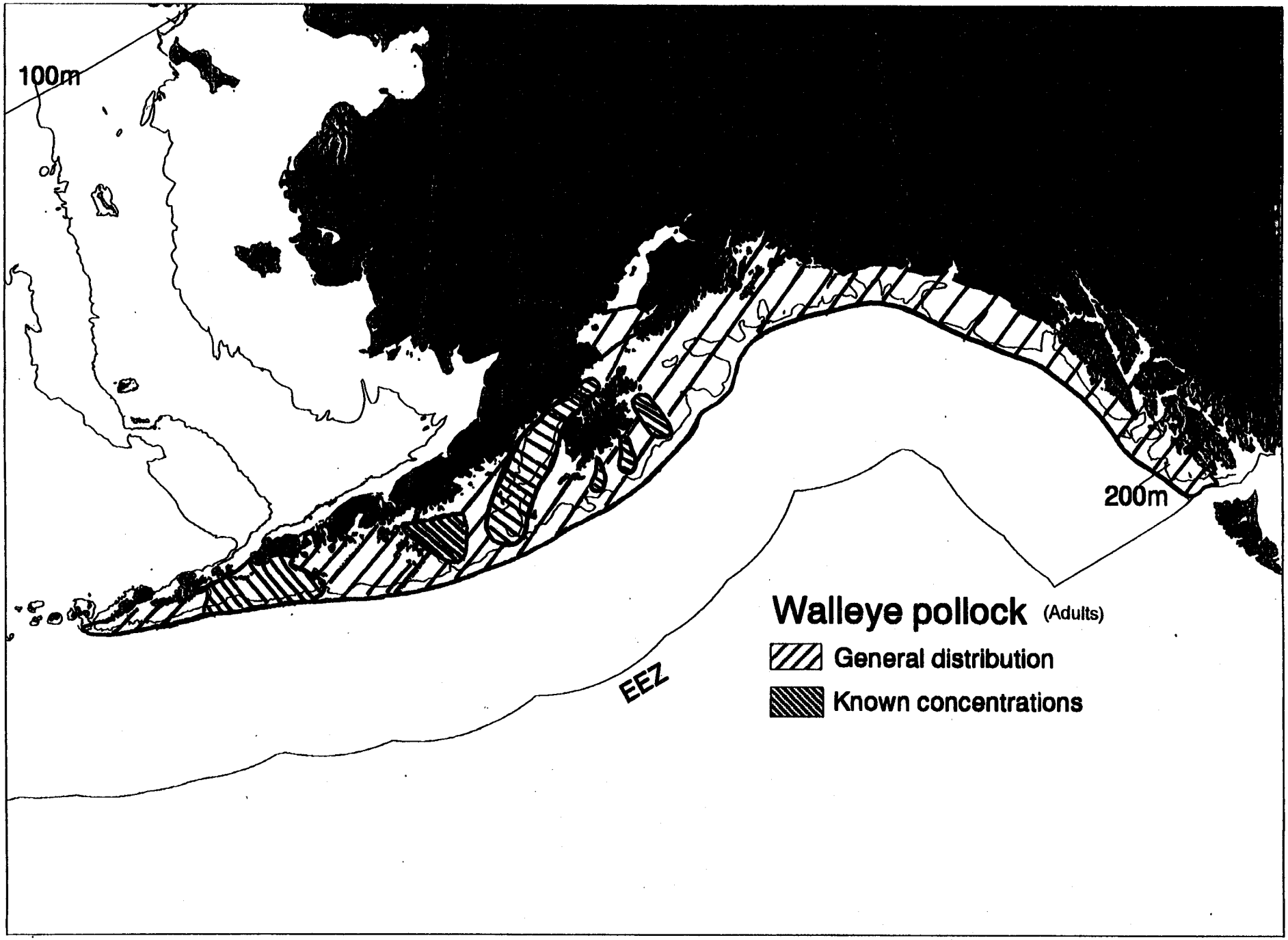
**Juveniles - Level $0_c$ - No EFH definition determined**
No information is available at this time.

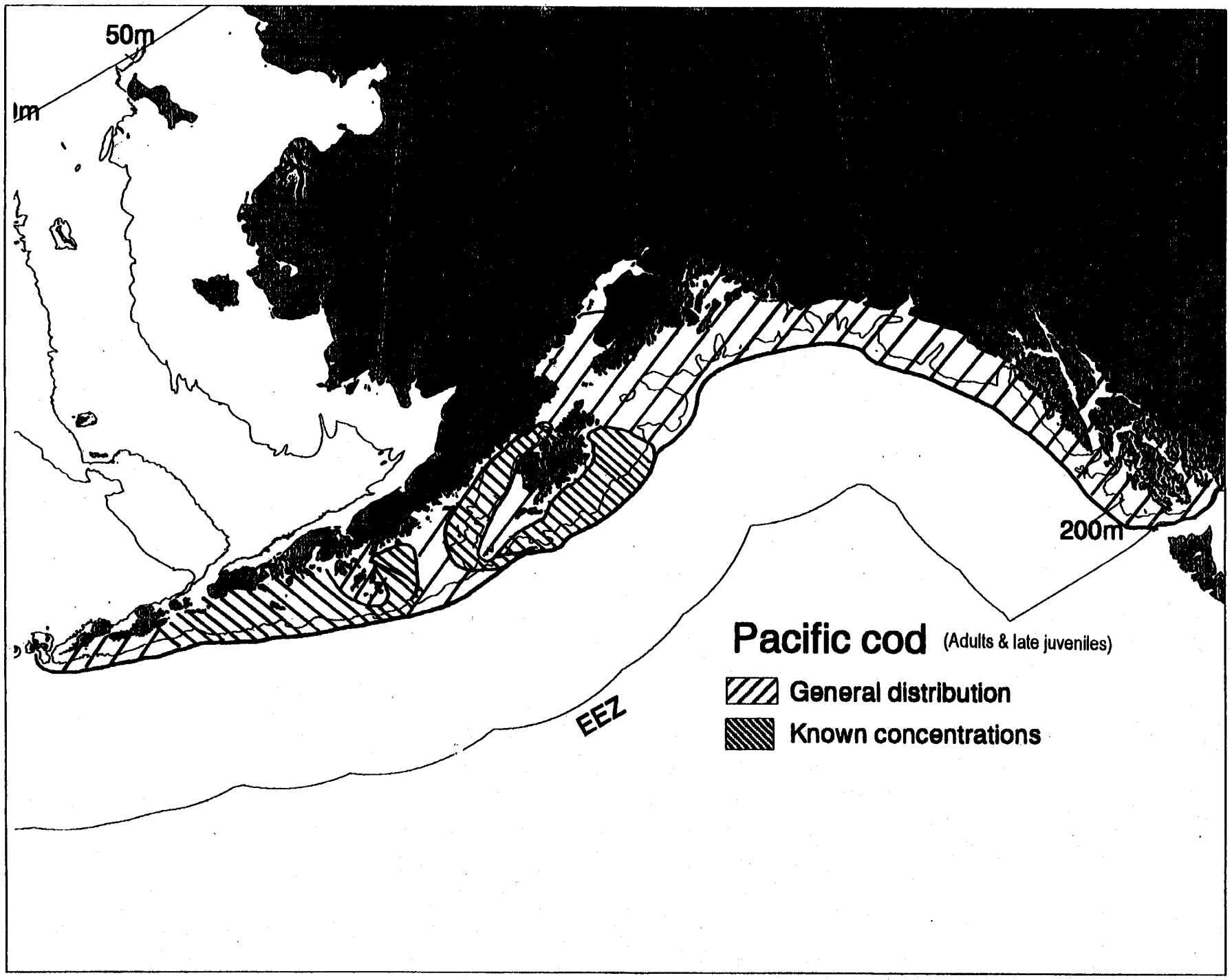
**Adults- Level $0_a$**
Bathypelagic waters throughout the Gulf of Alaska from Dixon Entrance to 170°W and to the seaward extent of the EEZ.

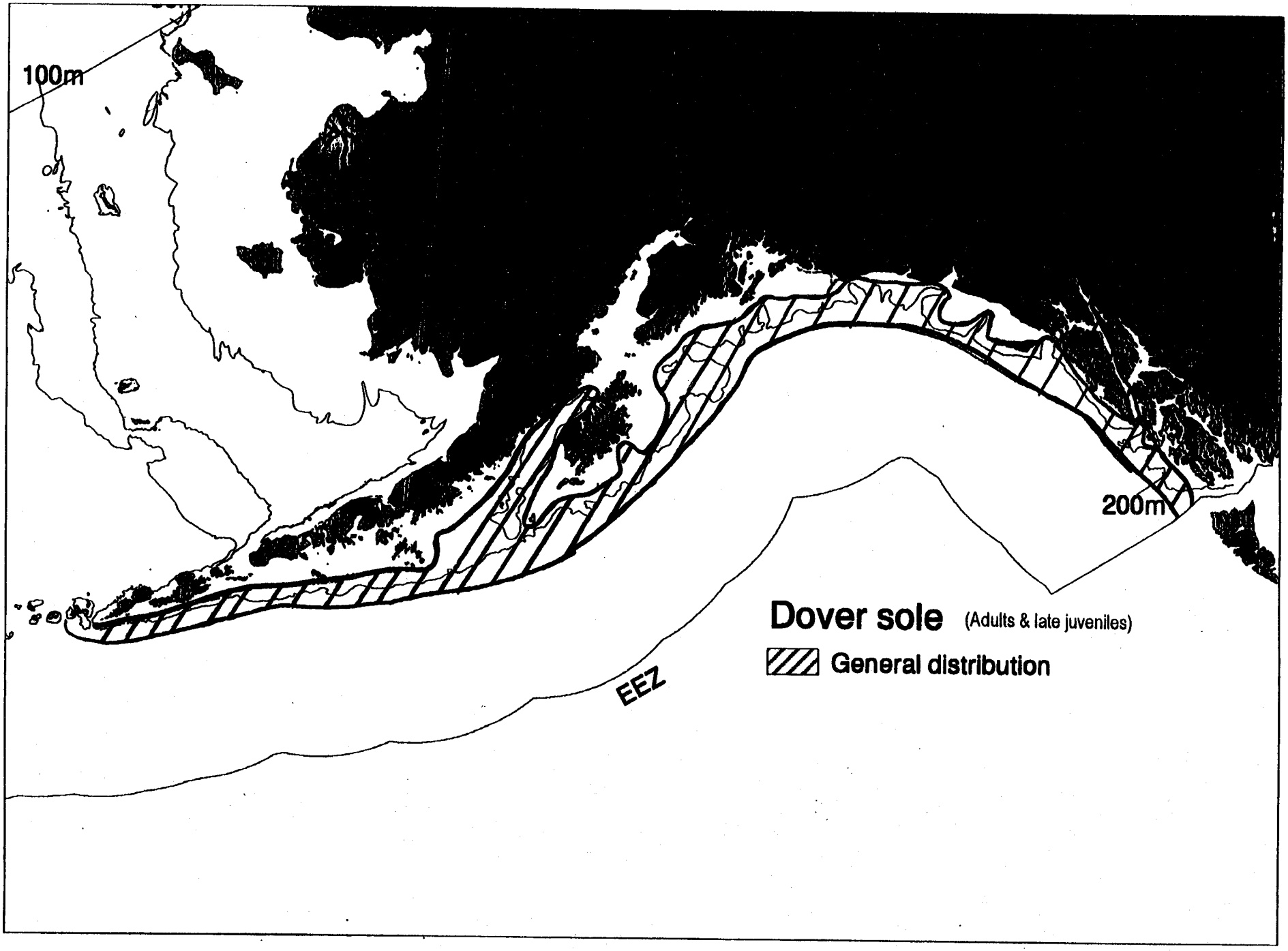

100m
200m
EEZ
Walleye pollock (eggs)
General distribution

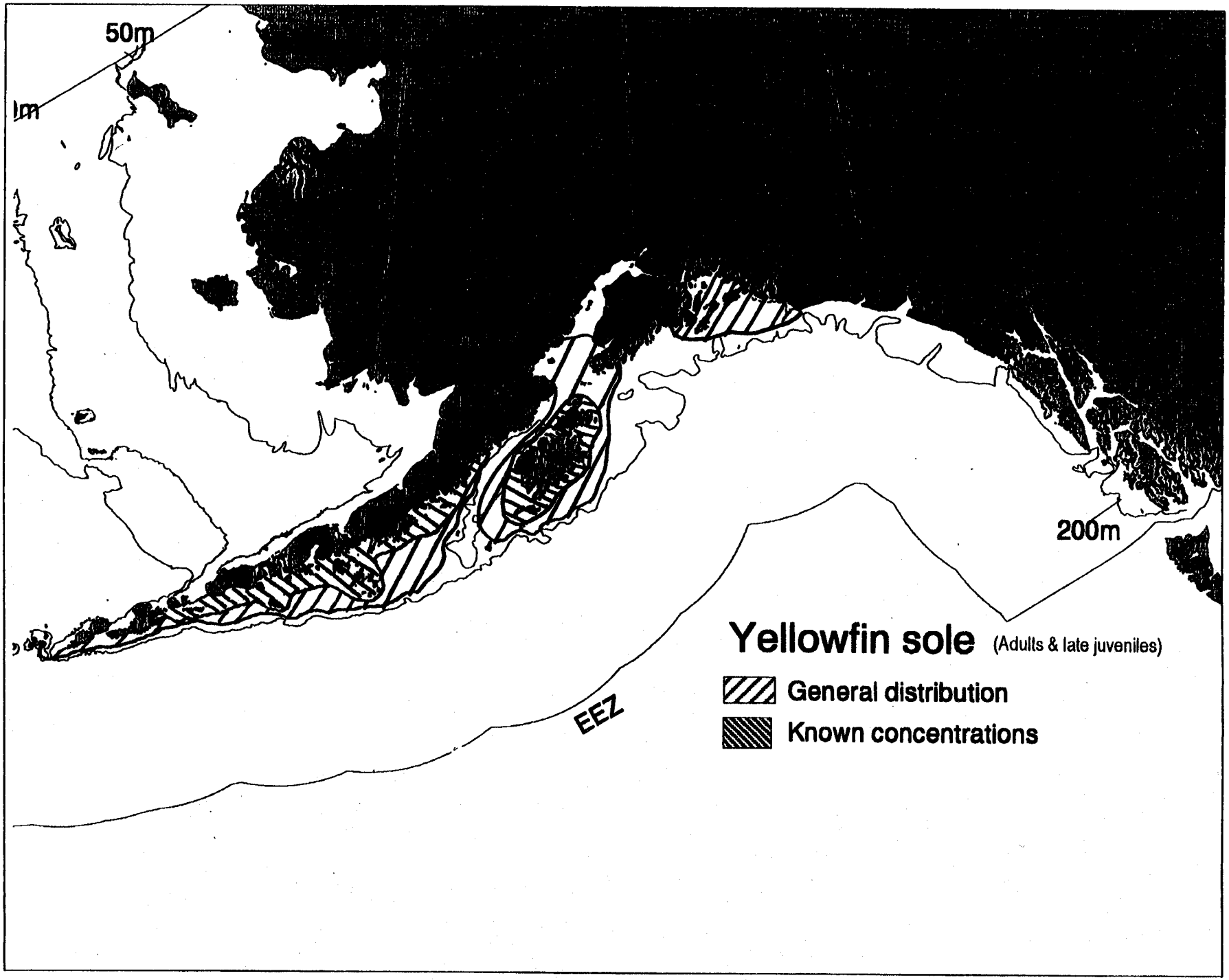

50m
1m
200m
EEZ
Walleye pollock
(larvae)
General distribution

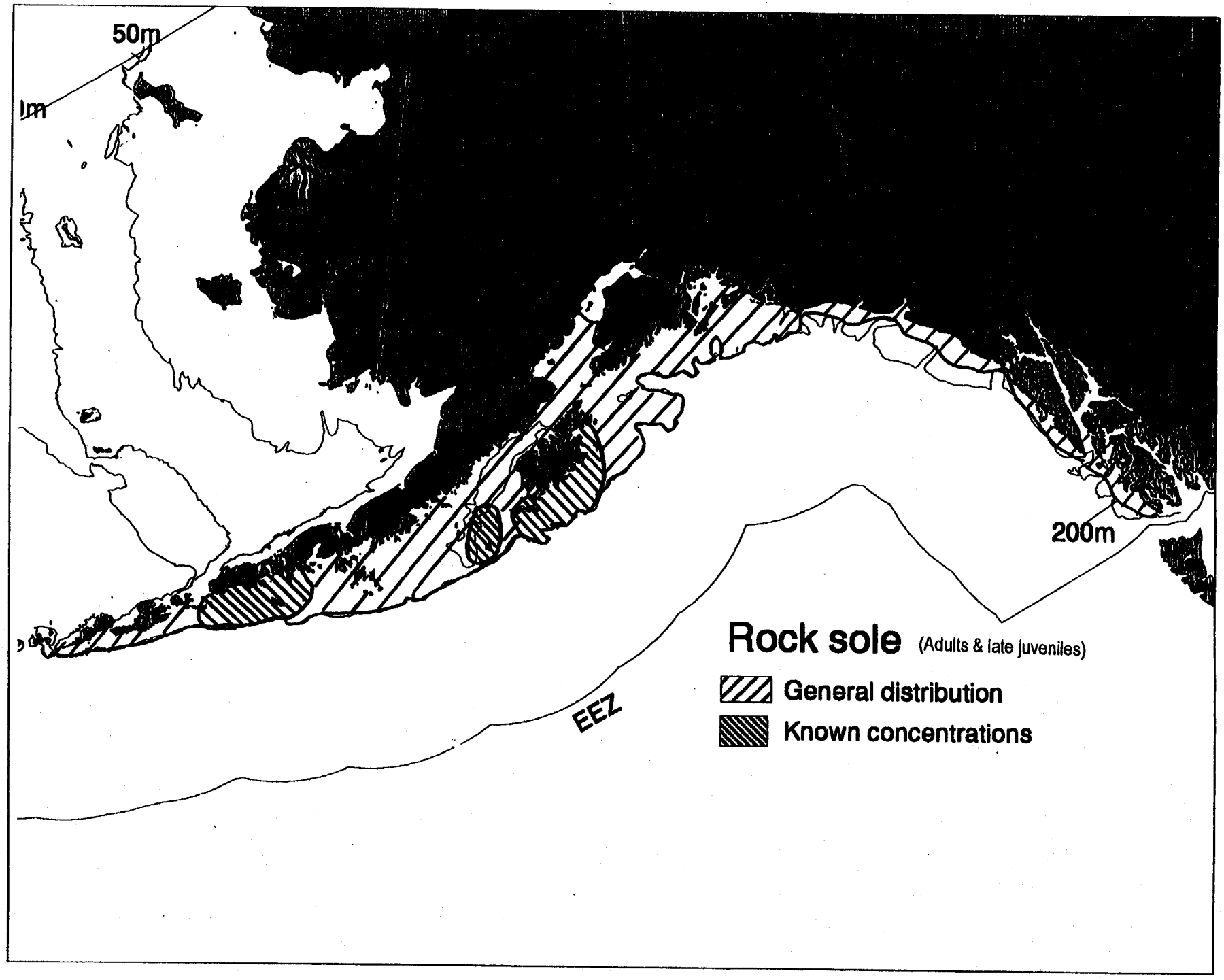

50m
1m
200m
EEZ
Walleye pollock
(juvenile)
General distribution

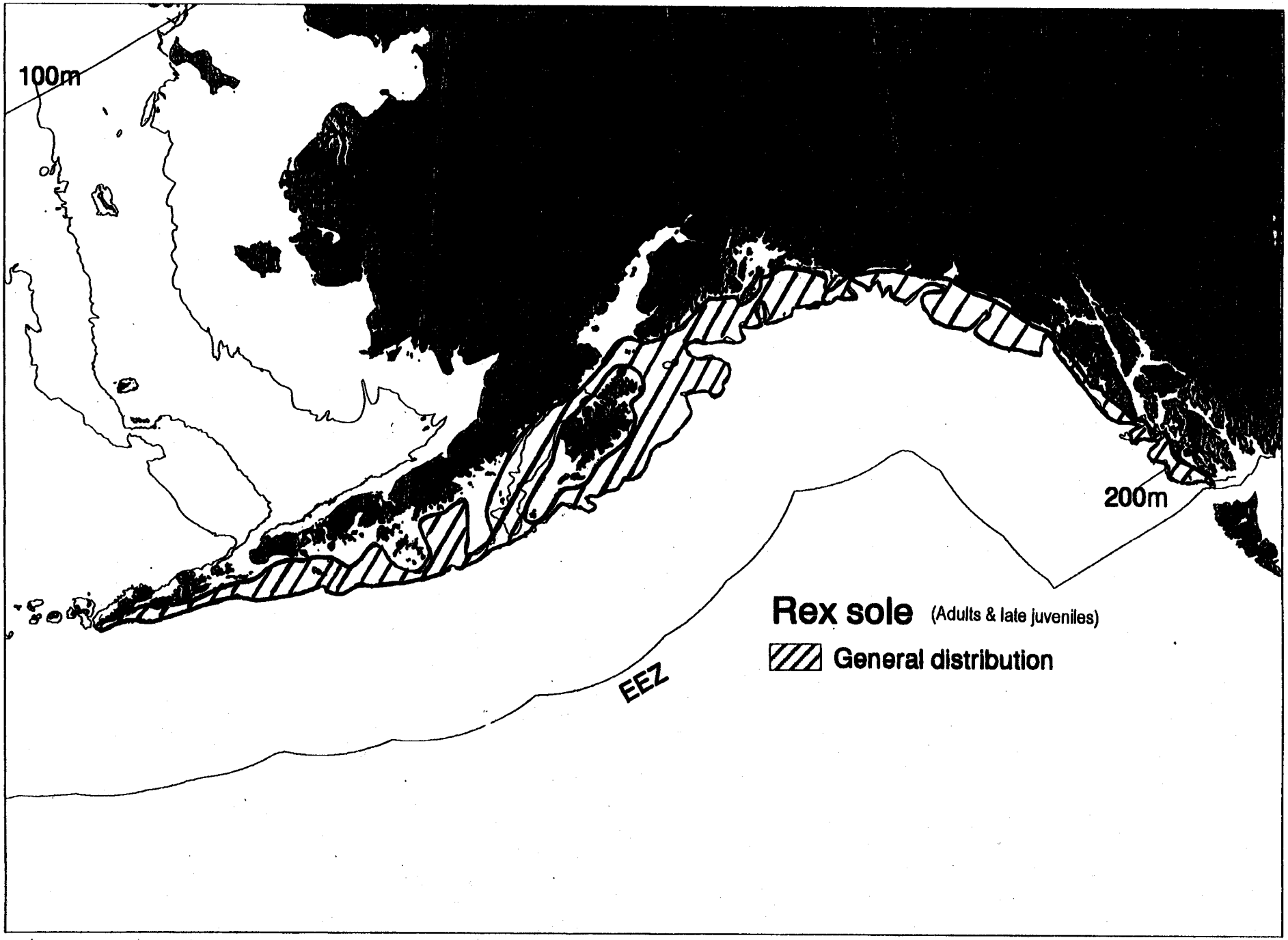

100m
200m
EEZ
Walleye pollock (Adults)
General distribution
Known concentrations

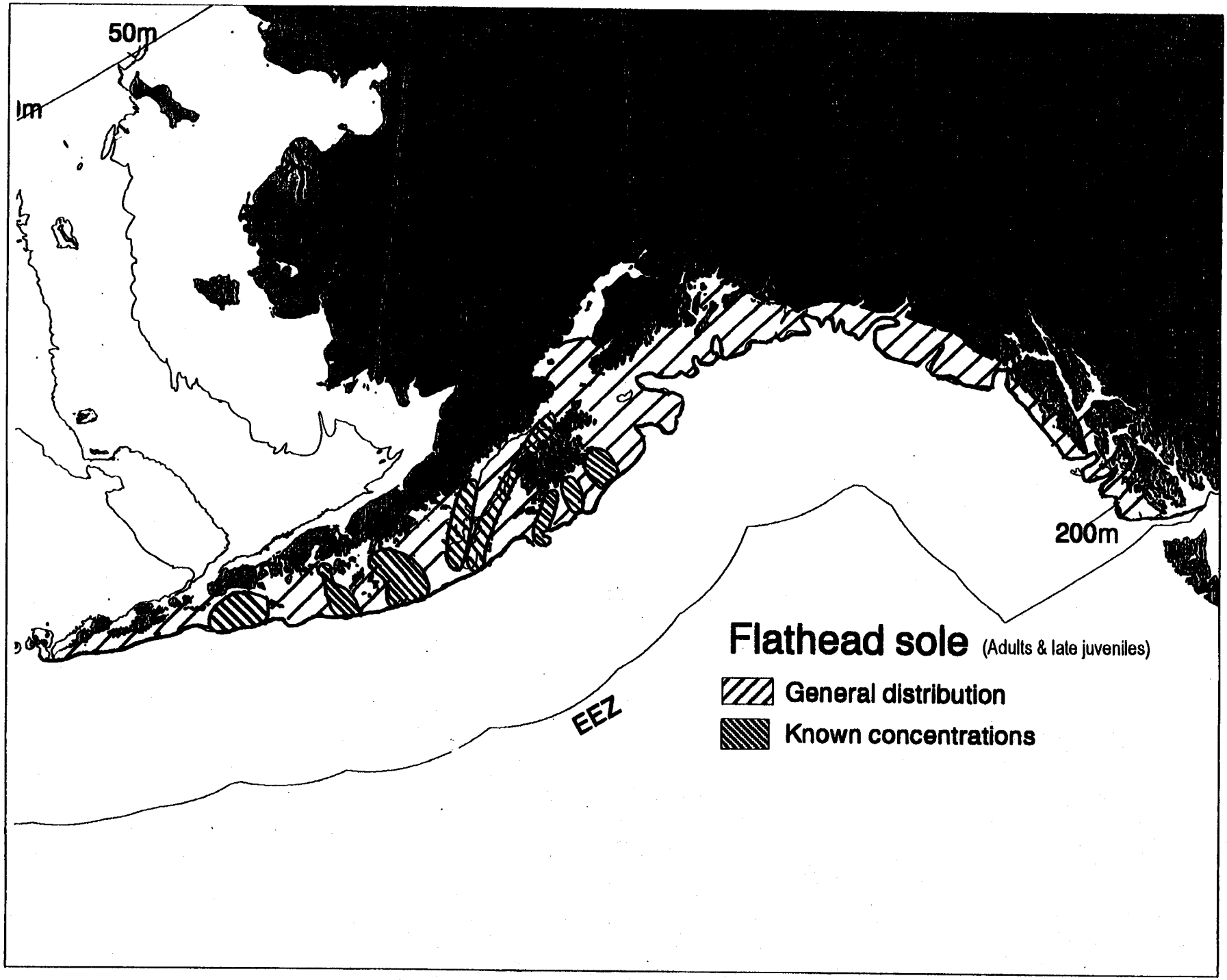

50m
1m
200m
EEZ
Pacific cod (Adults & late juveniles)
General distribution
Known concentrations

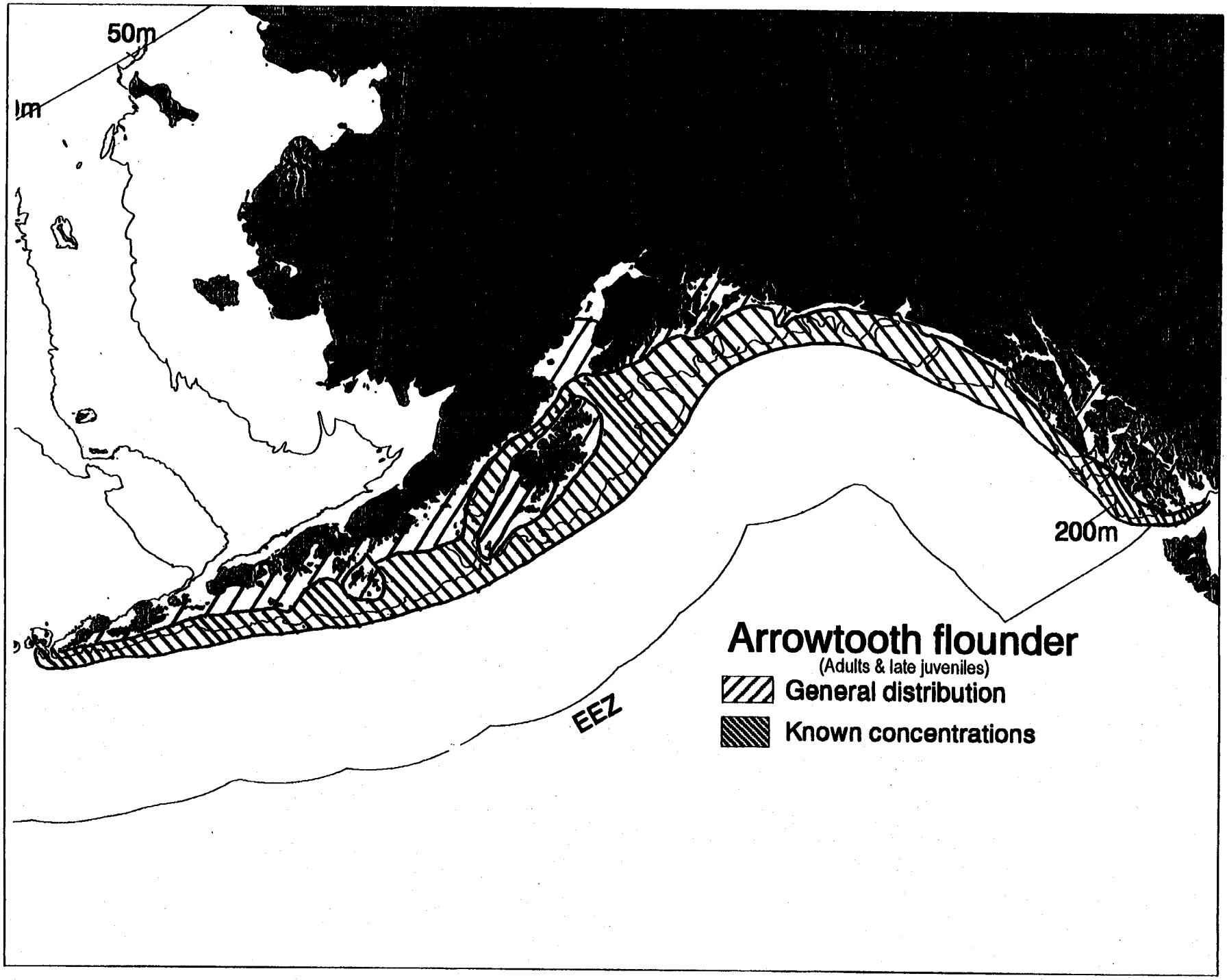

100m
200m
EEZ
Dover sole (Adults & late juveniles)
General distribution

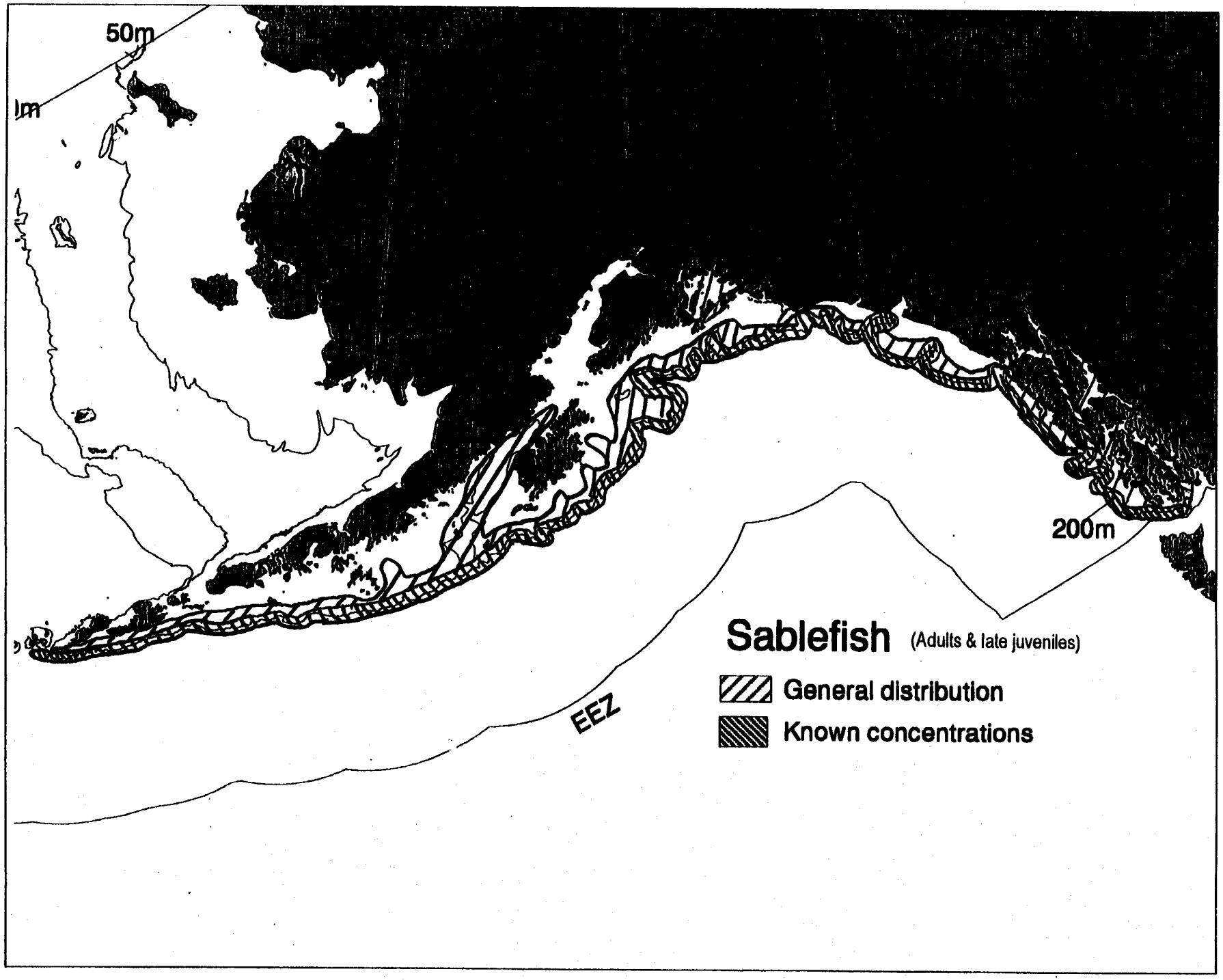

50m
1m
200m
EEZ
Yellowfin sole (Adults & late juveniles)
General distribution
Known concentrations

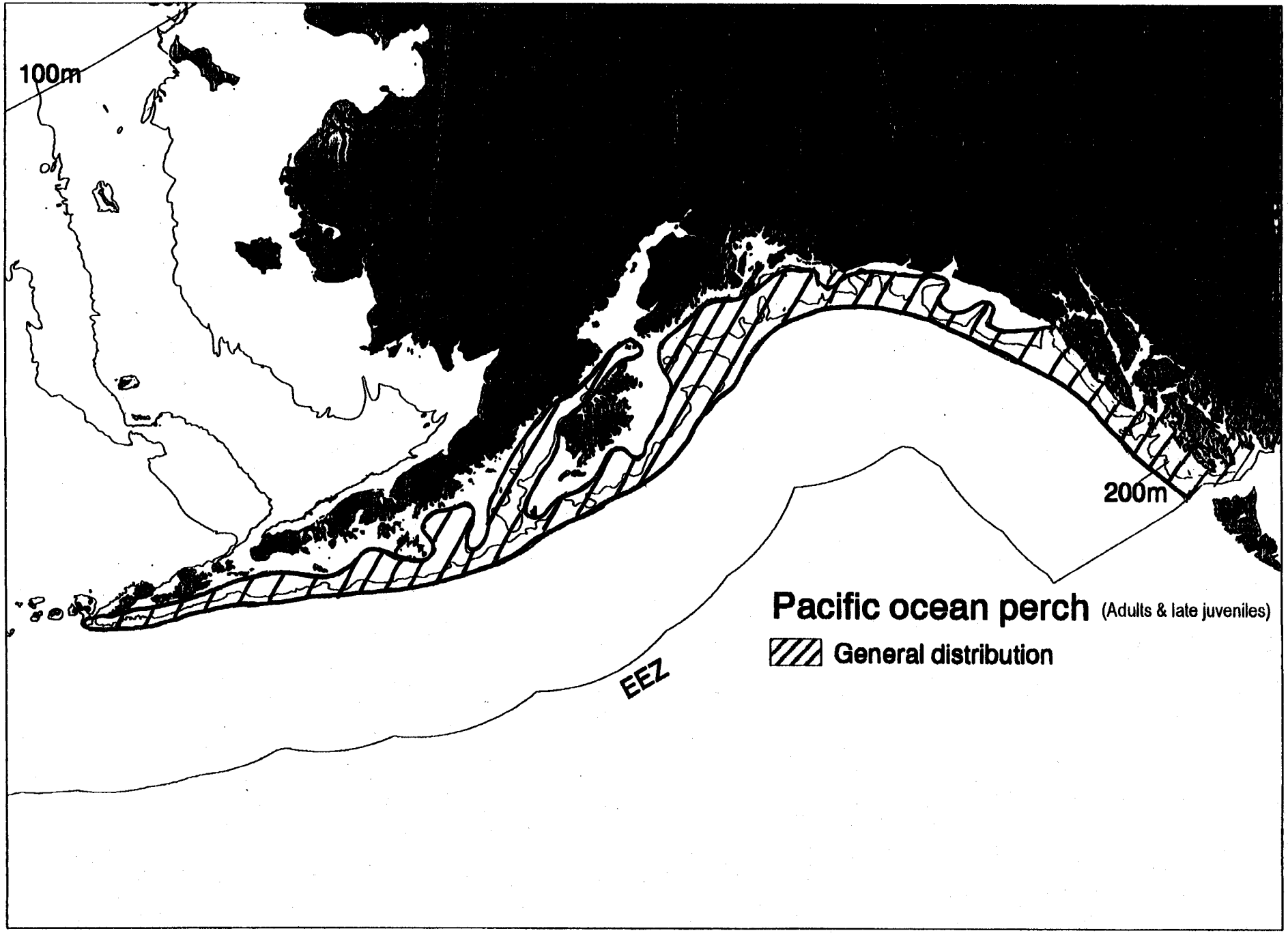

50m
1m
200m
EEZ
Rock sole (Adults & late juveniles)
General distribution
Known concentrations

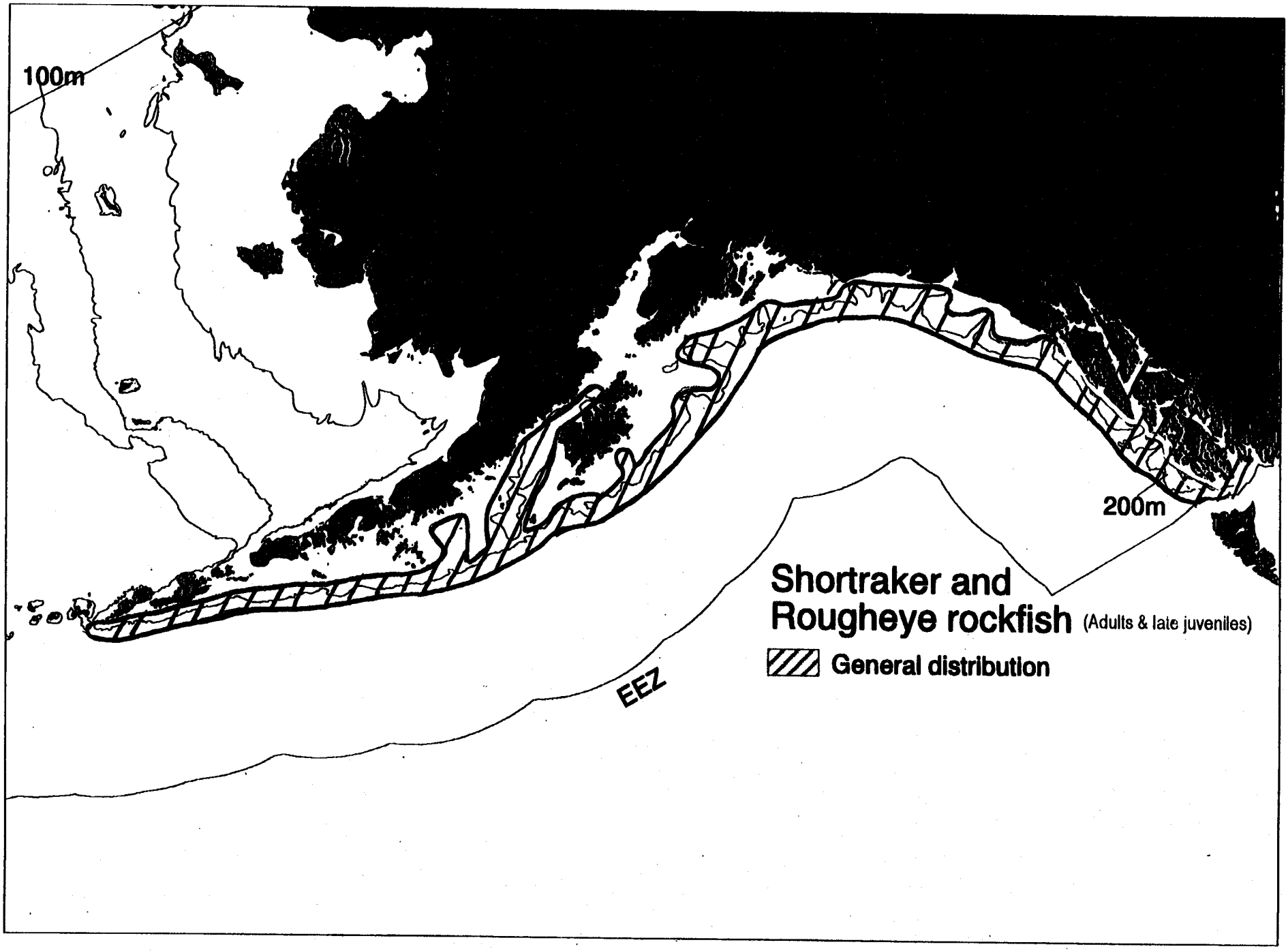

100m
200m
EEZ
Rex sole (Adults & late juveniles)
General distribution

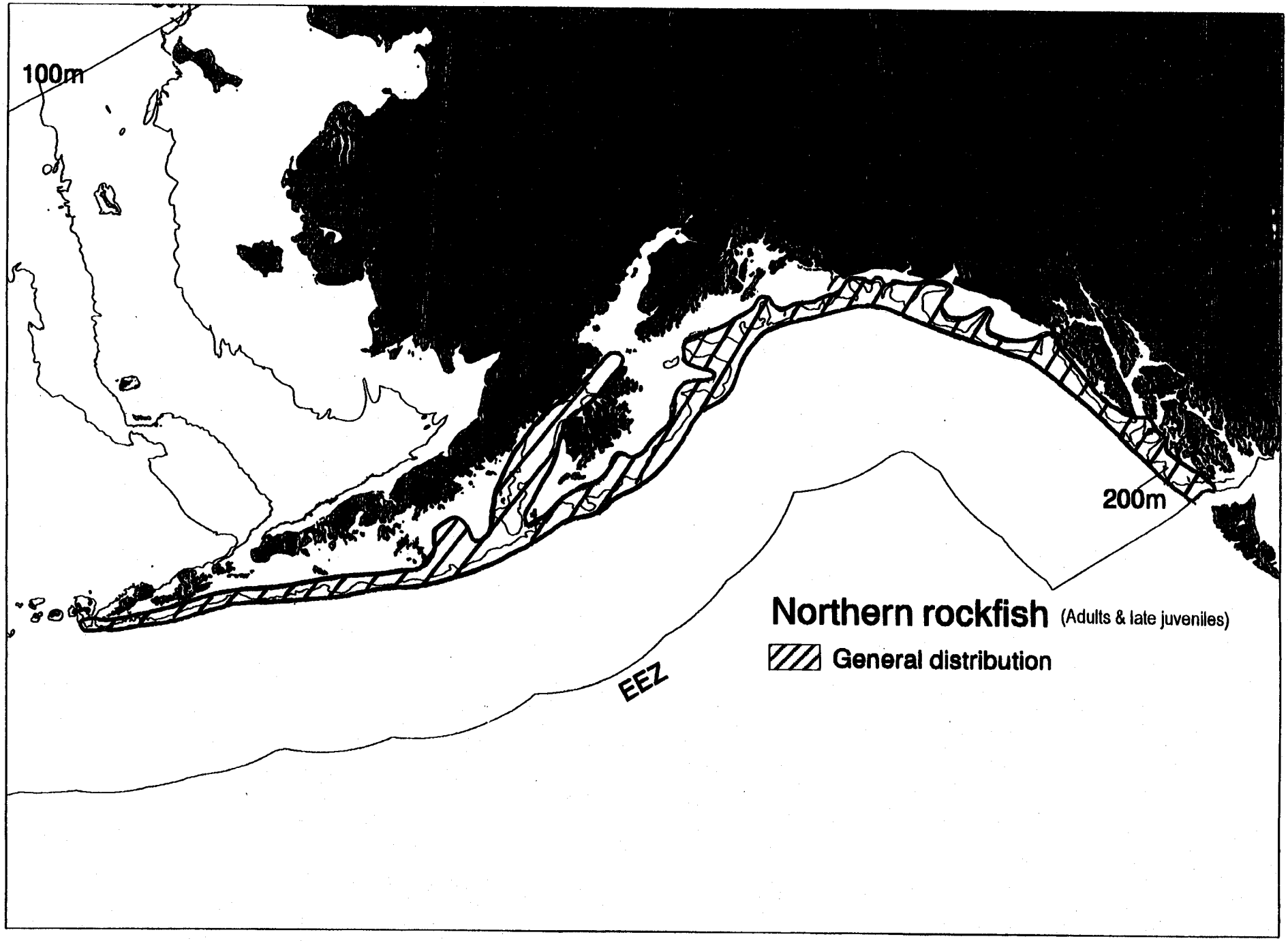

50m
1m
200m
EEZ
Flathead sole (Adults & late juveniles)
General distribution
Known concentrations

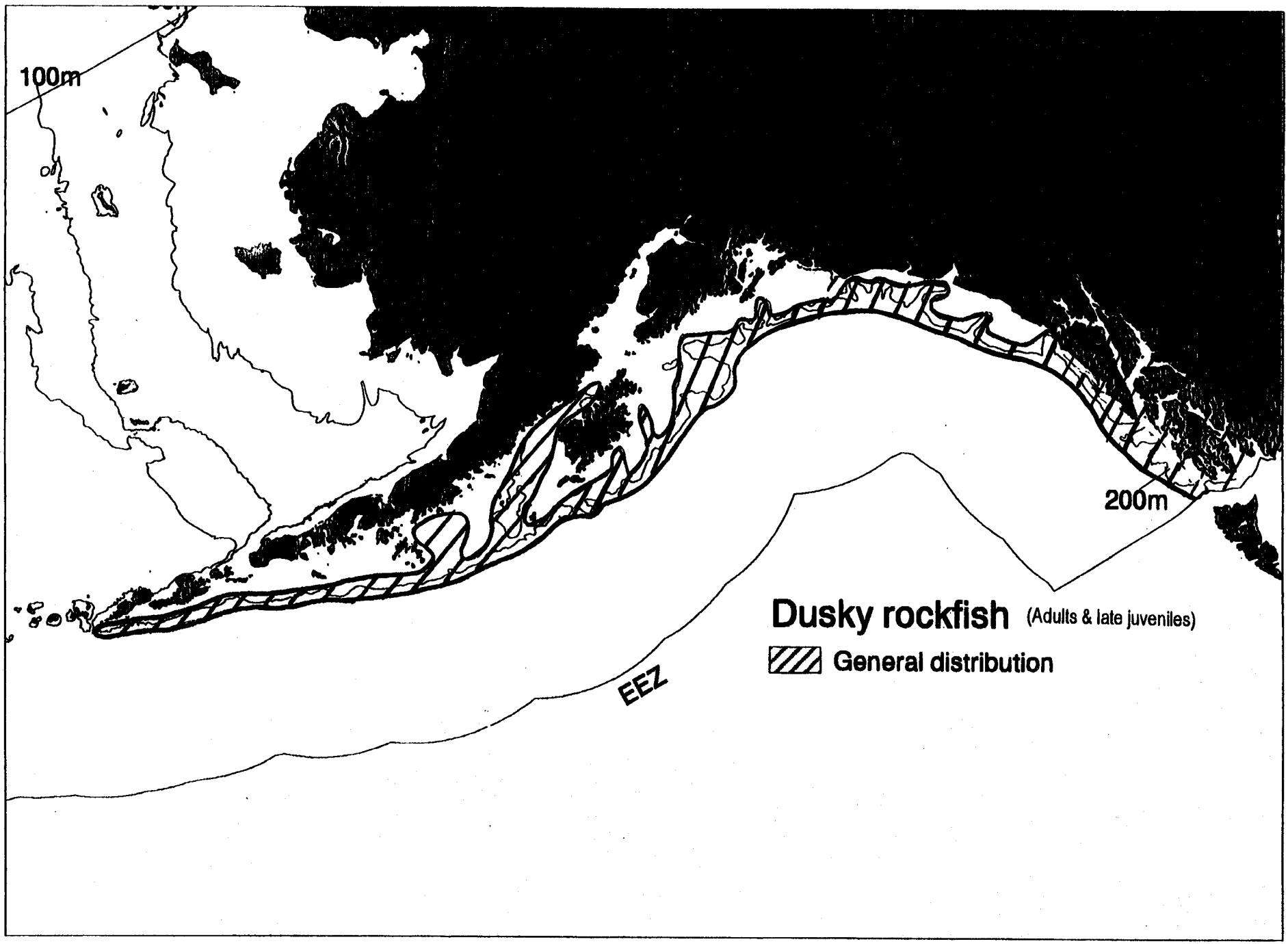

50m
1m
200m
EEZ
Arrowtooth flounder
(Adults & late juveniles)
General distribution
Known concentrations

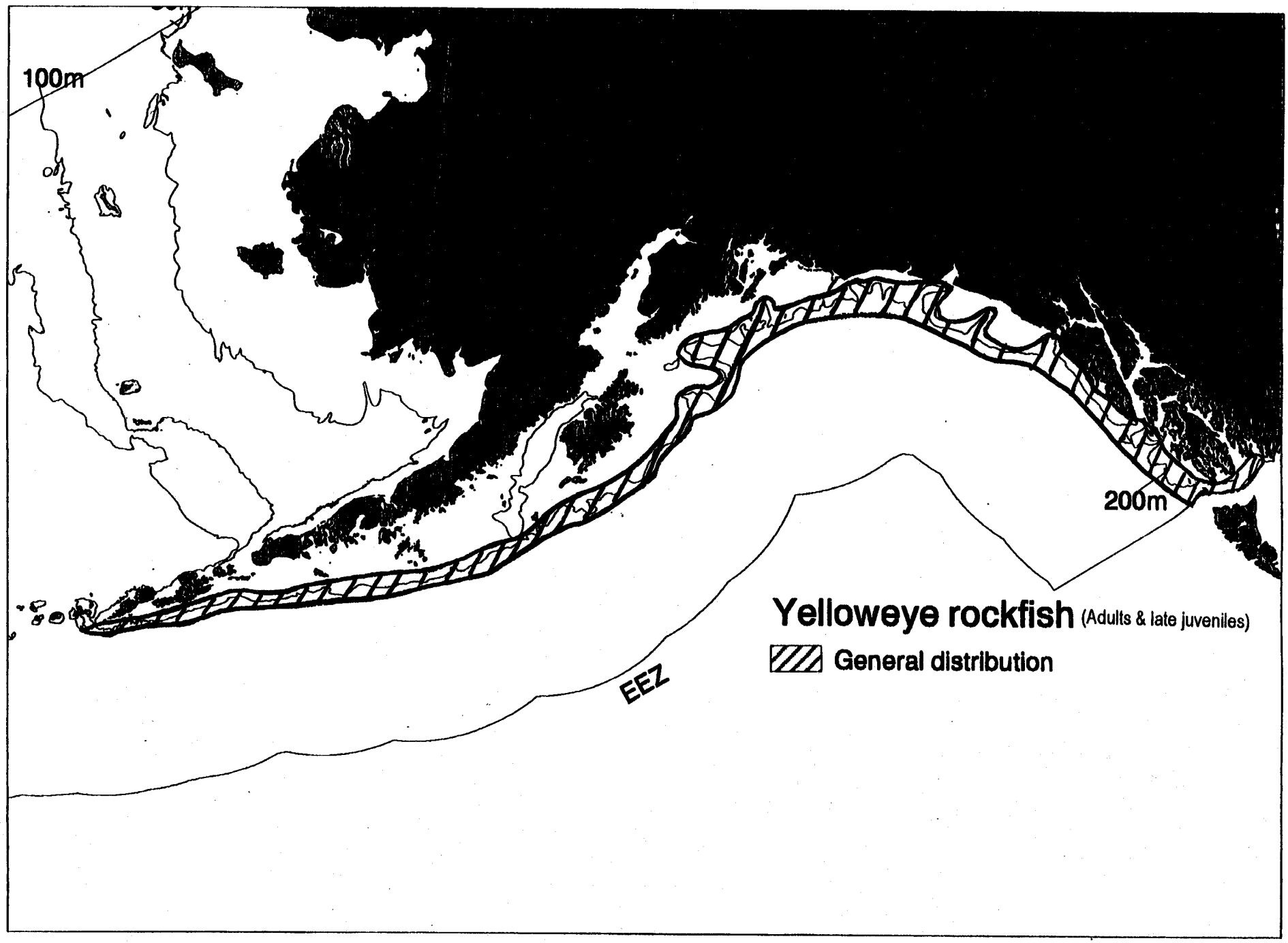

50m
1m
200m
EEZ
Sablefish (Adults & late juveniles)
General distribution
Known concentrations

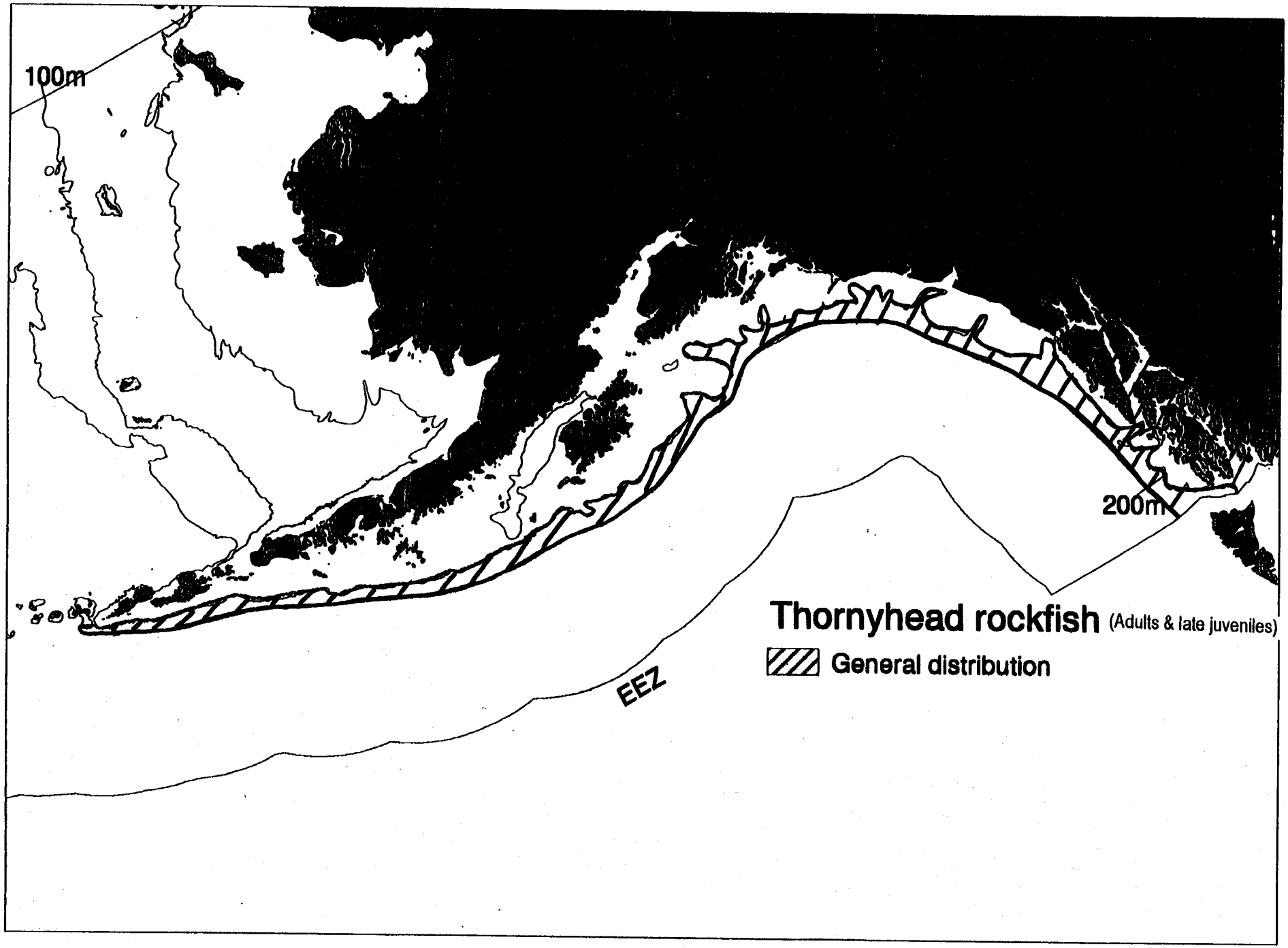

100m
200m
EEZ
Pacific ocean perch (Adults & late juveniles)
General distribution

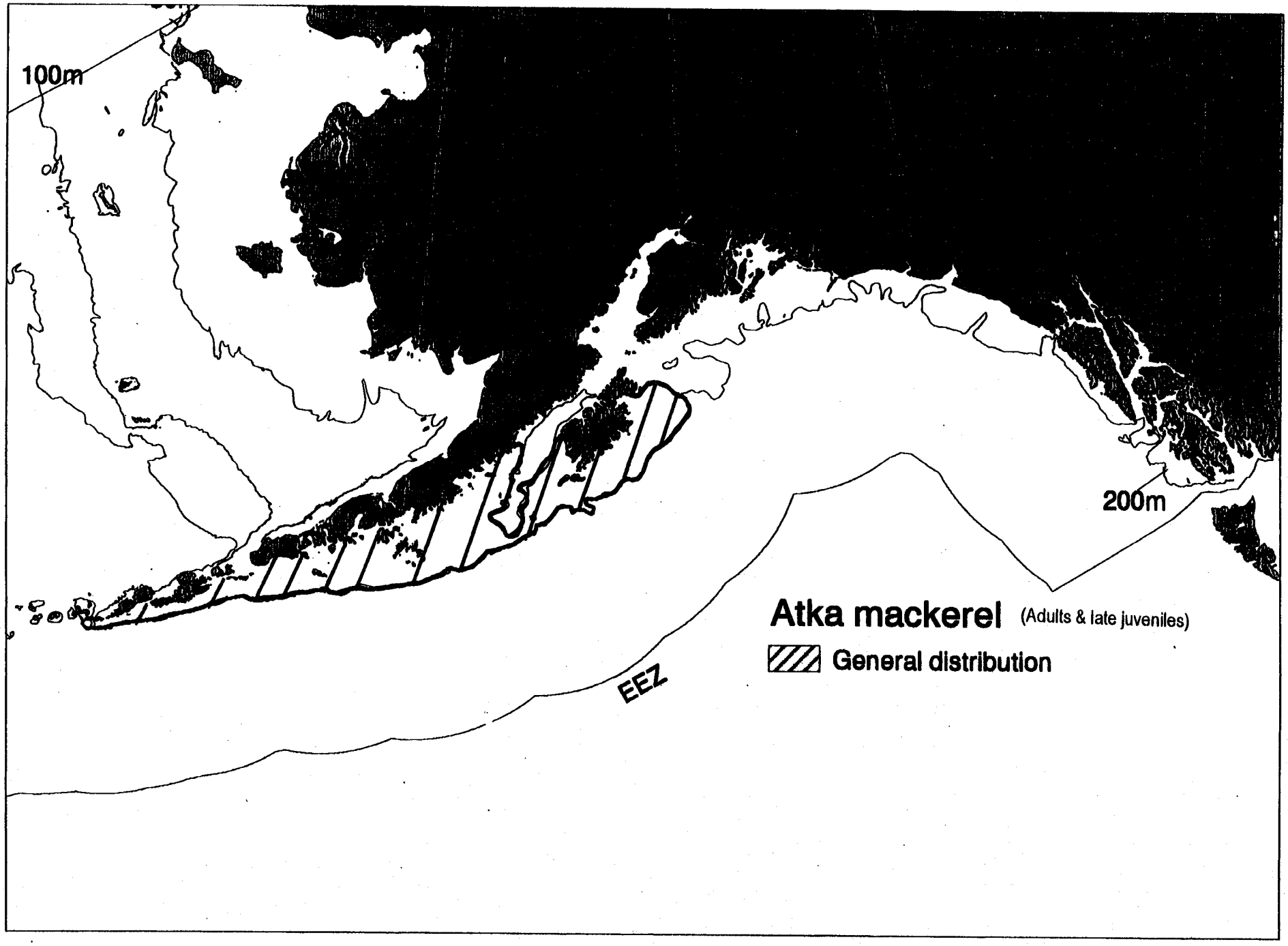

100m
200m
EEZ
Shortraker and
Rougheye rockfish (Adults & late juveniles)
General distribution

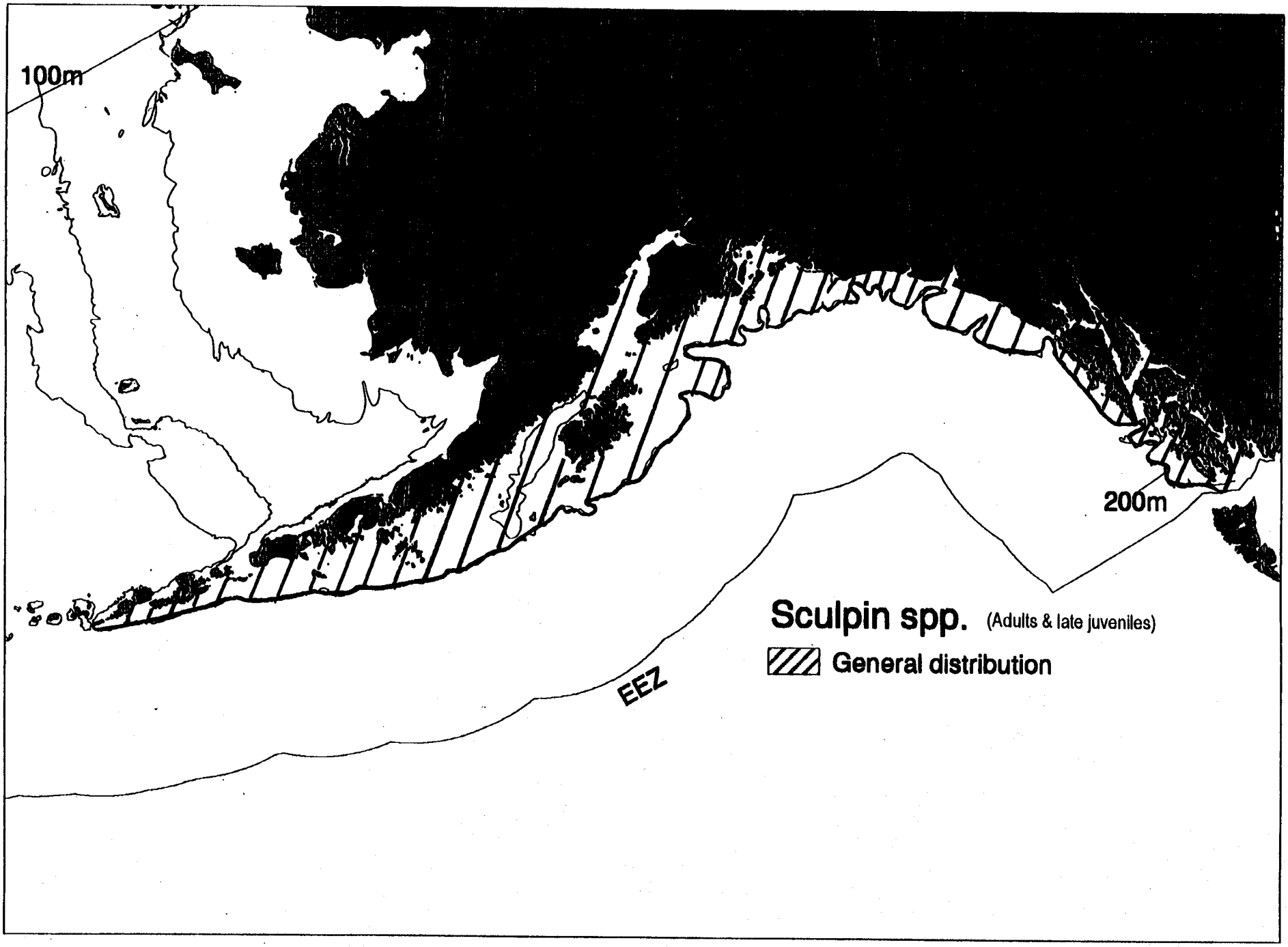

100m
200m
EEZ
Northern rockfish (Adults & late juveniles)
General distribution

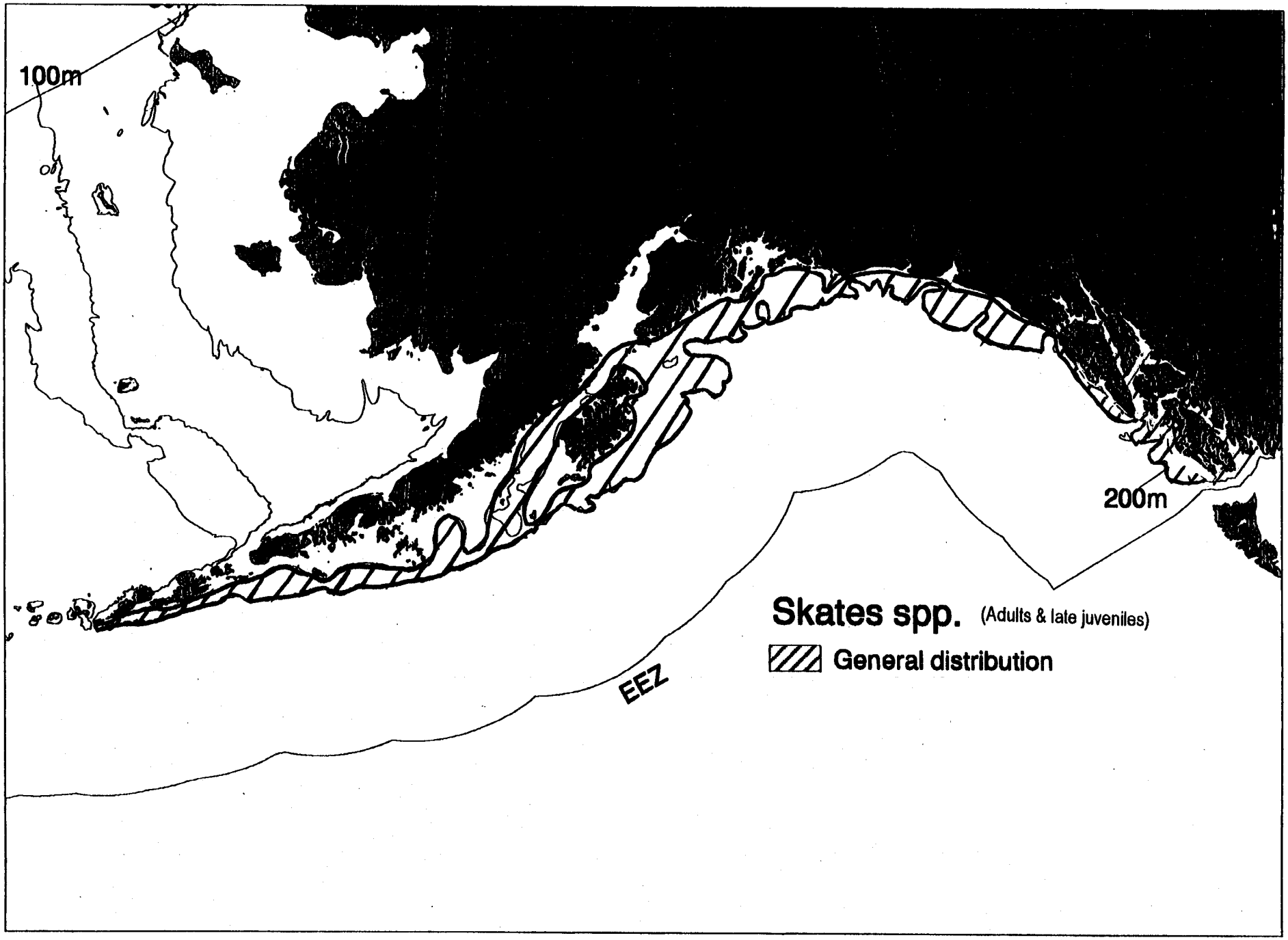

100m
200m
EEZ
Dusky rockfish (Adults & late juveniles)
General distribution


100m
200m
EEZ
Yelloweye rockfish (Adults & late juveniles)
General distribution


100m
200m
EEZ
Thornyhead rockfish (Adults & late juveniles)
General distribution


100m
200m
EEZ
Atka mackerel (Adults & late juveniles)
General distribution


100m
200m
EEZ
Sculpin spp. (Adults & late juveniles)
General distribution

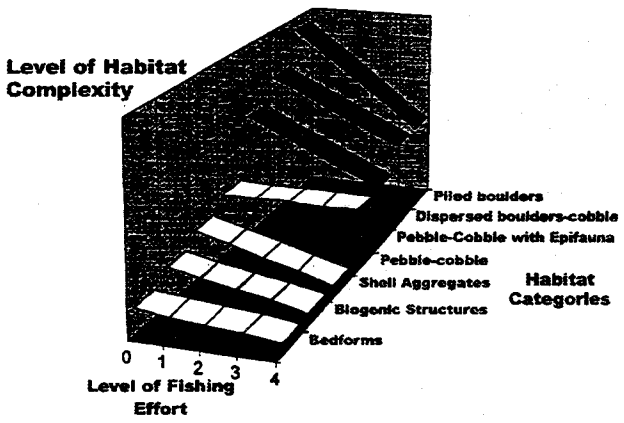

100m
200m
EEZ
Skates spp. (Adults & late juveniles)
General distribution

## 5.10.3 Fishing Activities that may adversely affect EFH

### 5.10.3.1 The indirect effects of fishing: An executive summary

A paper entitled "The Indirect Effects of Fishing" was prepared by Peter Auster and Richard Langton under contract from the American Fisheries Society. The paper summarizes and reviews the current literature on fishing impacts as they relate to EFH. A first draft was released for peer review on January 2, 1998 and a final draft released in April, 1998. 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. The adjacent figure 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.




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 essential fish habitat (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.

## 5.10.3.2 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 Gulf of Alaska, Bering Sea, and Aleutian Islands areas.

Fisheries in the North Pacific are numerous and utilize different gear types. The fisheries and associated gear for the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska fisheries (GOA) are listed in the adjacent table. Federal regulation § 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, scallop, and crab fisheries.

**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 of the Ecosystems Chapter 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 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; Russel 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 BSAI, 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 and BS since the Magnuson 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 and BS), 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 BS has relatively weak currents, on the other hand, with relatively strong tidal action (currents) accounting for up to 95% of all flow as deep as 200 m, with principally gravely-sand and silty-sand seabed (National Research Council 1996).

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. In one study, a standard sole trawl (with roller gear) in a subarctic area (Bering Sea) caught king and Tanner crabs while fishing for sole, sorted the catch with the time on deck being between .5-1.5 hours, then placed the crabs in holding tanks for 48 hours; the resulting mortality rate was 79% for king crab and 78% for Tanner crab (Stevens, 1990). 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). Fukuhara and Worlund (1973) observed an overall Tanner crab mortality of 60-70% in the foreign Bering Sea trawl fisheries. They also noted that mortality was higher in the summer (95%) than in the spring (50%). Hayes (1973) found that mortality of Tanner crab captured by trawl gear was due to time out of water, with 50% mortality after 12 hours. Natural Resource Consultants (1988) reported that overall survival of red king crab and Tanner crab bycaught and held in circulation tanks for 24-48 hours was <22%. In analyses of groundfish plan amendments, the estimated mortality rate of trawl bycaught red king crab and Tanner crab was assumed to be 80% (NPFMC 1993).

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 one 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 re-suspended 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 communications). 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).

Dredge Gear

Dredging for scallops may affect habitat by causing unobserved mortality to scallops and other marine life, mortality of discards, and modification of the benthic community and sediments. Similar to trawling, dredging places fine sediments into suspension, bury gravel below the surface and overturn 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). For some scallop species, it has been demonstrated that dredges may adversely affect substrate required for settlement of young to the bottom (Fonseca et al. 1984; Orensanz 1986). 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.

Several studies have addressed mortality of scallops not captured by dredges. In Australia, this type of fishing gear typically harvests only 5-35% of the scallops in their path, depending on dredge design, target species, bottom type, and other factors (McLoughlin et al. 1991). Of those that come in contact with the dredge but are not captured, some elude the passing dredge and recover completely from the gear interaction. Some injuries may occur during on board handling of undersized scallops that are returned to the sea or during gear interactions on the sea floor (Caddy 1968; Naidu 1988; Caddy 1989), and delayed mortality can result from siltation of body cavities (Naidu 1988) or an increased vulnerability to disease (McLoughlin et al. 1991) and predation (Elner and Jamieson 1979). Caddy (1973) estimated incidental dredge mortality to be 13 to 17%, based on observations of broken and mutilated shells of Atlantic sea scallops. However, a submersible study of sea scallops from the mid-Atlantic indicated that scallop dredges capture with high efficiency those scallops which are within the path of the scallop dredge and cause very low mortality among those scallops that are not captured (NEFMC 1988). Murawski and Serchuk (1989) made submersible observations of dredge tracks and found a much lower mortality rate (<5%) for Atlantic sea scallops. The difference in mortality between these two studies can be attributed to the substrate on which the experiments were conducted. Caddy's work was done in a sandy/gravelly area and Murawski and Serchuk worked on a smooth sand bottom. Shepard and Auster (1991) investigated the effect of different substrate types on dredge induced damage to scallops and found a significantly higher incidental damage on rock than sand, 25.5% versus 7.7%. For weathervane scallops, mortality is likely to

be lower as this species prefers smoother bottom substrates consisting of mud, clay, sand, or gravel (Hennick 1970a, 1973).

Atlantic sea scallop beds and the benthic community associated with scallop fishing grounds in the Bay of Fundy were assessed in 1969 (Caddy 1976). During the intervening years, the area has seen great changes in fishing pressure with recent effort amounting to more than 90 vessels of over 25 GRT continuously fishing the grounds with Digby drags for days at a time (Kenchington and Lundy 1991). Since 1969, there have also been dramatic fluctuations in scallop abundance, including both record highs and lows for this century. In particular, scallop abundance rose to over 1000 times "normal" levels with the recruitment of two strong year-classes in 1985 and 1986. This information indicates that extensive dredging does not affect the recruitment of scallops to a productive ground.

Observations from scallop fisheries across the state suggest that mortality of crab bycatch may be lower on average than those taken in trawl fisheries, perhaps due to shorter tow times, shorter exposure times, and lower catch weight and volume. For crab taken as bycatch in the Gulf of Alaska weathervane scallop fishery, Hennick (1973) estimated that about 30% of Tanner crabs and 42% of the red king crabs bycaught in scallop dredges were killed or injured. Hammerstrom and Merrit (1985) estimated mortality of Tanner crab at 8% in Cook Inlet. Kaiser (1986) estimated mortality rates of 19% for Tanner crab and 48% for red king crab bycaught off Kodiak Island. Urban et al. (1994) recorded that in 1992, 13-35% of the Tanner crab bycaught were dead or moribund before being discarded with the highest mortality rate occurring on small (<40 mm carapace width, CW) and large (>120 mm CW) crabs. Delayed mortality of Tanner crab resulting from injury or stress has not estimated. Mortality in the Bering Sea appears to be lower than in the Gulf of Alaska, in part due to different sizes of crab taken. Observations from the 1993 Bering Sea scallop fishery indicated lower bycatch mortality of red king crab (10%), Tanner crab (11%) and snow crab (19%) (Barnhart et al. 1996). As with observations from the Gulf of Alaska, mortality appeared to be related to size, with larger and smaller crabs having higher mortality rates on average than mid-sized crabs (Barnhart et al. 1996). Delayed mortality was not estimated. In one groundfish plan amendment analysis, all sources of crab mortality were examined; in this analysis a 40% discard mortality rate for all crab species was assumed for scallop fisheries (NPFMC 1993).

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.

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).

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). Bycatch in crab pot fisheries includes crabs, octopus, Pacific cod, halibut, and other flatfish (Tracy 1994). Crab bycatch includes females of target species, sublegal males of target species, and non-target crab.

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). Handling mortality may have contributed to the high natural mortality levels observed for Bristol Bay red king crab in the early 1980s (65% for males and 82% for females) that, along with high harvest rates, resulted in stock collapse (Zheng et al. 1995). However, another study concluded that handling mortality was not responsible for the decline on the red king crab fishery (Zhou and Shirley 1995a). 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. A relationship was developed to predict mortality as the product of temperature and duration of exposure (measured as degree hours). Because BSAI crab fisheries occur during November through February, cold exposure could cause significant handling mortality to crabs not immediately returned to the ocean. However, Zhou and Shirley (1995) observed that average time on deck was generally 2 to 3 minutes, and they concluded that handling mortality was not a significant source of mortality.

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) by-catch 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. By-catch and entanglement of non-target species can occur in the marine fisheries, such as by-catch of demersal rockfish in hook-and-line fisheries, and entanglement of seabirds and marine mammals in net fisheries. In the estuarine and riverine fisheries, direct impacts on riparian vegetation and channel morphology can occur from fishing activities, such as damage to the stream bank from boat wakes and removal of woody debris to provide access. Trampling of stream banks and the stream channel can also damage salmon habitat. Where use levels are high, this type of impact may require restoration or management initiatives. An example is the Kenai River where restoration work was needed to repair damage from recreational fishing for chinook salmon and other salmonids.

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.

Table 1. Summary of literature cited. Those studies done in Alaska are shown in bold.

| Authors | Year | Gear Type | Location | Fishery | Main Emphais 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** | | **1988** | **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 | 1988 | 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** | **Gulf of Alaska** | **Sole** | **Bycatch** |
| Suuronen et.al. | 1993 | | | | Bycatch |
| van Beek et.al. | 1989 | Otter+Beam Trawls | 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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5.10.4 Non-fishing activities that may adversely affect EFH

5.10.4.1 Identification of non-fishing adverse impacts to EFH in Alaska

An ***Adverse Impact***, by definition, means any impact which reduces quality and/or quantity of Essential Fish Habitat (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 essential fish habitat 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[4], 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 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.

**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.*

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

[4] 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.

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.
- 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 mat bury or damage scallops by abrasion and gill clogging (Larsen and Lee 1978). Scallops are efficient at concentrating PCB's and heavy metals, including silver, copper, and nickel (Pesch et al. 1979), mercury (Klein and Goldberg 1970), cadmium (Vattutone et al. 1976), 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.

**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.

**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 shore side and vessel processing has occurred in marine waters since the 1800's. 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 shore side 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).

**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 5°C, 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).

**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.

**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 the 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. Zones of low dissolved oxygen from their decomposition can retard growth of salmon eggs, larvae, and juveniles and may delay or block smolt and adult migration. Sewage and fertilizers also introduce nutrients into urban drainages that drive algal and bacterial blooms which may smother incubating salmon or produce toxins as they grow and die. Thermal effluents from industrial sites and removal of riparian vegetation from streambanks allowing solar warming of water can degrade salmon habitat. Heavy metals, petroleum hydrocarbons, chlorinated hydrocarbons, and other chemical wastes can be toxic to salmonids and their food, and they can inhibit salmon movement and habitat use in streams. Mining, ore processing, smelting, and refining operations often produce heavy metals as waste products that may effect the movement of salmon, causing migration delays. Petrochemicals and chlorinated compounds, such as those in herbicides and pesticides, are toxic or have long-term effects on survival, stamina, and reproduction in salmonids. Peripheral effects of pollution may include forcing rearing fish into areas of high predation or less than optimal salinity for growth.

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.

**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 the ocean disposal of dredged material to the EPA and the U.S. Army Corps of Engineers (COE). 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 since 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 to prohibit discharging or depositing any refuse matter, hazardous substance, oil, plastics and dunnage and will lessen 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.

**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.

**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 fishing gear 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 surface 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. It is believed 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.

**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 (Name Project #): 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.

**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 SAV 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), re-suspending 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 break free. Crushing damage is usually minimal. Grounding on coral reefs may cause extensive to the reef structure since 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.

***Natural Adverse Impacts*** *include potential threats from geophysical and seismic activity such as volcanoes, earthquakes, shelf vents; natural occurring elements such as oil seeps and coal outcrops; coastal and inland storms 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 patters. 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.

Ocean-atmospheric physics is hypothesized to cause variation in recruitment of several crab stocks in the North Pacific Ocean and Bering Sea with the decadal shifts in barometric pressure indices, sea level, sea surface temperature and ecosystem conditions (Zeng and Kruse, MS). In years of strong Aleutian Lows, warm incubation temperatures promote crab egg hatching too early to match the spring bloom reducing survival of first feeding larvae. A strong Aleutian Low also promotes a more diverse assemblage of species in the phytoplankton community and adversely effects larvae of red king crab. Wind stress causing advection of very specific stocks of crab larvae may also be important to the crab recruitment process.

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 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 1997a). 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 essential fish habitat 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 1997a).

Table 10.1

## Summary of Non-fishing Adverse Impacts to Habitat

| Threats | HABITAT ALTERATION | Alternation of original or normal habitat | Loss of offshore habitat | Loss of pelagic habitat | Loss of nearshore habitat | Loss of benthic habitat | Loss of aquatic vegetaion | Loss of wetland value | Loss of original sediment type | Detrital matter introduction | TOPOGRAPHIC ALTERATION | Change in original feature or structure | Accretion \ Overburden of original feature | Erosion \ Dispersal of feature | ORGANISM ALTERATION | Physical damage to organism | Mortality | Spatial alteration | Gene pool deterioration | Introduction of exotic species | Introduction of pathogens\disease | Change in photosynthetic regime | OCEANOGRAPHIC ALTERATION | Change in temperture regime | Change in salinity | Change in circulation pattern | WATER QUALITY ALTERATION | Change in dissolved oxygen content | Eutrophication, nutrient loading | Water contamination | Suspended sediments, turbidity | Atmospheric deposition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Excavation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dredging | | X | | | X | X | X | X | X | | | X | X | X | | X | X | | | | | X | | * | * | * | | * | X | X | X | |
| Dredge Material Disposal | | X | X | | X | X | X | X | X | X | | X | X | | | X | X | X | | | X | X | | * | * | * | | * | X | X | X | |
| Marine Mining | | X | X | | | X | | | X | X | | X | X | X | | X | X | | | | X | X | | X | X | X | | * | X | X | X | |
| Nearshore Mining | | X | | | X | X | X | | X | X | | X | X | X | | X | X | | | | X | X | | * | * | * | | * | X | X | X | |
| **Recreational Uses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Boating | | | | X | X | X | X | | | X | | | | | | X | X | | | X | X | | | * | * | * | | * | * | X | X | X |
| Stream Bank Over-usage | | X | | | | | | X | X | X | | X | X | X | | X | X | | | | X | X | | | | | | | X | X | X | |
| **Fish Waste Processing** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Shoreside Discharge | | X | | | X | X | X | | X | X | | X | X | | | | | | | | X | X | | X | X | | | * | X | X | X | |
| Vessel Discharge | | | | X | | X | | | | X | | | | | | | | | | | X | X | | | | | | * | X | | X | |
| Aquaculture | | | | | X | | X | | | X | | | | | | | | X | X | X | X | X | | X | X | X | | * | X | X | X | |
| **Petroleum Production** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production Facility | | X | X | | X | X | X | X | X | X | | X | X | X | | | X | X | | | X | X | | X | X | X | | | | X | X | X |
| Exploration | | X | X | | X | X | X | X | | | | X | X | X | | X | X | | | | X | X | | | | X | | | | X | X | X |
| Oil Spill | | X | X | | X | X | X | X | X | X | | | | | | X | X | | X | | X | X | | | * | | | X | | X | X | X |
| **Hydrological** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroelectric Dams | | | | | | | | | X | | | | | | | | X | | | | X | X | | | | | | X | | | X | |
| Impoundments | | X | | | | | X | X | X | | | X | X | X | | X | X | | | | X | X | | | | | | X | X | | X | |
| Flood Erosion/Control | | X | | | X | | X | X | X | | | X | X | X | | X | X | | | | | X | | | | | | X | X | | | |

Table 10.1 (continued)

| Threats | Agricultural/Farming | Insect Control | Forestry | Water Diversion/Withdrawl | Harbors/Ports/Marinas | Port Construction | Port Development | Artifical Reefs | Municipal and Industrial | Non-point Source | Coastal Urbanization | Sewage Treatment | Storm Water Runoff | Environmental | Climatic Changes/Shifts | Toxic Algal Bloom | Introduction of Exotic Species | Marine Transportation | Vessel Groundings | Ballast Water | Marine Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HABITAT ALTERATION** | | | | | | | | | | | | | | | | | | | | | |
| Alternation 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 vegetaion | 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 |
| Detrital 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 \ Dispersal of feature | X | 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 | X |
| Mortality | X | X | X | X | | X | X | | | | X | X | X | | | X | X | | X | X | X |
| Spatial alteration | X | X | | | | | X | X | | | X | X | | | | | X | | | | X |
| Gene pool deterioration | | | | | | | | | | | 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 | X | X |
| Change in photosynthetic regime | X | X | X | X | | X | X | X | | | X | X | X | | X | X | | | X | X | |
| **OCEANOGRAPHIC ALTERATION** | | | | | | | | | | | | | | | | | | | | | |
| Change in temperture regime | * | 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 | | | | X | | | | | | |
| **WATER QUALITY ALTERATION** | | | | | | | | | | | | | | | | | | | | | |
| Change in dissolved oxygen content | X | | X | X | | * | * | X | | | X | X | X | | | X | | | | | |
| Eutrophication, nutrient loading | X | | X | 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

## 5.10.4.2 References


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### 5.10.5 Cumulative Effects on EFH from Fishing and Non-fishing Activities

The NPFMC 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, which are produced annually for the crab, scallop, and 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 MSA, 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.

### 5.10.6 Habitat Conservation and Enhancement Recommendations for Non-fishing Threats to EFH

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 human activity we introduce to an environment. The following recommendations are offered to protect EFH.

**Near Shore Habitat and Waters (0-3nm)**

| 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 |

**Pelagic Habitat and Waters (3-12nm)**

| 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 |

**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 |

5.10.7 Habitat Conservation and Enhancement Recommendations for Fishing Threats to EFH

Area closures to trawling and dredging in the Bering Sea and Aleutian Islands area serve to protect EFH from potential adverse impacts caused by these gear types. Other management measures, such as the Pribilof Islands Habitat Conservation Area, the Bristol Bay Closure Area and the proposed Cape Edgecumbe pinnacle closure, 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 and research efforts on Alaskan scallops as discussed in section 1.3.13 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 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.

5.10.8 Prey species as a component of EFH

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.

Section 5.1.1 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 be found at section 5.10.1.

5.10.9 Habitat Areas of Particular Concern

5.10.9.1 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 meters. 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.

5.10.9.2 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 Gulf of Alaska and Aleutian Islands, much of the data analysis has focused on the eastern Gulf of Alaska. NMFS trawl surveys have indicated high concentrations in the immediate vicinity of Dixon Entrance, Cape Ommaney, and Alsek Valley (Draft EA/RIR for Amendment 29 to the GOA Groundfish FMP, September 1992). 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, 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 Gulf of Alaska, 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 Gulf of Alaska. These corals have a lower temperature tolerance, about 3.0 degrees 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 recognize following similar disturbances. For example, given a predicted growth rate of 1 cm/year for Primnoa, 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.

5.10.9.3 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.

5.10.10 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. Mapping and assessing impacted wetlands and eelgrass beds in an established GIS database with all salmonid producing streams (including riparian and upland land cover and use determinations) and escapements in the system is required to make necessary resource management decisions. 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 of 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 NPFMC 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 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.

5.10.11 Review and Revision of EFH Components of FMPs

To incorporate the regulatory guidelines requirement for review and revision of EFH FMP components the NPFMC 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 NPFMC 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 NPFMC 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 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.

5.11 Information on Important Habitat for Non-FMP Species Pacific halibut and GOA crab species

An FMP may include a description and identification of the habitat for a species that is not Federally managed by a Council FMP; however, such habitat may not be considered EFH. Pacific halibut and GOA crab species are not managed under this FMP. Nevertheless, these species are recognized as important components of the GOA ecosystem. Therefore, habitat assessments for these species were prepared and are appended to the GOA groundfish FMP. While this information may be used in the development of FMP management measures to protect these species, these habitat assessments are not considered EFH for the purposes of sections 303(a)(7) and 305(b) of the Magnuson-Stevens Act.

**Habitat Assessment for Pacific Halibut**

Life History and Distribution

Pacific halibut are found on the continental shelf of the North Pacific Ocean and the Bering Sea. They have been recorded on the North American coast from Santa Barbara, California to Nome, Alaska and along the Aleutian Islands, and also along the Asiatic Coast from the Gulf of Anadyr, Russia to Hokkaido, Japan. Adult halibut are demersal, living on or near the bottom, and can be found in a wide range of bottom habitat including rock, sand, gravel, and mud. Preferred water temperature is 3 to 8 degrees Celsius (Thompson and VanCleve 1936) although Best and Hardmann (1982) reported finding concentrations of halibut at temperatures as low as 0 degrees Celsius.

From November to March, mature halibut concentrate annually on spawning grounds along the edge of the continental shelf at depths from 185 to 460 meters. The summer months are spent in more shallow coastal waters ranging in depth from 25 to 275 meters.

The major spawning sites in North America are shown in Figure 1 and include Cape St. James, Langara Island (Whaleback), and Frederick Island in British Columbia; Yakutat, Cape Suckling - Yakataga ("W" grounds), Portlock Bank, and Chirikof Island in Alaska. Other reported spawning locations include Goose Islands, Hecate Strait, and Rose Spit in British Columbia, Cape Ommaney, Cape Spencer, and Cape St. Elias in Alaska, and the 200 m edge in the Bering Sea from Unimak Pass to the Pribilof Islands (St-Pierre 1984). In addition to these major grounds, there is reason to conclude that spawning is widespread and occurs in many areas, although not in as dense concentrations as those mentioned above. Evidence to support this conclusion is based on the widespread distribution of sexually mature halibut during the winter months as indicated by research and commercial fishing.

The number of eggs produced by a female is related to its size. A 31 kg[5] female will produce about 500,000 eggs, whereas a female over 151 kg may produce 4 million eggs. The age of 50% maturity is 8 years old for males and 12 years old for females (St-Pierre 1984). The free-floating eggs are about 3 mm in diameter when released and fertilization takes place externally. Developing ova generally are found at depths of 75 to 185 meters, but occur as deep as 500 meters. The temperature at which eggs are found varies from 2.3 to 9.7 degrees Celsius (St-Pierre 1984). The eggs hatch after 15 to 20 days at 5-6 degrees Celsius, and more quickly in warmer water (12 to 14 days at 7-8 degrees Celsius) (McFarlane et al., 1991). The larvae have a greater specific gravity than the eggs and are found below 200 m (St-Pierre 1989), drifting passively in the deep ocean currents. As the larvae grow, their specific gravity decreases and they gradually move towards the surface and drift to shallower waters on the continental shelf. Postlarvae in North American waters may be transported many hundreds of miles by the Alaskan Stream which flows counter-clockwise in the Gulf of Alaska and westward along the Alaska Peninsula and Aleutian Islands. Some of the larvae are carried into the Bering Sea.

Larvae begin life in an upright position with an eye on each side of the head. When the larvae are 2.5 cm long, the left eye moves over the snout to the right side of the head and pigmentation on the left side fades. When the young fish are about 6 months old and measure 3.5 cm, they have the characteristic adult form and settle to the bottom in shallow inshore areas (Thompson and VanCleve, 1936).

To counter the egg drift with ocean currents in a counter-clockwise direction, the young halibut migrate in a clockwise direction (IPHC 1987). One and two-year-old Pacific halibut are commonly found in inshore areas of central and western Alaska, but are virtually missing from southeast Alaska and British Columbia. They tend to move further offshore at age 2 or 3-years old and can be found off southeast Alaska and British Columbia by age 4 and older. IPHC tagging studies suggest that there is some intermixing of halibut between the North American and Asian populations, but the extent is not known (IPHC 1978).

By the time Pacific halibut are about 8 years old and measure approximately 82 cm, most of the extensive counter-migration to balance egg and larval drift has taken place. However, adult halibut migrate annually, moving to deeper depths on the edge of the continental shelf during the winter for spawning, and into shallow coastal waters in the summer months for feeding (St-Pierre 1984). Although halibut have been caught as deep as 550 meters, they are most often caught between 25 and 275 meters (Table 1).

Adult halibut are long-lived and the largest of all flatfish. The oldest halibut on record to date was 55 years old (Forsberg, J.E., IPHC, pers. comm.). Documented weights of up to 303 kg exist; however, few males reach 48 kg and nearly all halibut over 60 kg are females (IPHC 1987).

Removals from the population

The IPHC takes into account all removals of halibut from the North Pacific and Bering Sea within the Exclusive Economic Zones of the U.S. and Canada. Fishing for halibut does occur off the coasts of Japan and Russia, but those removals are not included in the IPHC population assessment.

The IPHC stock assessment is based on biological and fishery data obtained through port sampling, IPHC and National Marine Fisheries Service surveys, and special projects. Since the 1930s, biologists have collected lengths, otoliths for aging and catch per unit of effort data. More recently, IPHC surveys have also collected data on gender composition and maturity. Logbook information is supplied by the fishers either through interviews by IPHC staff in the landing ports or via mail post-season.

In North America, Pacific halibut is removed in a number of ways from the population; targeted commercially, for sport, for personal use, as bycatch in other commercial fisheries, as waste from the halibut fishery, and natural mortality (the IPHC uses a natural mortality rate of 0.2). In 1996, an estimated

[5]All weights in this report are head-on round weight.

42,336 metric tons of directed and non-directed catch was removed from the population (Sullivan and Parma, Unpub. [1997]).

The directed commercial fishery is conducted by hook and line gear only. Fish begin recruiting to this gear type at approximately 60 cm in length, but the commercial minimum size limit is 82 cm. The fishery takes place from March to November ranging from shallow inshore waters to as deep as 275 meters along the continental shelf (Figures 2-10). The directed catch consists of individuals chiefly from 7 to 121 kg. The average size in the commercial catch in 1996 was between 9 and 20 kg depending on the area caught, and the average age was 12 years old (Forsberg, J., Unpub [1997]).

Today's commercial fishing fleet is diverse, using various types of longline gear and strategies to obtain their quarry. Both Alaska and British Columbia have implemented an individual quota (IQ) system, which enables a vessel to fish anytime between March and November. The U.S. West Coast fishery continues to use short, 10 hour seasons and fishing period limits to manage the fishery.

Interception of juvenile halibut (~30 cm and greater) often occurs in trawl fisheries targeting other groundfish species (such as rock sole, pollock, yellowfin sole, and Pacific cod). Incidental catch of halibut also occurs in groundfish hook and line and pot fisheries. Regulations in both Canada and U.S. currently dictate that all halibut caught incidentally must be discarded regardless of whether the fish is living or dead. These fisheries take place throughout the range of halibut and throughout most of the year. The total mortality of halibut since 1990 has averaged 10,323 metric tons per year (Williams, G.H. Unpub [1997].

Trophic Information

Adult halibut are only rarely found as prey of other fish, and mortality on halibut by marine mammals seems low (Best and St-Pierre, 1986). The size, active nature, and bottom dwelling habits make halibut less vulnerable to predation than other species. However, the juvenile fish are much more vulnerable and are preyed upon by larger groundfish such as Pacific cod.

Halibut are opportunistic, carnivorous feeders. In larval halibut, nutrition is derived from a yolk sac until it is absorbed during the early postlarval stage, about 2 months after hatching. The young fish then begin feeding on zooplankton. Halibut 1 to 3 years old are usually less than 30 cm in length and feed on small shrimp, crab, and fish (Best and Hardman, 1982). As halibut increase in size, fish become a more important part of the diet. They are both benthic and pelagic feeders. The species of fish frequently observed in stomachs of large halibut include cod, sablefish, pollock, rockfish, sculpins, turbot, other flatfish, sand lance, and herring (Best and St-Pierre, 1986; Brodeur and Livingston, 1988). Octopus, crabs, clams, and occasional smaller halibut also contribute to their diet although Pacific halibut do not appear to be a primary predator of these species.

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**Table 1. Summary of habitat information for Pacific halibut.**

| Life stage | Age | Diet | Season | Location | Water column | Bottom type | Oceanographic features |
|---|---|---|---|---|---|---|---|
| **Eggs** level 0 | 0-20 days | n/a | November - March | Continental shelf edge - pelagic | 75-185 m (found as deep as 500 m) | | 2-10°C |
| **Larvae** level 0 | 20 days - 2 months | yolk sac | December - May | Continental shelf edge - pelagic | > 200 m | | |
| **Post larvae** level 0 | 2 - 6 months | zoo-plankton | January - August | Continental shelf - pelagic | 0-200 m | | |
| **Juveniles** level 1 | 6 months - 7 years | small crustaceans and fish | Year round | Continental shelf - demersal | 25-275 m | Rock, sand, mud, gravel | Prefer 3-8°C |
| **Adults** level 2 | 8+ years | pelagic and demersal fish and crustaceans | (spawning) Nov. - Mar.<br><br>(not spawning) Mar. -Nov. | (spawning) Cont. shelf edge - demersal<br><br>(not spawning) Cont. shelf - demersal | (spawning) 185-460 m<br><br>(not spawning) 25-275 m | Rock, sand, mud, gravel | Prefer 3-8°C |

# Habitat Description for GOA Red King Crab

*Paralithodes camtschaticus*

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska

Life History and General Distribution

Red king crab (*Paralithodes camtshaticus*) is widely distributed throughout the Bering Sea and Aleutian Islands, Gulf of Alaska, Sea of Okhotsk, and along the Kamchatka shelf. On the coast of North America it is found from Point Barrow, Alaska, to the Queen Charlotte Islands and waters adjacent to mainland northern British Columbia. Red king crab occupy depths from the intertidal region (young-of-the-year crabs) to 366 meters. Red king crab molt several times per year through age 3 after which molting is annual. At larger sizes, king crab may molt less frequently than annually as growth slows. Females grow more slowly and do not attain the size of males. In the northeastern Gulf of Alaska, fifty percent maturity is attained by females at 106 mm (about 6 yrs.). Natural mortality of adult red king crab males increases with size and has been estimated to reach about 25 percent per year (M=0.3) in crab greater than 135 mm carapace length, owing to old age, disease, and predation.

Fishery

Red king crab fisheries have been prosecuted in the Gulf of Alaska since 1954. The gear has evolved to include side loading mesh covered pots approximately 6 to 8 feet square and top loading pyramid or conical style gear. Discrete populations are found in the Alaska Peninsula, Kodiak, Cook Inlet, Prince William Sound and Southeastern Management areas.

Historically, the red king crab fishery has been Alaska's top shellfish fishery. Since the mid-1950's fishermen have harvested over 1 billion pounds of red king crab from Gulf of Alaska waters. The peak harvest came in 1965 when approximately 113 million pounds were landed from the five management areas. The Kodiak area was the major contributor at 94 million pounds. A near peak harvest occurred in the 1980/81 season, but three years later the fishery had crashed with the harvest down sixty-fold and all management areas in the Gulf closed completely for the first time.

A long period of few juvenile king crabs surviving to adult size was the reason for the crash. Biologists theorize that fish predation on king crabs and/or a warmer ocean environment were possibly responsible for the low numbers of red king crabs rather than overfishing. Their populations remain depressed and fisheries have not been open since 1983 with the exception of a small fishery in inside waters of Southeastern Alaska, that has occurred yearly since 1993.

Relevant Trophic Information

Subadult and adult Red King Crabs eat a variety of benthic invertebrates including clams, cockles, snails, barnacles, amphipods, crabs, polychaetes, hydroids, brittle stars, sand dollars, sea urchins and sea stars, and fishes such as Capelin (*Mallotus villosus*), Pacific Sand Lance (*Ammodytes hexapterus*), and Pacific Herring (*Clupea pallasi*). At least some of these fish are probably scavenged. A total of 98 different species were found in the stomachs of Red King Crabs from depths of 50 to 200 meters (164 to 656 feet) in late winter and late spring on the Kodiak Shelf. Red King Crabs in the Okhotsk Sea have been found to prefer echinoderms and barnacles (*Balanus* sp.) just prior to and after molting. These species provide a good source of calcium carbonate which the crabs may need to replace that lost during ecdysis (molting).

The zoeae of the Red King Crab are planktivores, consuming both phytoplankton and zooplankton. Stomach contents of the third and fourth zoeal stages collected in Cook Inlet, Alaska, included diatoms and the larvae of barnacles and the Helmet Crab (*Telmessus cheiragonus*). In the laboratory, the larvae will eat diatoms, crustacean nauplii, copepods, polychaete larvae and rotifers. In Auke Bay, Alaska, the larvae feed

during the day at a depth of 5-10 meters (16-33 feet) and not at night. This feeding periodicity is consistent with the reverse diel vertical migration exhibited by Red King Crab larvae in Auke Bay.

Young-of-the-year Red King Crab eat diatoms, foraminiferans (protozoans with calcareous shells), sponge tissue, hydroids, bryozoans, polychaetes, bivalves, gastropods, ostracods, harpacticoid copepods, and sand dollars. In the laboratory postlarval, 1-year-old, and 2-year-old Red King Crabs are cannibalistic. The frequency of cannibalism in 1-year-old crabs depends on the quality of the diet fed to them, crab density and the complexity of the habitat. The frequency of cannibalism in 2-year-old crabs does not depend on crab density or the availability of cover in the laboratory.

A variety of predators consume the various life stages of the Red King Crab. The eggs are preyed upon by at least three species of nemertean worm: *Carcinonemertes regicides*, an undescribed small eyeless species, and *Alaxinus oclairi*. The first two species are the most widespread and abundant nemertean egg predators on Red King Crabs. The gammarid amphipod *Ischyrocerus* sp. also preys on Red King Crab eggs. Walleye pollock (*Theragra chalcogramma*) preys on larval king crab. Yellowfin Sole (*Limanda aspera*) eat large numbers of the glaucothoe stage. Juvenile and adult crabs are preyed upon by Pacific Cod (*Gadus macrocephalus*), Pacific Halibut (*Hippoglossus stenolepis*), sculpins (*Hemilepidotus* and *Myoxocephalus*), the Korean Hair Crab (*Erimacrus isenbeckii*), octopus (*Octopus* sp.) and the Sea Otter (*Enhydra lutris*).

What is the approximate upper size limit of juvenile fish (in cm)?
The size of 50 percent maturity is 10 cm carapace length for female red king crabs from the northeastern Gulf of Alaska.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative

Egg/Spawning See Adults.

Larvae The larval stages consist of a prezoeal stage and four zoeal stages. The first post larval stage is the glaucothoe. The prezoeal stage lasts a few minutes, the zoeal stages each last 2-4 weeks, and the glaucothoe lasts 3-4 weeks. Metamorphosis to the first benthic stage occurs 3-4.5 months after hatching. Red king crab larvae occupy the upper 40-100 meters of the water column depending on the geographical area. The position of the larvae in the water column varies with the time of day. In Auke Bay, Alaska, red king crab larvae exhibit reverse diel vertical migration. The larvae are most abundant at 5 to 10 meters (16 to 33 feet) during the day and at 30 meters (98 feet) at night. A similar pattern of vertical migration has been observed at Kodiak Island, Alaska. The first and second stage zoeae of red king crab females from Auke Bay tolerate temperature/salinity combinations for short periods that exceed the range to which they are exposed in nature. Stage I zoeae show high survival at temperatures from 0 to 12 C (32 to 54 F) and salinities of 20 to 30 ppt. Stage II zoeae show highest survival at temperatures from 0 to 6 C (32 to 41 F) and salinities of 20 to 30 ppt. Stage I and II zoeae studied in Japan showed similar temperature and salinity tolerances as those at Auke Bay. At Auke Bay, stage II zoeae preferred more saline conditions (29.4 ppt) than did stage I zoeae (27.5 ppt). Zoeae exposed to low salinity water passively sink until they reach higher salinity.

Juveniles Young-of-the-year crab occur at depths of 50 m or less. They are solitary and need high relief habitat or coarse substrate such as boulders, cobble, shell hash, and living substrates such as bryozoans and stalked ascidians. Between the ages of two and four years, there is a decreasing reliance on habitat and a tendency for the crab to form pods consisting of thousands of crabs. Podding generally continues until

four years of age (about 6.5 cm), when the crab move to deeper water and join adults in the spring migration to shallow water for spawning. The remainder of the year crab are found in deep water. Juvenile crabs are somewhat more tolerant of reduced salinities than adults (see below).

Adults Adult and older juvenile red king crabs occur on a variety of substrata including rock or gravel (especially nearshore) and mud, sand, shell fragments or mixtures of these substratum types. Mating crabs often occur in areas with kelp (*Alaria, Costaria* and *Laminaria*). The kelp can provide cover for the courting pair when the female is soft and vulnerable to predation following molting. Red king crab do not osmoregulate and cannot tolerate low-salinity water. Adults show signs of stress when immersed in sea water of less than about 18 ppt salinity. Red king crabs exhibit seasonal migration. Adult crabs occupy deeper offshore areas in summer. In late fall and early winter the crabs migrate onshore to shallow waters prior to larval hatching, molting of females, mating and egg extrusion which takes place from January through June depending on the geographical area. After this period of reproduction the crabs return to deep water. of reproduction. In southeastern Alaska, red king crab mate when they enter shallower waters (<50 m), generally beginning in January and continuing through June. Males grasp females just prior to female molting, after which the eggs are fertilized and extruded onto the pleopods of the female's abdomen. In the northeastern Gulf of Alaska fecundity ranges from 148,300 to 446,600 eggs for females ranging in carapace length from 128 to 145 mm (5 to 5.7 in). The female red king crab carries the eggs for 11-12 months before they hatch, generally in March through May. Hatching of king crab larvae is temporally synchronized with the spring phytoplankton bloom in southeastern Alaska.

SPECIES: Red king crab, *Paralithodes camtschaticus*

| Stage - EFH | Duration or | Diet/Prey | Season/Time | Location | Water | Bottom | Oceanographic | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs 1 | 11- 12 mo | NA | May-April | NA | NA | NA | NA | |
| Larvae 1 | 3-4.5 mo | Diatoms, | April-August | BAY, ICS | P | NA | F | |
| Juveniles 1 | 1 to 5-6 yrs | Diatoms | All year | BCH, BAY | D | SAV | NA | Found |
| Adults 1 | 10-15 yrs | Mollusks, | Spawning | ICS, BAY, | D | S, M, CB, G | CL | |

# Habitat Description for GOA Blue king crab
## *Paralithodes platypus*

Management Plan and Area(s)
No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution
The Blue King Crab ranges discontinuously from Kamchatka to Hokkaido, Japan and from Kotzebue Sound, Alaska, to southeastern Alaska. In the Gulf of Alaska, small populations have been found in Olga Bay at Kodiak Island, Port Wells in Prince William Sound, and Russell Fiord, Glacier Bay, Lynn Canal and Endicott Arm in southeastern Alaska. Blue king crab molt many times as juveniles. In Olga Bay, 50 percent maturity of females is attained at 9.4 cm carapace length, which occurs at about 5 years of age. Blue king crab in Prince William Sound mature at a somewhat smaller size (50 percent maturity at 8.7 cm carapace length for females). Male size at maturity has been found to be 8.7 and 9.3 cm carapace length at Olga Bay and Prince William Sound, respectively. Skip molting occurs with increased probability in males larger than 10 cm carapace length. Larger female blue king crab have a biennial ovarian cycle and a 14 month embryonic period. Unlike red king crab, juvenile blue king crab do not form pods, instead rely on cryptic coloration for protection from predators. Adult male blue king crab occur at an average depth of 70 m and an average temperature of 0.6 degrees C.

Fishery
Blue king fisheries have been prosecuted using mesh covered pots. Landings have been relatively minor with records combined with red king crab for the most part. Some harvest has occurred from the Kodiak, Prince William Sound and Southeastern Alaska areas. The highest recorded catch was 13,000 pounds from Prince William Sound in 1979.

Relevant Trophic Information
Little information is known on the diet or predators of the blue king crab in the Gulf of Alaska. Pacific cod prey on soft-shell blue king crabs, and walleye pollock and yellowfin sole prey on the glaucothoe in the Bering Sea.

What is the approximate upper size limit of juvenile fish (in cm)?
The size of 50 percent maturity is 9.4 cm carapace length for females from Olga Bay, and 8.7 cm for Prince William Sound. Male size at maturity has been found to be 8.7 and 9.3 cm carapace length at Olga Bay and Prince William Sound, respectively.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative

Egg/Spawning See Adults.

Larvae Blue king crab spend 3.5 to 4 months in pelagic larval stages before settling to the benthic life stage. Larvae are found in waters of depths between 40 to 60 m.

Juveniles Juvenile blue king crab require refuge substrate characterized by gravel and cobble overlaid with shell hash, and sponge, hydroid and barnacle assemblages. These habitat areas have been found at 40-60 m around the Pribilofs Islands. The habitat requirements of juvenile blue king crab have not been studied in the Gulf of Alaska.

Adults Adults occur most often between 45-75 m depth on mud-sand substrate adjacent to gravel rocky bottom. Female and juvenile crab are found in a habitat with a high percentage of shell hash. It has been suggested that spawning and successful recruitment of first in-star juveniles may depend on availability of nearshore rocky-cobble substrate for protection of both females and small juveniles. Spawning occurs in mid-spring. Larger older females reproduce biennially while small females tend to reproduce annually. Fecundity of females range from 50,000-200,000 eggs per female. Larger older crabs disperse farther offshore and are thought to migrate inshore for molting and mating.

SPECIES: Blue king crab, *Paralithodes platypus*

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs 1 | 14 mo. | NA | Starting April-May | BAYS | NA | NA | F | |
| Larvae 1 | 3.5 to 4 mo. | | April-July | BAYS | P | NA | F | |
| Juveniles 1 | | | All year | BAYS | D | CB, G, R | F | |
| | | | | | | | | |

# Habitat Description for GOA Golden king crab

*Lithodes aequispina*

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution

Golden king crab (*Lithodes aequispina*), also called brown king crab, range from Japan to the Sea of Okhotsk and the Bering Sea to British Columbia. In the north Pacific, golden king crab are found at depths from 120 m to 900 m. Golden king crab are usually found in high relief habitat such as inter-island passes and fiords, and often inhabit slopes. Size at sexual maturity depends on latitude ranging from 9.8 - 11 cm carapace length, with crabs in the northern areas maturing at smaller sizes. The fecundity of females in northern British Columbia ranges from 10,620 to 27,040 eggs for females ranging in size from 11 to 15 cm. The season of reproduction appears to be protracted, and may be year-round.

Fishery

The golden king crab fisheries are prosecuted using mesh covered pots. Some landings have occurred from the Kodiak and Prince William Sound areas but the primary fishery has occurred in Southeast Alaska. Since the mid-1960's there has been approximately 10 million pounds harvested. The peak catch of 1.0 million pounds occurred in the 1986/87 season. The fishing season runs from February 15 until closed by emergency order.

Relevant Trophic Information

Trophic information on the golden king crab in the Gulf of Alaska is lacking. In the Bering Sea the crab eats a variety of invertebrates including sponges, hydroids, polychaetes, mollusks, amphipods, decapod crustacea, ophiuroids, echinoids and fish.

Describe any potential gear impacts on the habitats of this or other species

What is the approximate upper size limit of juvenile fish (in cm)?

The size (carapace length) at 50% maturity for females in northern British Columbia is 10.6 cm; the size at maturity for males is 11.4 cm.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative

Golden king crab occur on hard bottom, over steep rocky slopes and on narrow ledges. Strong currents are prevalent. Golden king crab coexist with a diverse group of epifauna, including sponges, hydroids, coral, sea stars, bryozoans, and brittle stars.

Egg/Spawning Eggs brooded by females collected in southeastern Alaska and brought into the laboratory in March hatched from April to August. The total duration of hatching was 123 d.

Larvae Golden king crab larvae are lecithotrophic. The zoeal and glaucothoe stages last 2.2 months and probably occupy near-bottom waters before settling to the benthic life stage.

Juveniles Juvenile golden king crab are found throughout the depth range of the species. In British Columbia, juvenile crab are most common at depths >100 m.

Adults Adult crabs occur at all depths within their distribution. In northern British Columbia, males are less migratory and tend to inhabit shallower waters than females. Males are found from 50 to 150 m. Females usually mate and extrude eggs at <150 m, and brood eggs from 150 to 250 m. Post-spawned females are found from 200 to 400 m.

SPECIES: Golden king crab, *Lithodes aequispina*

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs 0 | | | | IP, BAY, OCS, USP | | R | | |
| Larvae 0 | 2.2 mo | Yolk | | | SP | | | |
| Juveniles 0 | | | | | | R | | |
| Adults 0 | | Ophiuroids, sponges, plants, polychaetes, amphipods, echinoids, hydroids | Spawning Feb.-Aug. | | | R | | |

# Habitat Description for GOA Scarlet king crab
## *Lithodes couesi*

Management Plan and Area(s)
No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution
The scarlet king crab (*Lithodes couesi*) is distributed from Onohama, Japan to the Bering Sea to San Diego, California. It is a deep water species found primarily on the continental slope and on seamounts in the depth range 258 to 1829 m. Little information is available on the biology of the scarlet king crab. Spawning may be asynchronous. Fecundity increases up to a size of 9.5 cm carapace length (CL), then remains relatively constant as size increases further. Fecundity ranges from 2,700 to 5,500 eggs in females ranging in size from 8.3 to 11.5 cm CL. Crabs have been observed brooding eggs in June and July in the Gulf of Alaska; crabs have not been sampled in other months.

Fishery
Directed fishing for scarlet king crab may only occur under conditions of a permit issued by the Commissioner of Fish and Game. Fishing operations are restricted to pot gear only in waters 200 fathoms or greater in depth. Exploratory fishing has been minor with only a few small landings recorded from the Gulf of Alaska.

Relevant Trophic Information
Unknown.

What is the approximate upper size limit of juvenile fish (in cm)?
The estimated size (carapace length) of 50% maturity for female and males is 8 cm and 9.1 cm in the Gulf of Alaska.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative
On seamounts adult and subadult scarlet king crab are associated with steep rocky outcrops and narrow ledges interspersed with sediments. The species is also found on the continental slope of southeastern Alaska. Strong currents are often prevalent in these habitats.

Egg/Spawning Eggs are large, averaging 2.3 mm in length.

Larvae Stage 1 zoeae of *L. couesi* have substantially more yolk than red king crab (Paralithodes camtschaticus) suggesting that they may be lecithotrophic. The distribution of *L. couesi* larvae in the water column is not known.

Juveniles Subadults have been collected in the same habitats as adults on seamounts (see below).

Adults In the Gulf of Alaska, adults have been found on seamounts in the depth range 384 to 850 m. The species occurs deeper (> 592 m) on the continental slope in southeastern Alaska.

SPECIES: Scarlet king crab, *Lithodes couesi*

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs 0 | | | | USP, LSP | | R | | |
| Larvae 0 | | | | | | | | |
| Juveniles 0 | | | | USP | | R | | |
| Adults 0 | | | | USP, LSP | | R | | |

# Habitat Description for GOA Tanner crab
## *Chionoecetes bairdi*

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution

Tanner crabs (*Chionoecetes bairdi*) are distributed on the continental shelf of the North Pacific Ocean and Bering Sea from Kamchatka to Oregon. In Alaska, Tanner crabs are concentrated around the Pribilof Islands and immediately north of the Alaska Peninsula, and are found in lower abundance in the Gulf of Alaska and throughout the Alexander Archipelago. Crabs occur from the littoral zone to 473 m. Females reach a terminal size with their maturity molt. Large numbers of small-clawed males migrate into shallow waters (<18 m) of Southeast Alaska bays and inlets to molt en masse in March and April. Mature male Tanner crabs may skip a year or more of molting after they attain maturity. Adult male crabs have limited migratory movements. Female crabs also have limited annual migrations especially while brooding eggs. Eggs generally hatch from March through May in the Gulf of Alaska, and peak hatching occurs in early May in Southeast Alaska (Robert Stone, NMFS, Auke Bay Laboratory, personal observation).

Fishery

The Tanner crab fisheries have been prosecuted in the Gulf of Alaska since 1967. Approximately 700 million pounds have been harvested since that time. The gear has evolved to include side loading mesh covered pots approximately 6 to 8 feet square and top loading pyramid or conical style gear. Fisheries have occurred in the South Peninsula, Chignik, Kodiak, Cook Inlet, Prince William Sound, Yakutat and Southeast Alaska Management Areas. The peak harvest of 54 million pounds was taken in 1978 with the Kodiak area contributing 33 million pounds. Tanner crab populations and fisheries diminished after that time with no harvest from the South peninsula and Chignik areas after 1989. Prince William Sound has remained closed since 1988. Kodiak and Cook Inlet had their most recent fisheries in 1994. Small fisheries continue to occur in Yakutat Bay and Southeast Alaska. The fishing season runs from February 15 through May 1.

Relevant Trophic Information

Tanner crab larvae are planktotrophic feeding on phytoplankton and small zooplankton. Crabs of different size, sex and state of maturity consume similar prey species, but diet differs from one area to another depending on prey availability. Food of juvenile crabs includes other crabs, bivalves, polychaetes, ophiuroids, barnacles, and sediment. Cannibalism may be prevalent in juvenile crabs. Adults near Kodiak are opportunistic and feed mainly on arthropods (mainly juvenile *C. bairdi*), fish, mollusks and polychaetes. In Southeast Alaska, polychaetes constitute a large portion of the diet of adult crabs.

Throughout their range *Chionoecetes* spp. are prey for at least seven species of invertebrates, twenty-six species of fishes, and four species of marine mammals. Pacific cod (*Gadus macrocephalus*) is the main predator on Tanner crabs in the Kodiak Island area; crabs up to 70 mm CW are consumed but most are between 7 and 23 mm CW. Sculpins (*Myoxocephalus* spp.) are also an important predator of crabs in the Kodiak area, including ovigerous females. Both adult and juvenile *C. bairdi* are cannibalistic. Other demersal fishes, including the yellow Irish Lord (*Hemilepidotus jordani*), are important predators. Larval predators include salmon, herring, jellyfish and chaetognaths. In the Gulf of Alaska juvenile coho salmon (*Oncorhynchus kisutch*) are important predators of Tanner crab zoeae (Mary Auburn-Cook, NMFS, Auke Bay Laboratory, personal communication).

Describe any potential gear impacts on the habitats of this or other species

Bottom trawls and dredges could disrupt nursery and adult molting and mating areas.

What is the approximate upper size limit of juvenile crab (in mm)?

One hundred percent of male *C. bairdi* 80 mm CW from the GOA are sexually mature as determined from the presence of spermatophores in the vas deferens and mating experiments. Estimates of the median size at maturity ($SM_{50}$) or mean size at maturity for Kodiak Island males are between 100 and 115 mm CW. The size of 50% maturity for females (50% have undergone the molt to maturity) was estimated at 83 mm CW. Since females do not continue to grow after maturity, measuring the mean size of a sample of multiparous females would reflect the mean size at maturity. Using this method, the mean size at maturity would be 97.3 mm CW for Kodiak Island females and 103.7 mm CW for Southeast Alaskan females.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative

In May and June, Age 1 crabs are abundant in Cook Inlet at 150 m depth in areas where small sponges, hydroids, and polychaete tubes dominated the benthic community. Ovigerous female crabs often bury in the sediment while brooding eggs.

Egg/Spawning See Adults

Larvae There are two zoeal stages which inhabit the upper and middle zones of relatively shallow water in Cook Inlet. Larvae are strong swimmers and perform diel vertical migrations in the water column (down at night). They usually stay near the depth of the chlorophyll maximum during the day. The length of time larvae take to develop is unknown, although it has been estimated at only 12 to 14 days. The first benthic stage (megalops) settles on the bottom.

Juveniles In Southeast Alaskan bays young-of-year crab (8 to 15 mm CW) are locally abundant in early fall on silt/fine sand slopes between 4 and 10 m depth (Robert Stone, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). Age 2 crab (34 to 48 mm CW) are locally abundant in similar habitat between 10 and 20 m depth during spring. Numerous crabs < 40 mm were observed from a submersible on silt substrate at 225 m depth along the Southeast Alaska coast. These observations indicate that juveniles are either widely distributed or make extensive seasonal migrations with respect to depth.

Adults *C. bairdi* females have a terminal molt at maturity and breed for the first time in the soft-shelled state. In subsequent years multiparous crabs breed in the hard-shelled state and may use stored sperm to fertilize their eggs. Pubescent females molt and mate between January and May in nearshore waters (3-13 m) near Kodiak and between late-December and mid-June in the nearshore waters (4-19 m) of Southeast Alaska. Near Kodiak Island multiparous females are known to form high density mating aggregations consisting of hundreds of crabs per mound. These mounds may provide protection from predators and also attract males for mating. In Southeast Alaska, however, multiparous females have been observed

mating in low-density aggregations in shallow water (including the intertidal zone) during May. Females have clutches of 50,000 to 400,000 eggs. Multiparous females annually produce an average of 170,000 eggs. Multiparous females carry and brood the embryos for one year after fertilization. Primiparous females may carry the fertilized eggs for as long as 1.5 years.

SPECIES: Tanner crab, *Chionoecetes bairdi*

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs 1 | 1 to 1.5 years | NA | All Year | ICS, MCS, OCS | D | Silt/Fine Sand | | Carried by ovigerous female |
| Larvae 0 | Unknown (12-14 d) | Diatoms<br>Algae<br>Zooplankton | April-September | MCS, ICS | P | NA | F | |
| Juveniles 1 | 1 to 5 years | Crustaceans<br>polychaetes<br>bivalves<br>ophiuroids<br>algae<br>hydroids | All year | MCS, ICS, BAY, | D | Silt/Fine Sand | | |
| | | | | | | | | |

# Habitat Description for GOA Grooved Tanner crab
## *Chionoecetes tanneri*

Management Plan and Area(s)
No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution
In the North Pacific Ocean the grooved Tanner crab (*Chionoecetes tanneri*) ranges from northern Mexico to Kamchatka. Little information is available on the biology of the grooved Tanner crab; existing information is from surveys conducted off the Oregon and British Colombian coasts and the Eastern Bering Sea. This species occurs in deep water (to 1925 m)of the outer continental shelf and continental slope and is uncommon at depths < 300 m. Male and female crabs are found at similar depths, especially during winter when mating probably occurs.

Fishery
Directed fishing for grooved Tanner crab may only occur under condition of a permit issued by the Commissioner of Fish and Game. The Gulf of Alaska was initially explored for deepwater Tanner crab in 1994. Six vessels participated in 1995 and landed 947,000 pounds. Most of the fishing occurred on the bank of continental shelf from 375-475 fathoms. Interest and landings declined in 1996 as the value of Tanner crab declined. There have been no landings since that time.

Relevant Trophic Information
Juvenile crabs (3-10 mm CW) are preyed upon by sablefish (*Anoplopoma fimbria*) and Dover sole (*Microstomus pacificus*).

What is the approximate upper size limit of juvenile fish (in mm)?
The $SM_{50}$ (size at 50% maturity) is estimated at 119 mm CW for males and 79 cm CW for females in the eastern Bering Sea.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative

Egg/Spawning See Adults

Larvae Like other *Chionoecetes* spp., *C. tanneri* has a brief prezoeal stage followed by two zoeal stages and a megalops. The total pelagic period of the larvae is estimated at about 80 days. Larvae are probably planktotrophic and must migrate vertically to feed in surface waters where prey concentrations are greater. Larvae probably hatch during winter off the Oregon coast.

Juveniles Juvenile *C. tanneri* occur in shallower water than mature male crabs in the eastern Bering Sea.

Adults In the Eastern Bering Sea adult males may be found somewhat more shallower than females but sexes do not show clear segregation by depth. All reproductively active females mate and extrude eggs at about the same time of year. Mean fecundity of *C. tanneri* is 86,500 eggs. Reproduction is probably seasonal and synchronous and mating probably occurs during winter but as late as July. Like other members of the genus *Chionoecetes*, females probably have a terminal molt. Shell condition data suggest that male grooved Tanner crab continue to molt after maturity.

SPECIES: Grooved Tanner crab, *Chionoecetes tanneri*

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | 1 year | NA | All Year | USP, LSP | NA | Silt | | |
| Larvae | About 80 days | Plankto-trophic | Late-Winter to ? | | P | NA | | |
| Juveniles | Unknown | Unknown | All Year | OCS,USP, LSP | NA | Silt | | |
| | | | | | | | | |

# Habitat Description for GOA Triangle Tanner crab
## *Chionoecetes angulatus*

Management Plan and Area(s)
No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution
In the eastern North Pacific Ocean the triangle Tanner crab (*Chionoecetes angulatus*) ranges from Oregon to the Sea of Okhotsk. Little information is available on the biology of the grooved Tanner crab; existing information is mostly from one survey conducted in the Eastern Bering Sea. This species occurs on the continental slope in depths > 300 m and has been reported as deep as 2,974 m in the eastern Bering Sea . Mature male crabs inhabit shallower depths (mean 647 m) than mature females (mean 748 m) in the eastern Bering Sea possibly indicating seasonal segregation by depth.

Fishery
Directed fishing for triangle Tanner crab may only occur under the conditions of a permit issued by the Commissioner of Fish and Game. There have not been any landings recorded from the Gulf of Alaska.

Relevant Trophic Information
Unknown.

Describe any potential gear impacts on the habitats of this or other species

What is the approximate upper size limit of juvenile fish (in cm)?
In the eastern Bering Sea, male triangle Tanner crabs reach 50% maturity at 91 mm CW and females at 58 mm CW.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative

Unknown

Egg/Spawning See Adults

Larvae Larvae are probably planktotrophic and must migrate vertically to feed in surface waters where prey concentrations are greater.

Juveniles Juvenile males are found at similar depths (650 m) as mature males.

Adults The mean depth occupied by mature males (647 m) is significantly less than that of mature females (748 m) indicating some pattern of sexual segregation by depth. Adult male crabs probably molt in June

or July. All reproductively active females mate and extrude eggs at about the same time of year. Fecundity of triangle Tanner crabs increases with size. Females of 70 mm CW are estimated to have approximately 40,000 - 50,000 eggs. Reproduction is probably seasonal and synchronous and mating probably occurs during winter but as late as July. Like other members of the genus *Chionoecetes*, females probably have a terminal molt. Shell condition data suggest that male triangle Tanner crab continue to molt after maturity.

SPECIES: Triangle Tanner crab, *Chionoecetes angulatus*

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | Probably 1 year | Unknown | All year | USP, LSP | NA | Silt | | |
| Larvae | Unknown | Unknown | Late-winter and spring ? | NA | P | | | |
| Juveniles | Unknown | Unknown | All year | USP, LSP | NA | Silt | | |
| | | | | | | | | |

# Habitat Description for Dungeness Crab
## *Cancer magister*

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution

The Dungeness crab is distributed from the Pribilof Islands, Alaska, to Santa Barbara, California. A single specimen has been collected on Amchitka Island, Alaska; the published western limit of distribution is Tanaga Island, Aleutian Islands, Alaska. The species is found from the intertidal region to a depth of 230 meters. In northern Puget Sound, Washington, males and females reach sexual maturity at 10.0 cm in width in their second year of life. Females mate for the first time in their second year; males mate first in their third year. In southeastern Alaska, male/female pairs have been observed in premating embrace from May to December (Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation), but the peak period of mating is July to October has seen. In more southern waters crabs mate from April to September in British Columbia, and March to June in Washington. Males embrace smaller females about to molt for seven to eight days. Mating occurs about an hour after the female molts. During mating the male deposits spermatophores in the spermathecae (receptive organs) of the female. Mating lasts up to two hours or more. After mating in the laboratory, the male embraces the female again for two days. In nature, males have been observed standing over or near buried females with soft exoskeletons. Presumably the male is guarding the female until her new exoskeleton hardens. A female can retain viable sperm through a molt as well as retain sperm for at least 2.5 years and use it to fertilize an egg clutch that develops normally.

In Washington, both sexes migrate offshore away from estuaries after the mating season. Females might undertake these migrations to avoid exposure of their eggs to osmotic stress when the eggs are extruded. In Oregon, female crabs migrate inshore in order to reach the sandy bottoms they require for the proper formation of their egg clutches at the time of egg extrusion. In southeastern Alaska, the females mate and brood their eggs in shallow water (less than 10 m) on sandy bottoms in estuaries. Ovigerous crabs often aggregate in sandy areas near stream mouths, and are presumably exposed to low salinities in these areas.

Fertilization of the eggs takes place when the female extrudes the eggs onto the setae of her pleopods. Egg extrusion usually occurs several months after mating. In Southeastern Alaska, egg extrusion occurs in August-October; September-February in British Columbia, and October-December in Washington and Oregon. Fecundity ranges from 134,100 to 1,545,940 eggs/brood in females ranging in carapace width from 11.0 to 16.6 cm.

Hatching occurs in late April-June in southeastern Alaska. For those females in glacial systems, hatching takes place when glacial runoff is high and surface salinities are low. In the Queen Charlotte Islands hatching occurs in late April, throughout British Columbia in December-June, and in Washington in January-April. The larvae hatches as a prezoea and molts to the first zoeal stage within an hour. The five zoeal stages and the megalopal stage together last 90-110 d at 10°C; the megalopal stage alone lasts 25-30 d.

The period of peak settlement of Dungeness crab megalopae varies with latitude. Throughout British Columbia settlement occurs in July or later (in the Queen Charlotte Islands it peaks in late August-

September); May to August in Washington. The first juvenile stage appears in greatest numbers in late May or early June at a carapace width of about 0.7-0.8 cm. The maximum age of the Dungeness crab is about eight years.

Fishery

Dungeness fishing in the Gulf of Alaska dates back to the 1930's. Prior to 1960, landings were combined into a single total. Since then, catch records detail harvest from the Alaska Peninsula, Kodiak, Cook Inlet, Prince William Sound, Yakutat and Southeast Alaska management areas. All registration areas in Alaska apply generally passive management measures limiting the size and sex of harvested animals. Gear has been limited to pots or ring nets with two escape rings of 4 3/8" diameter required in each pot. Since 1960, approximately 263 million pounds of Dungeness crab have been harvested from the Gulf of Alaska.

Relevant Trophic Information

Dungeness crabs are generalist predators that consume a variety of invertebrates and fish. A large part of the diet of adult Dungeness crabs in British Columbia is clams. In Hecate Strait near the Queen Charlotte Islands where 116 prey species have been identified in the stomachs of the crab, juvenile Pacific Razor Clams (*Siliqua patula*) and the Alaska Bay Shrimp (*Neocrangon* alaskensis)] are a major component of the diet of Dungeness crabs. The crab will prey on Pacific Oysters (*Crassostrea gigas*) planted on the bottom at oyster farms. In Southeastern Alaska, Dungeness crabs have been observed eating various species of bivalves including the Pacific Blue Mussel (*Mytilus trossulus*), the Nuttall Cockle (*Clinocardium nuttallii*), and *Macoma* sp. Crabs were also seen carrying the Butter Clam (*Saxidomus giganteus*) and the Kennerley Venus (*Humilaria kennerleyi*) in their claws, presumably with the intent of eating them (Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). Dungeness crabs have been observed "digging-up" (to a depth of 0.3 m) and clutching large Nuttall Cockles (*Clinocardium nuttallii*) in Southeastern Alaska. The crabs will also scavenge animal flesh. They have been observed feeding on the carcasses of Pacific Halibut (*Hippoglossus stenolepis*) and unidentified flatfish in southeastern Alaska (Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). At San Juan Island in northern Puget Sound, Washington, adult Dungeness crabs move into the intertidal zone during nocturnal high tides, and feed mostly on bivalves and polychaetes. Elsewhere on the coast of Washington, crustaceans and fish are important food items in the diet of adult crabs.

Dungeness crab larvae are primarily zooplankton predators, although phytoplankton are also eaten. In the laboratory, the larvae can be raised to the megalopal stage with reasonably good survival on the diatom, *Skeletonema* sp. and the brine shrimp, *Artemia* sp.. Juvenile crabs (less than 10.0 cm in carapace width) eat primarily crustaceans in the Queen Charlotte Islands, British Columbia, and fish in California. In Grays Harbor, Washington, juvenile crabs eat primarily small bivalves and small crustaceans in their first year, shrimp (*Crangon* spp.) and fish in their second year, and fish in their third year. Both juvenile and adult crabs are cannibalistic, but the frequency of cannibalism is greatest in crabs less 6.0 cm in width, which prey on smaller crabs of the same year class.

The various life stages of the Dungeness crab are consumed by a diverse group of predators. The nemertean, *Carcinonemertes errans*, eats crab eggs and can cause heavy mortality (over 55%) in Dungeness crab egg clutches. In Oregon and northern California, the megalopae are preyed upon by King Salmon (*Oncorhynchus tshawytscha*) and Coho Salmon (*O. kisutch*) as well as by other fishes, such as the Copper Rockfish (*Sebastes caurinus*). Sea birds also consume the megalopae. In California, the Giant Pink Star (*Pisaster brevispinus*) preys on newly-settled megalopae and small juvenile crabs.

In addition to falling prey to larger conspecific, juvenile Dungeness crabs suffer predation from a wide variety of invertebrates, fish, birds and mammals. In Grays Harbor on the outer coast of Washington, the

Staghorn Sculpin (*Leptocottus armatus*) is a major predator of newly-settled Dungeness crabs in late spring and early summer; in Puget Sound, large juvenile crabs are found in stomachs taken from this fish. Crabs up to 11.4 cm in carapace width are consumed by the Pacific Halibut (*Hippoglossus stenolepis*) in Alaska and by the Cabezon (*Scorpaenichthys marmoratus*) in Oregon. Wading birds also prey on young crabs.

Perhaps the most important predator on adult Dungeness crabs in certain areas of Alaska is the sea otter (*Enhydra lutris*). The dramatic decline in crab abundance in Orca Inlet, Prince William Sound, beginning in 1979 has been attributed to predation by sea otters which prey heavily on Dungeness crabs in Prince William Sound. Sea otter predation is also probably responsible for a recent decrease in the abundance of Dungeness crabs in part of Dundas Bay, Glacier Bay National Park, Alaska. Octopuses also prey on adult crabs. Intertidal juveniles and large crabs in poor health are subject to bird predation. Bald eagles (*Haliaeetus leucocephalus*), northwestern crows (*Corvus caurinus*), and gulls (*Larus* sp.) Have been observed eating the eggs of apparently previously healthy, ovigerous crabs that had been dug out of sand in which the crabs had buried themselves in the low intertidal zone (Robert Stone and Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). One or more of these birds had excavated the females and inverted them to gain access to the crab's egg clutch. Virtually every female that had been attacked in this way was dead by the time they were observed. The Dungeness crab is also infrequently preyed upon by river otters (*Lutra canadensis*) in southeastern Alaska.

What is the approximate upper size limit of juvenile fish (in cm)?

Male and female Dungeness crabs reach sexual maturity at 10.0 cm in width.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

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Habitat and Biological Associations (if known) Narrative

Dungeness crabs are most common on sand or muddy-sand bottoms in the subtidal region, and are often found in or near eelgrass beds. However, in southeastern Alaska as well as elsewhere they can also be found on a variety of other substrata including various mixtures of silt, sand, pebble, cobble and shell.

Egg/Spawning See Adults

Larvae On the outer coasts of Washington, Oregon and California the zoeae are transported offshore. Subsequently, the megalopae are transported near shore, probably by wind-induced currents acting in conjunction with the diel vertical migratory behavior of the megalopae. Little is known of the movements and distribution of Dungeness crab larvae in southeastern Alaska. The megalopae have been observed among the gonozooids of the pelagic hydrozoan, *Velella velella*, collected 1-10 km from shore in northern California. The megalopae eat the gonozooids, gain protection from pelagic fish predators and possibly are transported to juvenile crab habitats nearshore while associated with the cnidarian. In northern Puget Sound, Washington, megalopae settle onto relatively open sandy areas where they are vulnerable to fish predation.

Juveniles Juvenile Dungeness crabs are found in similar habitats to the adults, but they generally occupy shallower depths than the adults. Juvenile crabs can be very abundant in the intertidal zone, but also occur in shallow subtidal areas. Survival of young crabs is greatest in habitats where they can gain refuge from predators such as in intertidal shell and eelgrass beds.

Adults In sand or muddy-sand the adult crabs frequently bury themselves so deeply that only their eyes, antennules and antennae are visible. Ovigerous crabs can bury themselves so completely that there is no visible indication of their presence on the surface of the sand. Crabs unencumbered by an egg clutch move very quickly, running on the tips of the walking legs. The crabs are especially fast over sand or mud bottoms where obstacles are lacking. In southeastern Alaska the amount of movement varies with the sex of the crab and the reproductive state of female crabs. On average, males move at a greater rate than females and ovigerous females move around less than males or nonovigerous females.

SPECIES: Dungeness crab, *Cancer magister*

| Stage - EFH Level | Duration or Age | Diet/Prey | Season/Time | Location | Water Column | Bottom Type | Oceano-graphic Features | Other |
|---|---|---|---|---|---|---|---|---|
| Eggs | 8-10 mo | NA | August - June | BAY, BCH, ICS | NA | S, MS | | |
| Larvae | 3-3.7 mo | Zooplankton, phytoplankton | June - September | BAY, ICS | P | NA | | |
| Juveniles | 0-2 yr | Crustaceans, bivalves, fish | All year | BAY, BCH, | NA | S, MS, G, CB, SAV | | |
| | | | | | | | | |

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