FISHERY MANAGEMENT PLAN
for the
SCALLOP FISHERY OFF ALASKA

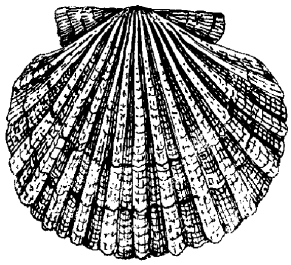

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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Scallop Management Background 1
1.2 Description of the Management Area 3
1.2.1 Geographic description of the management area 3
1.2.2 Physical characteristics of the management area 3
1.3 Biological and Environmental Characteristics of the Resource 8
1.3.1 General description 8
1.3.2 Reproduction and early life history 9
1.3.3 Longevity and natural mortality 9
1.3.4 Stock structure and productivity 11
1.3.5 Essential fish habitat for Alaska scallops 11
1.3.6 Fishing activities that may adversely affect EFH 21
1.3.7 Non-fishing related activities that may adversely affect EFH 36
1.4 Alaska State Management of the Scallop Fishery 64
1.4.1 Current State management regime 64
1.4.2 Impact of Federal regulations on State management activities 68

2.0 PROCEDURES FOR FMP IMPLEMENTATION 68
2.1 Management Objective 69
2.2 Management Areas 69
2.3 Registration Areas 69
2.4 Framework Measures 73
2.4.1 Setting harvest limits 73
2.4.2 Total allowable catch (TAC) 73
2.4.3 Crab bycatch limits (CBLs) 74
2.5 Conventional Measures 76
2.5.1 Catch restrictions 76
2.5.2 Prohibited Species 76
2.5.3 Gear Limitations 76
2.5.4 Efficiency limits 76
2.5.5 Closed areas 77
2.5.6 Seasons 77
2.5.7 Observer requirements 77

3.0 MANAGEMENT GOALS AND OBJECTIVES 78

4.0 OPTIMUM YIELD AND OVERFISHING 81
4.1 Assessment of the available scientific data 81
4.2 Specification of OY and Overfishing 84

5.0 MANAGEMENT MEASURES 86
5.1 Category 1: Management Measures Delegated to the State 86
5.1.1 Guideline Harvest Levels 86
5.1.2 Registration Areas, District, Subdistrict, and Section Boundaries 88
5.1.3 Gear Limitations 88
5.1.4 Crew and Efficiency limits 88
5.1.5 Fishing Seasons 89

5.1.6 Observer Requirements 89
5.1.7 Prohibited Species and Bycatch Limits 89
5.1.8 Recordkeeping and Reporting Requirements 89
5.1.9 In-season Adjustments 89
5.1.10 Closed areas 90
5.1.11 Other 90
5.2 Category 2 Measures: Limited Access Management 90
5.2.1 Moratorium Permit Program 90
5.2.2. Scallop License Limitation Program (LLP) 90

6.0 DATA ASSESSMENT AND COLLECTION 92
6.1 At-Sea Catch Sampling 92

7.0 ADMINISTRATIVE AND ENFORCEMENT COSTS 93

8.0 APPENDICES 94
Appendix A. History of the Alaska Scallop Fishery 94
Appendix B. National Standards of the Magnuson Act 107
Appendix C State of Alaska Management Structure 108
Appendix D: Scallop Registration Areas 111

9.0 REFERENCES 113

1.0 INTRODUCTION

1.1 Scallop Management Background

The scallop resource off Alaska has been commercially exploited for almost 30 years. Weathervane scallop stocks off Alaska were first commercially explored by a few vessels in 1967. The fishery grew rapidly over the next 2 years with about 19 vessels harvesting almost 2 million pounds of shucked meat. Since then vessel participation and harvests have fluctuated greatly, but have remained below the peak participation and harvests experienced in the late 1960's. Between 1969 and 1991, about 40 percent of the annual scallop harvests came from State waters. Since 1991, Alaska scallop harvests have increasingly occurred in Federal waters. In 1994, only 14 percent of the 1.2 million lbs landed were harvested in State waters, with the remainder harvested in Federal waters off Alaska.

The State of Alaska has managed the scallop fishery in State and Federal waters, consistent with section 306(a)(3) of the Magnuson Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) (Magnuson Act), which allows a state to directly regulate any fishing vessel outside state waters if the vessel is registered under the laws of that state. Until 1995, all vessels participating in the Alaska scallop fishery were registered under the laws of the State of Alaska and the fishery was monitored and controlled under State jurisdiction. The North Pacific Fishery Management Council (Council) concluded that the scallop management program implemented by the State provided sufficient conservation and management of the Alaska scallop resource and did not need to be duplicated by direct Federal regulation. Therefore, no Federal regulations were implemented to govern the scallop fishery in Federal waters.

The Council currently is considering options for a fishery management plan for the scallop fishery off Alaska that would authorize a moratorium on vessel entry into the fishery. A vessel moratorium cannot be implemented under Alaska State regulations given existing State statutes. At its April 1994 meeting, the Council requested NMFS to initiate rulemaking to implement a fishery management plan for the scallop fishery off Alaska that would establish a vessel moratorium and defer most other routine management measures to the State of Alaska. The Council was informed that section 306(a)(3) of the Magnuson Act prohibits a state from regulating a fishing vessel in Federal waters unless the vessel is registered under the laws of that state. As a result, routine management measures deferred to the State of Alaska under the Council's proposed management plan could not be applied in Federal waters to vessels not registered with the State. The Council recognized the potential problem of unregistered vessels fishing in Federal waters, but noted that all vessels fishing for scallops in Federal waters were registered under the laws of the State of Alaska. Therefore, the Council recommended that NMFS proceed with implementing the Council's proposed fishery management plan given that all vessels used to fish for scallops off Alaska had been registered with the State and that no information was available to indicate that vessels would not continue to register with the State.

During the period of time that NMFS was developing regulations to implement the Council's proposed management plan, the State of Alaska informed NMFS that a fishing vessel was fishing for scallops in Federal waters of the Prince William Sound management area closed by the State and that the vessel was not registered under the laws of the State. As a result, the vessel operator was not subject to State regulations governing the scallop fishery, including requirements to carry an observer at all times to monitor scallop catch and crab bycatch. The State could not stop this uncontrolled fishing activity because the vessel was not registered with the State of Alaska and was, therefore, operating outside the State's jurisdiction. On February 17, 1995, the Council held a teleconference to address concerns about uncontrolled fishing for scallops in Federal waters by one or more vessels fishing outside the jurisdiction of State regulations and

requested that NMFS implement an emergency rule to close Federal waters to fishing for scallops to prevent overfishing of the scallop stocks. Subsequent to the Council's recommendation, the U.S. Coast Guard boarded the vessel fishing for scallops outside the jurisdiction of the State and was informed that 54,000 lbs of shucked scallop meat was on board. This amount exceeded the State's guideline harvest level for the Prince William Sound area (50,000 lbs) by over 100 percent.

NMFS implemented the emergency rule to close Federal waters off Alaska to fishing for scallops on February 23, 1995 (60 FR 11054, March 1, 1995) to respond to concerns that continued uncontrolled harvest of scallops in Federal waters would result in localized overfishing of the scallop resource. At its February 17, 1995, teleconference, the Council recommended that NMFS should extend the emergency rule for a second 90-day period, through August 28, 1995.

Based on recent events in the scallop fishery that warranted the emergency interim rule, the Council's proposed management plan no longer is an appropriate option for the management of the scallop fishery in Federal waters. Recent participation in the scallop fishery by at least one vessel fishing outside the jurisdiction of the State, contemplation by other vessel owners to fish in Federal waters outside State regulations governing the scallop fishery, and the likelihood that uncontrolled fishing for scallops could occur anywhere off Alaska by the highly mobile scallop processor fleet now requires that Federal regulations be implemented to control scallop fishing activity by vessels that choose not to register with the State of Alaska.

To respond to the need for Federal management of the scallop fishery once the emergency rule expires, the Council prepared the Fishery Management Plan for the Scallop Fishery off Alaska (FMP) under section 304(c) of the Magnuson Act. The FMP originally authorized an interim closure of Federal waters to fishing for scallops. The intent of the FMP was to prevent an unregulated and uncontrolled fishery for scallops in Federal waters that could result in overfishing of scallop stocks during the period of time an alternative fishery management plan is prepared that would authorize fishing for scallops under a Federal management regime. The Council pursued this approach because it determined that the suite of alternative management measures necessary to support a controlled fishery for scallops in Federal waters could not prepared, reviewed, and implemented before the emergency rule expires. Instead, the Council prepared the proposed FMP to protect the long-term productivity of scallops stocks off Alaska necessary to support the future harvest of optimum yield on a continuing basis without the "boom and bust" syndrome that other scallop fisheries historically have portrayed.

In June 1995 the Council adopted Amendment 1 to the FMP which would establish a Federal management regime to replace the interim closure of Federal waters to fishing for scallops. The Council's preferred alternative for Amendment 1 was to federalize the State's management regime and implement a vessel moratorium, based on criteria adopted in April 1994, and reaffirmed in January 1995. 18 vessels would qualify under the moratorium. NMFS has subsequently removed the vessel moratorium from Amendment 1 and will propose the vessel moratorium as Amendment 2 in order to prevent vessel moratorium issues from delaying reopening of the fishery.

Amendment 1 to the FMP establishes a Federal management regime to replace the interim closure of Federal waters to fishing for scallops (paragraphs 2.3 through 2.5 of the FMP). This new Federal management regime has been developed in coordination with the Council and the State of Alaska (State) and is designed to be consistent with current State management of the scallop fishery. The Federal management regime established under Amendment 1 does not preclude the Alaska Department of Fish and Game (ADF&G) from imposing any additional regulations on vessels registered under the laws of the State. A description of the

scallop fishery off Alaska, as well as harvest amounts and the number of vessels annually participating in the fishery is presented in Appendix A.

Amendment 5: Description and Identification of Essential Fish Habitat.

On April 26, 1999, NMFS approved Amendment 5 to the FMP which implemented the Essential Fish Habitat (EFH) provisions contains in the Magnuson-Stevens Fishery Conservation and Management Act and 50 CFR 600.815. Amendment 5 describes and identifies EFH fish habitat for scallops and describes and identifies fishing and non-fishing threats to scallop EFH, research needs, habitat areas of particular concern, and EFH conservation and enhancement recommendations.

1.2 Description of the Management Area

1.2.1 Geographic description of the management area

The management areas covered under the FMP includes all Federal waters of the Gulf of Alaska (GOA) and the Bering Sea/Aleutian Islands area (BSAI). The GOA is defined as the U.S. exclusive economic zone (EEZ) of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170°W longitude and Dixon Entrance at 132°40'W longitude. The BSAI is defined as the U.S. EEZ south of the Bering Strait to the Alaska Peninsula and Aleutian Islands and extending south of the Aleutian Islands west of 170° W long.

1.2.2 Physical characteristics of the management area

The continental shelf parallels the southeastern Alaska coast and extends around the GOA. Total area of continental shelf in the GOA is about 160,000 square km, which is more than the shelf area in the Washington-California region but less than 25 percent of the eastern Bering Sea Shelf. Between Canada and Cape Spencer the Continental Shelf is narrow and rough. North and west of Cape Spencer it is broader. Although its width is less than 10 miles at some points, it is generally 30 to 60 miles wide. 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. More detailed information on the Alaskan shelf can be found in Sharma (1979).

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. Seasonal changes in temperature and salinity diminish with increasing depth and distance from shore. Along the outer shelf and upper slope, bottom water temperatures of 4 to 5° C persist year-round throughout the periphery of the GOA. With further increase in depth, water temperature shows no significant seasonal change but gradually decreases with depth, reaching 2° C or less at greater depths. The water circulation pattern in both the eastern Bering Sea and Gulf of Alaska is a counterclockwise gyre (Sharma 1979). Inshore current flow patterns are affected by weather, tides, and topography.

1.2.3 Commercial fisheries for Alaska scallops

All commercial fisheries for Alaskan scallops take place in relatively shallow waters (< 200 m) of the continental shelf. Weathervane scallops are found at depths ranging from intertidal waters to depths of 300 m (Foster 1991), but abundance tends to be greatest between depths of 45-130 m on substrates consisting

of mud, clay, sand, or gravel (Hennick 1973). Although weathervane scallops are widely distributed along the shelf, the highest densities in Alaska have been found to occur in discrete areas. Areas fished during the 1993 scallop fishery included beds in the Bering Sea, off the Alaska Peninsula, in Shelikof Strait, on the east side of Kodiak Island, and along the Gulf coast from Yakutat to Kayak Island (Figure 1). Testimony from fishermen indicate that the Kodiak stocks are currently depressed.

Figure 1. Areas fished statewide diuring the 1993 scallop fishery. Fishing in Southeast Alaska and parts of Dutch Harbor remain confidential. From Urban et al. (1994)

1.2.4 Benthic community

In both the Bering Sea and Gulf of Alaska, scallops are only a part of a diverse benthic community. Besides scallops, several other species of invertebrates are commercially harvested off Alaska, including clams, crabs, octopus, squid, and shrimp. Commercially important crab species include red king crab (Paralithodes camtschatica), blue king crab (P. platypus), brown or golden king crab (Lithodes aequispina), dungeness crab (Cancer magister), and two species of Tanner crab (Chionoectes bairdi, and C. opilio). Distribution of these species in the Bering Sea and Aleutian Islands is shown in Figure 2, and summarized by Otto (1981) and Lewbel (1983). Red king crabs are distributed from Southeast Alaska to Kodiak Island and northward into Norton Sound, with highest densities at depths of 40-100 meters. Blue king crabs also occur at those depths, but are distributed primarily around the Pribilof, St. Matthew, and St. Lawrence Islands. Tanner crabs occur at those depths, and deeper to 700 meters. C. opilio are distributed throughout the Bering Sea. C. bairdi, on the other hand, are distributed through the Gulf of Alaska and Aleutian Islands to the Bering Sea, with highest concentrations in the Bering Sea from the Alaska Peninsula to the Pribilof Islands. A summary of life history information for crabs is provided by Adams (1979), Somerton (1981), and Kessler (1985). Fisheries information for king and Tanner crabs can be found in the following references: Browning (1980), Otto (1981), and NPFMC (1989).

In addition to a crab fishery, there also large fisheries for groundfish using pot, longline, jig, and trawl gear. Fisheries for groundfish target walleye pollock (Theragra chalcogramma), Pacific cod (Gadus macrocephalus), lingcod (Ophiodon elongatus), sablefish (Anoplopoma fimbria) Atka mackerel (Pleorogrammus monopterygius), Pacific ocean perch (Sebastes alutus) and other rockfish species, and numerous species of flounder. In the Bering Sea yellowfin sole (Limanda aspera) dominates the flounder community, but is comparatively scarce in the Gulf and absent off Washington-California. The arrowtooth flounder, (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, Dover sole (Microstomus pacificus). Pacific salmon (Oncorhynchus sp.), and herring (Clupea pallasii) tend to be of a pelagic nature. A more complete description of commercial groundfish, other finfish, and shellfish stocks can be found in the Council's annual Stock Assessment and Fishery Evaluation report for the groundfish stocks (NPFMC 1994b) and several plan amendment analyses (e.g., Amendment 18/23, NPFMC, 1992).

Figure 2. King and Tanner crab distribution in the Bering Sea and Aleutian Islands. Areas of highest crab density are shown in vertical bars. From Otto (1981)

Scallops also share the benthic habitat with non-economically important fish and invertebrate species. Non-commercial fishes include skates, sharks, sculpins, and numerous species of small fishes. Large invertebrates not usually commercially harvested include some crab and shrimp species, snails, clams, worms, jellyfish, seasquirts, bryozoans, sea urchins, seastars, sea anemones, sponges, corals, and many others. Various types of corals inhabit the Gulf of Alaska, including fan corals, bamboo corals, cup corals, soft corals, and hydrocorals (Cimberg et al. 1981). Generally, corals do not have the same habitat requirements as scallops and occur at greater depths than scallops. Two of the more abundant species in waters less than 100 fathoms are red tree (Primnoa wailleyi) and sea raspberry (Eunephtya sp). These species occur in areas of rugged habitat consisting of boulders and bedrock, habitats that are not inhabited by most scallop species.

1.3 Biological and Environmental Characteristics of the Resource

1.3.1 General description

The weathervane scallop (Patinopecten caurinus), is a bivalve and classified by having a single adductor muscle, a socket-like hinge, and distinct dorsal and ventral valves. Scallops have a limited swimming ability by utilizing hydraulic water pressure achieved by clapping the valves together. Numerous eyes, or ocelli, are located along the outer mantle on stalks. Scallops are non-burrowing filter feeders, subsisting primarily on phytoplankton.

Although the weathervane scallop has been the principal commercial species off Alaska, several other species of scallop found in the EEZ off Alaska have commercial potential. These scallops, thought to be closely related to the Icelandic scallops (Chlamys islandica) of the North Atlantic, grow to smaller sizes than weathervanes, and thus have not been extensively exploited in Alaska. Chlamys behringiana inhabit the Chukchi Sea to the Western Bering Sea. Chlamys albida are distributed from the Bering Sea and Aleutian Islands to the Japan Sea. Pink scallops, Chlamys rubida, range from California to the Pribilof Islands. Spiny scallops, Chlamys hastata, are found in coastal regions from California to the Gulf of Alaska.

Little is known about the biology of these scallop species. Chlamys species occupy different habitats and have different growth characteristics than weathervanes. Pink scallops are found in deep waters (to 200 m) in areas with soft bottom, whereas spiny scallops occur in shallower (to 150 m) areas characterized by hard bottom and strong currents. Spiny scallops grow to slightly larger sizes (75 mm) than pink scallops (60 mm). Both species mature at age 2, or about 35 mm, and are characterized by high natural mortality, with maximum age of about 6 years. Spiny scallops are autumn spawners (August-October), whereas pinks are winter spawners (January-March) (Bourne and Harbo 1987).

Rock scallops, Crassadoma gigantea, range from Mexico to Unalaska Island. The abundance of this species is not known, and a commercial fishery has never been developed. Because they attach themselves to rocks, trawls and dredges are not efficient in capturing rock scallops. As suggested by the species name, these scallops attain a large size (to 250 mm) and exhibit fast growth rates. Rock scallops are found in relatively shallower water (0-80 m) with strong currents. Apparently, distribution of these animals is discontinuous, and the abundance in most areas is low. Rock scallops may spawn during two distinct periods, one in the autumn (October -January), and one in the spring-summer (March-August) (Jacobsen 1977).

1.3.2 Reproduction and early life history

For weathervanes and the other scallop species, sexes are separate although one case of hermaphroditism in weathervanes has been observed (Hennick 1971). Mature male and female scallops are distinguishable: female gonads are pink or orange-red whereas gonads of males are white (Haynes and Powell 1968; Robinson and Breese 1984). Although spawning time varies with latitude and depth (Robinson and Breese 1984; MacDonald and Bourne 1987; Starr and McCrae 1983), weathervane scallops in Alaska appear to mature in mid-December to late January and spawn in May to July depending on location (Hennick 1970a).

Scallops develop through egg, larval, juvenile, and adult life stages (Figure 3). Eggs and spermatozoa are released into the water, where the eggs become fertilized (Cragg and Crisp 1991). After a few days, eggs hatch, and larvae rise into the water column and drift with ocean currents. Larvae are pelagic and drift for about one month until metamorphosis to the juvenile stage (Bourne 1991). The "post-larvae" settle and attach to a hard surface on the bottom with strings called "byssal threads". Young juveniles may remain attached, or they may become mobile by use of a "foot", or they may swim. Within a few months the shell develops pigmentation, and juveniles then resemble the adult in appearance.

Weathervane scallops mature by age 3 at about 7.6 cm (3 inches) in shell height (SH), and virtually all scallops are mature by age 4 (Haynes and Powell 1968; Hennick 1970b, 1973). Growth is most rapid during the first 10-11 years (Hennick 1973). However, growth, maximum size, and size at maturity vary significantly within and between beds and geographic areas. For example, on average, maximum size as measured by (SH), tends to be about 190 mm (7.5 inches) SH for Marmot Flats off Kodiak Island and only 144 mm (5.7 inches) SH for the Cape Fairweather - Cape St. Elias area. The largest recorded specimen measured 250 mm (9.8 inches) SH and weighed 340 g (12 ounces, Hennick 1973). Although increasing with age and size, weight varies seasonally; meat yield declines during the spawning season and increases during the growing season. In addition, adductor weights of weathervane scallops apparently vary among regions, with the west side of Kodiak Island producing the largest meats relative to shell size.

1.3.3 Longevity and natural mortality

Weathervane scallops are long-lived; individuals may live 28 years or more (Hennick 1973). The natural mortality rate (M) is thought to be low, although estimates vary. Instantaneous natural mortality (M) for weathervane scallops has been estimated by Kruse and Funk (1995), based on data presented in published papers (Kaiser 1986, Hennick 1973). A median M value of 0.13 was estimated using the methodology of Alverson and Carney (1975) based on growth parameters, Robson and Chapman (1961) based on catch curves, and Hoenig (1983) and Beverton (1963) based on maximum age. Little is known about the causes of natural mortality for scallops. Scallops are likely prey for various fish and invertebrates during the early part of their life cycle. Flounders are known to prey on juvenile weathervane scallops and seastars also may be important predators (Bourne 1991).

Figure 3. Weathervane scallop life history (U.S. BLM 1980)

1.3.4 Stock structure and productivity

The stock structure of weathervane scallops has not been studied. Until recently, benthic ecologists generally believed that invertebrate species generally have "open" populations that are well-connected to other, geographically-distinct populations by advection of pelagic larvae. Growing evidence exists, however, that some invertebrate populations are actually comprised of multiple discrete, self-sustaining populations (Sinclair 1988; Orensanz et al. 1991). Sinclair et al. (1985) suggested that three species of scallops in the North Atlantic Ocean were comprised of a number of discrete, self-sustaining populations. From Virginia to Newfoundland, at least 19 discrete concentrations of Atlantic scallops may be self sustaining populations (Sinclair 1988). Fevolden (1989) provided strong evidence for restricted gene flow among different concentrations of Iceland scallop (Chlamys islandica) in the northeast Atlantic Ocean and concluded that scallops sampled from different areas of the northeast Atlantic Ocean should be treated as discrete genetic units for management purposes. Last, Caddy (1989) asserted that it is reasonable to assume that historically-maintained centers of scallop concentrations are self-sustaining populations. Further, he recommended that these commercially-important scallop beds should compose the unit stock upon which management measures are based. He also noted that a scallop fishing ground may contain several beds of high scallop density that are surrounded by a number of low-density scallop fishing areas.

Only limited information on biological productivity is available for weathervane scallops to promote the conservation of stocks and sustained yield of the fishery. Much of this information (Haynes and Powell 1968; Hennick 1970b, 1973) was collected during the early years of the fishery, but has been summarized more recently by Kaiser (1986). Although the fishery has been prosecuted every year since 1967 except 1978, the only assessment survey since 1972 was conducted in 1984 in lower Cook Inlet (Hammarstrom and Merritt 1985). Total scallop biomass in the Yakutat and Kodiak area ranged from 12,335 to 17,445 tons (Ronholt et al. 1977), but these estimates were based on inefficient shrimp trawls and were considered by Kaiser (1986) to be a minimum biomass estimate. A population of weathervanes in the Gulf Islands area of southern British Columbia was estimated to have a density of about 1 scallop per 65 square meters (Bourne 1991). In addition to a lack of good abundance estimates, there have been no routine biological or fishery sampling programs conducted on weathervane scallops. A new observer program, instituted in July 1993 by the State of Alaska, may provide better abundance information. The distribution of scallops in Alaskan waters is rather well-known, but insufficient information on abundance, exploitation rates, recruitment, and other key population dynamics parameters hampers fishery management based on population dynamics.

1.3.5 Essential fish habitat for Alaska scallops

1.3.5.1 Habitat requirements by life history stage

Summaries and assessments of habitat information for scallops off the coast of Alaska are provided in the “Essential Fish Habitat Assessment Report for the Scallop Fisheries Off the Coast of Alaska” dated March 31, 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 scallops, it was determined that information at levels 0, 1, and 2 was available.

The information available for weathervane scallops and other scallop species is primarily broad geographic distributions based on specific samples from surveys and fisheries which have not been linked with habitat

characteristics. The ability to precisely define the habitat (and its location) of each life stage in terms of its oceanographic (temperature, salinity, nutrient, current) trophic (presence of food, absence of predators), and physical (depth, substrate, latitude and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions and life stage is restricted primarily to broad biogeographic and bathymetric areas and occasional references to known bottom type associations.

Information about the entire range of a species is included in the textual descriptions of EFH; however, the maps only show EFH and known areas of high weathervane scallop concentrations in the State and Federal waters off Alaska. Identification of EFH for weathervane scallops included historical range information. Traditional knowledge and sampling data have indicated that distributions may contract and expand due to a variety of factors including, but not limited to, temperature change, current patterns, changes in population size, and changes in predator and prey distribution.

Habitat Description for Weathervane Scallops
(*Patinopectin caurinus*)

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

Scallops are managed under the Fishery Management Plan for the Scallop Fishery off Alaska. Scallops occur throughout the area covered by the FMP and extend south to California.

Life History and General Distribution

Weathervane scallops are distributed from Point Reyes, California, to the Pribilof Islands, Alaska. The highest known densities in Alaska have been found to occur in the Bering Sea, off Kodiak Island, and along the eastern gulf coast from Cape Spencer to Cape St. Elias. Weathervane scallops are found from intertidal waters to depths of 300 m, but abundance tends to be greatest between depths of 40-130 m on beds of mud, clay, sand, and gravel. Beds tend to be elongated along the direction of current flow. A combination of large-scale (overall spawning population size and oceanographic conditions) and small-scale (site suitability for settlement) processes influence recruitment of scallops to these beds. Sexes are separate and mature male and female scallops are distinguishable based on gonad color. Although spawning time varies with latitude and depth, weathervane scallops in Alaska spawn in May to July depending on location. Eggs and spermatozoa are released into the water, where the eggs become fertilized. After a few days, eggs hatch, and larvae rise into the water column and drift with ocean currents. Larvae are pelagic and drift for about one month until metamorphosis to the juvenile stage when they settle to the bottom.

Several other species of scallops found in the EEZ off Alaska have commercial potential. These scallops grow to smaller sizes than weathervanes, and thus have not been extensively exploited in Alaska. Pink scallops, *Chlamys rubida*, range from California to the Pribilof Islands. Pink scallops are found in deep waters (to 200 m) in areas with soft bottom, whereas spiny scallop occur in shallower (to 150 m) areas characterized by hard bottom and strong currents. Pink scallops mature at age 2, and spawn in the winter (January-March). Maximum age for this species is 6 years. Spiny scallops, *Chlamys hastata*, are found in coastal regions from California to the Gulf of Alaska. Spiny scallops grow to slightly larger sizes (75 mm) than pink scallops (60 mm). Spiny scallops also mature at age 2 (35 mm) and spawn in the autumn (August-October). Rock scallops, *Crassadoma gigantea*, range from Mexico to Unalaska Island. Rock scallops are found in relatively shallower water (0-80 m) with strong currents. Apparently, distribution of these animals is discontinuous, and the abundance in most areas is low. These scallops attach themselves to rocks, attain

a large size (to 250 mm), and exhibit fast growth rates. Rock scallops are thought to spawn during two distinct periods, one in the autumn (October -January), and one in the spring-summer (March-August).

Fishery

The weathervane scallop resource consists of multiple, discrete, self sustaining populations that are managed as separate stock units. Scallop stocks in Alaska have been managed under a federal fishery management plan (FMP) since 1995. The FMP controls the fishery through permits, registration areas and districts, seasons, closed waters, gear restrictions, efficiency limits, crab bycatch limits, scallop catch limits, inseason adjustments, and observer monitoring. Most of these regulations were developed by the State prior to 1995. Dredge size is limited to a maximum width of 15 feet, and only 2 dredges may be used at any one time. In the Kamishak District of Cook Inlet, only 1 dredge with a 6' maximum width is allowed. Dredges are required to have rings with a 4" minimum inside diameter. To reduce incentives to harvest small scallops, crew size on scallop vessels is limited to 12 persons and all scallops must be manually shucked. Dredging is prohibited in areas designated as crab habitat protection areas, similar to the groundfish FMPs.

Since 1967, when the first landings were made, fishing effort and total scallop harvest (weight of shucked meats) have varied annually. Total commercial harvest of weathervane scallops has fluctuated from a high of 157 landings totaling 1,850,187 pounds of shucked meats by 19 vessels in 1969 to no landings in 1978. Prices and demand for scallops have remained high since fishery inception. Prior to 1990, about two-thirds of the scallop harvest has been taken off Kodiak Island and about one-third has come from the Yakutat area; other areas had made minor contributions to overall landings. Harvests in 1990 and 1991 were the highest on record since the early 1970s. The 1992 scallop harvest was even higher at 1,810,788 pounds. The increased harvests in the 1990s occurred with new exploitation in the Bering Sea.

Relevant Trophic Information

Scallop predators have not been well studied. Scallops are likely prey to various fish and invertebrates during the early part of their life cycle. Flounders are known to prey on juvenile weathervane scallops, and seastars may also be important predators.

Upper size limit of juveniles

Weathervane scallops begin to mature by age 3 at about 7.6 cm (3 inches) in shell height (SH), and virtually all scallops are mature by age 4. Growth, maximum size, and size at maturity vary significantly within and between beds and geographic areas. Weathervane scallops are long-lived; individuals may live 28 years old or more. The natural mortality rate is thought to be about 15% annually (M = 0.16).

SPECIES: Weathervane Scallops off Alaska

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features
Eggs	several days	None	May-July	MCS, ICS	D		N/A
Larvae	2-3 weeks		May-August	ICS, MCS, OCS	P		N/A
Juveniles	Age 0 to Age 3		Aug. +	MCS	D	CL, M, S, G	N/A
Adults	Age 3 - 28		Spawning May-July	MCS	D	CL, M, S, G	UNK

Sources for additional distribution data

Distributional information is contained in the Literature cited section.

Habitat and Biological Associations

Scallops are found from intertidal waters and to 300 m. Abundance tends to be greatest between 45-130 m on beds of mud, clay, sand and gravel (Hennick 1973). Weathervane scallops are associated with other benthic species, such as red king crabs, Tanner crabs, shrimps, octopi, flatfishes, Pacific cod, and other species of benthic invertebrates and fishes.

Table 1.1 Levels of essential fish habitat information currently available for Alaska scallops, by life history stage. Juveniles were subdivided into early and late juvenile stages based on survey and fishery selectivity curves.

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Weathervane scallops	0a	0a	0a	1	2
Pink scallops	0a	0c	0a	0a	0a
Spiny scallops	0a	0c	0a	0a	0a
Rock scallops	0a	0c	0a	0a	0a

Note: for the larval stages of Pink, Spiny, and Rock scallops information is insufficient to infer general distributions.
0a: Some information on a species' life stage upon which to infer general distribution.
0c: No information on the actual species' life stage and no information on a similar species or adjacent life stages, or where complexity of a species stock structure prohibited inference of general distribution.

Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.

Location

BCH = beach (intertidal)
ICS = inner continental shelf (1-50 m)
MCS = middle continental shelf (50-100 m)
OCS = outer continental shelf (100-200 m)
USP = upper slope (200-1000 m)
LSP = lower slope (1000-3000 m)
BSN = basin (>3000 m)
BAY = nearshore bays, give depth if appropriate (e.g., fjords)
IP = island passes (areas of high current), give depth if appropriate

Water column

D = demersal (found on bottom)
SD/SP =semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom
P = pelagic (found off bottom, not necessarily associated with a particular bottom type)
N = neustonic (found near surface)

Bottom Type

M = mud S = sand R = rock
SM = sandy mud CB = cobble C = coral
MS = muddy sand G = gravel K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features

UP = upwelling G = gyres F = fronts
CL = thermo- or pycnocline E = edges

General

U = Unknown NA = not applicable

1.3.5.2 EFH Determination

<u>EFH definition for Alaskan weathervane scallops</u>

Eggs (several days) - Level 0_a
Demersal waters of the inner and middle continental shelf of the Gulf of Alaska and to a lesser extent in the Bering Sea and Aleutian Islands. Eggs are released in the late spring and early summer.

Larvae (2-3 weeks) - Level 0_a
Pelagic waters along the inner, middle, and outer continental shelf of the Gulf of Alaska west of Dixon entrance, extending into the Bering Sea and Aleutian Islands.

Juveniles (to 3 years of age) - Level 1
Areas of clay, mud, sand, and gravel along the mid-continental shelf of the BSAI and GOA.

Adults (3+ years of age) - Level 2
Areas of clay, mud, sand, and gravel along the mid continental shelf of the GOA and BSAI. Areas of concentration are those between the depths of 40-130 m. Scallop beds are generally elongated in the direction of current flow.

<u>EFH definition for Alaskan pink scallops</u>

Eggs (several days) - Level 0_a
Demersal waters of the inner and middle continental shelf of the Gulf of Alaska and to a lesser extent in the Bering Sea and Aleutian Islands. Eggs are released in the winter and early spring.

Larvae (2-3 weeks?) - Level 0_c - No EFH definition determined
Pelagic waters with unknown distribution.

Juveniles (to 2 years of age) - Level 0_a
Soft bottom areas along the inner and mid-continental shelf of the BSAI and GOA.

Adults (2+ years of age) - Level 0_a
Soft bottom areas less than 200 m along the inner, middle, and outer continental shelf of the GOA and BSAI.

<u>EFH definition for Alaskan spiny scallops</u>

Eggs (several days) - Level 0_a
Demersal waters of the inner continental shelf of the Gulf of Alaska and to a lesser extent in the Bering Sea and Aleutian Islands. Eggs are released in the late summer.

Larvae (2-3 weeks?) - Level 0_c - No EFH definition determined
Pelagic waters with unknown distribution.

Juveniles (to 2 years of age) - Level 0_a

Hard bottom areas characterized by strong currents along the inner and middle continental shelf of the GOA.

Adults (2+ years of age) - Level 0_a
Hard bottom areas shallower than 150 m, characterized by strong currents along the inner and middle continental shelf of the GOA.

<u>EFH definition for Alaskan rock scallops</u>

Eggs (several days) - Level 0_a
Demersal waters of the inner continental shelf of the Gulf of Alaska. Eggs are released in the spring and also the autumn months.

Larvae (2-3 weeks?) - Level 0_c - No EFH definition determined
Pelagic waters with unknown distribution.

Juveniles (to 3 years of age) - Level 0_a
Rocky bottoms in shallow waters (0-80m) characterized by strong currents.

Adults (3+ years of age) - Level 0_a
Rocky bottoms in shallow waters (0-80m) characterized by strong currents.

1.3.5.3 EFH maps

Figure 4: BSAI Weathervane scallops(late juveniles and adults)

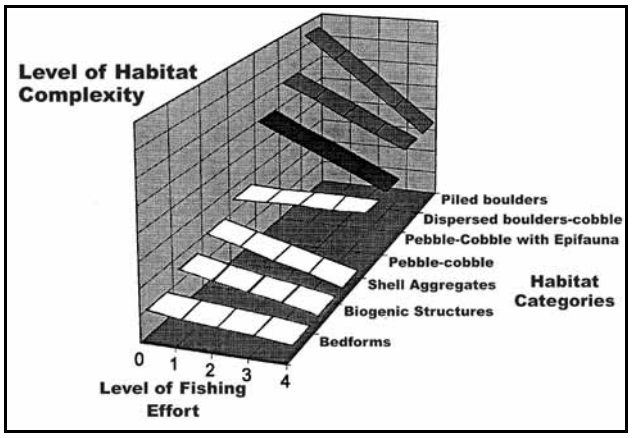
Figure 5: GOA Weathervane scallops(late juveniles and adults)

1.3.6 Fishing activities that may adversely affect EFH

1.3.6.1 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.

1.3.6.2 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 resuspended can recover to pre-trawl densities in 24 hours (Rumohr and Krost, 1991). The sponges and most of the corals damaged in the hard-bottom studies, returned to their pre-study levels in approximately a year.

One of the principle concerns associated with trawling is the potential effects on benthic organisms that fish depend on for food. At least in the short term, prey items immediately available to fish do not appear to be reduced. Caddy (1973) found that fish and crabs were attracted to the trawl path, presumably to feed on exposed or dead benthos, within 1 hour after fishing. Other studies have also observed increases in scavenging in the wake of beam-trawls (Kaiser and Spencer 1994; Kaiser and Spencer 1996a). Furthermore, the densities of some of the species examined in the study, were 30 times greater than outside the trawl tracks. In Kiel Bay (Baltic Sea), it was believed that cod fed extensively on Arctica islandica which were crushed or broken by trawl doors (Rumohr and Krost 1991; Jones 1992).

Minor short-term changes in individual species distribution are not likely to greatly affect the entire ecosystem, excessively. The ecosystem is in a constant flux, with many natural phenomena making changes to the environment (de Groot 1984; Brylinsky et al. 1994). The specific question is whether fishing causes long-term changes (negative) in the benthic community structure.

There have been changes to benthic communities from trawling due to habitat alteration. The trawl doors may be the most damaging to benthic organisms on a short-term basis. However, even in deep areas where the troughs may be recognized after long periods (5 years), the doors do not likely have an excessive long-term effect on the overall area, because the relatively small trough is between 0.2 - 2 m (Krost et al. 1990; Rumohr and Krost 1991; Brylinsky et al. 1994). The greater long-term damage to the habitat may be caused by the net and footrope due to their much larger width at 3-166 m (1.5-90 fathoms), with many between 20-50 m (Grahm 1955).[1] 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 resuspended 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,

[1] Pers. comm., Chris Blackburn, Alaska Groundfish Databank, Kodiak, AK.

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.[2] 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

[2] Pers. comm., Teresa Kandianis, 2977 Fox Road, Ferndale, WA 98248.

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 9.2 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**

1.3.6.3 Literature of Scientific Studies on Fishing Threats to Habitat

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1.3.7 Non-fishing related activities that may adversely affect EFH

1.3.7.1 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[3], 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.

[3] 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.

Specific projects involving offshore marine disposals may directly impact EFH by overburdening and covering marine habitats. Because of the desirability of finding protection from Bering Sea storms, suitable port development sites often are valuable to the fishery fleet infrastructure. Recently, once such project in King Cove, Alaska, potentially could impact 20+ acres of marine habitat. This site was investigated and found not to be EFH for two species of crab, nevertheless the impact warranted investigation. Construction of a port facilities are planned for the City of Nome, Sand Point, and St. Paul, Alaska. In other areas, shallow water depth requires construction of long structures projected seaward in order to provide direct access from the uplands to deeper-draft ocean going vessels. These causeways alter the physical processes of the shoreline such as currents and disruption of fish migration. Another project in the village of Unalaska, required an extension of the airport runway into water depths approximately 50-feet, and received the necessary permits for construction. Beyond these specific projects, development activity in the coastal areas of the Bering Sea and the Aleutian Islands has been largely limited to construction of erosion control measures and breakwaters (e.g., the city of Bethel). As human population increase, so will the desire to have new harbor developments. In Alaska, there are over 40 known Ports of Call. Many villages lack large enough harbors for trade and therefore are not a port. All these require routine dredging ranging from 1-20 year intervals.

From a broad perspective, the environmental effects of dredging can include:

- Direct removal/burial of organisms as a result of dredging and placement of dredged material.
- Turbidity/siltation effects, including increased light attenuation from turbidity.
- Contaminant release and uptake, including nutrients, metals, and organics.
- Release of oxygen consuming substances.
- Noise disturbance to aquatic and terrestrial organisms.
- 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 impacts 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 impacts include: direct and/or non-point source discharge of nutrients, chemicals, fish by-products, and stick water; overburdening of original habitats; particle suspension.

Discharge of fish waste from shoreside and vessel processing has occurred in marine waters since the 1800's. The discharge can cause water quality problems. Although all fish waste is biodegradable, including heads, viscera, and bones, fish parts that are ground to fine particles may remain suspended for some time. Also, "stick water,"a byproduct of processing fish meal, takes the form of a fine gel or slime which can concentrate on surface waters and move onshore to cover intertidal areas. Crab and fish have been processed for years in various Alaskan ports including Kodiak, Dutch Harbor, St. Paul, and Akutan, with little impact on 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. Processors discharging fish waste are required to have 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.[4]

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).

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[4] Pers. comm., Dr. Bruce Duncan, U.S. Environmental Protection Agency, 701 C Street, Box 19, Anchorage, AK 99513)

Timber Harvest

Potential impacts include: increase in bedload suspended sediments and turbidity from construction of logging roads, in-water stream crossings, exposed slope erosion, removal of streamside vegetation; alter streamflow; introduce excessive nutrients, decrease large woody debris; increase streambank erosion; alter temperature, and have toxic effects on biota.

Forest road construction can destabilize slopes and increase erosion and sedimentation. This erosion occurs in two forms, as mass soil movement (i.e., landslides) and as surface erosion. Both types can introduce debris and sediment into adjacent streams for many years after initial construction. Erosion is most severe where poor construction practices are allowed, inadequate attention is paid to proper road drainage, and where construction occurs in inclement weather. After construction, unpaved logging roads can be a chronic source of sediment to streams. Juvenile salmon avoid habitat areas with suspended sediment (Bisson and Bilby 1982)

Stream crossings by forest roads may block fish migration. Culverts are often installed as an economical alternative to bridges, although bridges are usually less disruptive to the stream environment. Culverts are a serious threat to salmon unless specifically designed, installed, and maintained to accommodate fish passage.

Removal of streamside vegetation during timber harvest activities increases solar radiation to the stream and results in warmer water during summer, especially in small streams. The magnitude of temperature change depends on the amount of timber harvested adjacent to the stream (Meehan et al, 1969; Brown and Krygier, 1970) and time for regrowth of riparian areas. In Southeast Alaska, Meehan et al., (1969) found that maximum temperature in logged streams exceeded those of unlogged control streams by up to 5ºC, but the temperature did not reach lethal levels. The increased water temperature, however, frequently exceeded the optimum for pink and chum salmon documented by Reiser and Bjornn (1979).

High summer air temperature has been associated with adult salmon mortality. The Alaska Department of Fish and Game compiled a list of 43 streams that had mortality of pink and chum salmon in 1977 associated with high water temperature and low flow. The largest clear-cut in Alaska is located in the Staney Creek watershed. In 1979, 15,000 pink salmon died there before spawning, a result of warm water and low oxygen. In northern areas, the removal of riparian vegetation may cause lower stream temperature during winter, increasing the formation of frazil and anchor ice.

By removing vegetation, timber harvest temporarily reduces transpiration losses from the watershed, thereby elevating water content of soil and increasing run-off during base-flow periods. The elevated water content can reduce soil strength and destabilize slopes, causing increased sediment and debris inputs to streams (Swanston 1974). Sediment deposition in streams can reduce benthic community production (Culp and Davies, 1983) and can cause mortality of incubating salmon eggs and alevins, and habitat loss for juvenile salmon (Heifetz et al. 1996). Cumulative sedimentation from logging activities can significantly reduce the egg-to-fry survival of coho and chum salmon (Cederholm et al. 1981; Cederholm and reid 1987; Hartman et al. 1987). Where egg-to-fry survival is impaired by habitat deterioration escapement goals may have to be increased to offset the effect of decreased spawning success.

Converting large portions of old-growth forests to rapidly growing second-growth forests can permanently reduce summer stream flows and thus permanently reduce salmonid production (Myren and Ellis, 1984).

The studies of streams in second-growth forests have demonstrated that the input of large, potentially stable debris (logs and stumps) into salmon habitat from second-growth is reduced relative to inputs from old growth stands (Bisson et al. 1987). Further, the initial high productivity of prey organisms in streams running through open canopy (clear-cut) is short-lived and eventually the quantity of food organisms declines as the canopy closes (Sedell and Swanson, 1984).

Non-point Source Pollution and Urbanization

Potential impacts: 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 impacts 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 impacts 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 impacts 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 impacts 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), resuspending sediments, and increasing turbidity (Stolpe 1997; Goldsborough 1997).

Grounding tends to be an infrequent occurrence on fishery habitats such as seagrass beds and coral reefs. The degree of damage is related to the size of the grounded vessel. Large vessels that ground in shallow water seagrass beds may cause considerable localized damage especially when propeller force is used 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

Potential 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 9.1 Summary of non-fishing adverse impacts to essential fish habitat.

Table 9.1 (continued)

1.3.7.2 References

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1.3.8 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. This includes cumulative effects from fishing activities and non-fishing activities. Cumulative effects on EFH from fishing activities are 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 scallop habitats such as accretion of sediments from at-sea disposal areas, oil and gas exploration, sea floor mining, ice scouring and significant storm events. Also, water quality is a significant factor for healthy larval and juvenile life stages of mollusks. 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.

1.3.9 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

1.3.10 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.

1.3.11 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.

Scallops are non-burrowing filter feeders, subsisting primarily on phytoplankton.

1.3.12 Habitat Areas of Particular Concern

There are several habitat types in Alaska that meet all of the criteria specified in the interim final rule. These habitat types have important ecological functions, are sensitive and vulnerable to human impacts, and are relatively rare. A summary of these habitat types is provided below.

1.3.12.1 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.

1.3.12.2 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 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 to the 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 recolonize 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.

1.3.12.3 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.

1.3.13 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), nursery areas (i.e. rocky outcroppings and/or fine 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.
The level of knowledge about the distribution, biology, life history, population dynamics of pink, spiny and rock scallops in Alaska is very poor. For weathervane scallops, limited information about biology and life history is available, and information about distribution is relatively good for adults but poor for other life stages. Accordingly, evaluations of fishery management strategies and potential impacts on Essential Fish Habitat of Alaskan scallops are data-limited. Highest priority research areas include (1) scallop biology and life history including spawning timing, ocean conditions favorable to early life survival, specific habitat features that determine scallop bed locations, and predators, (2) estimation of recruitment, mortality, and growth rates, (3) stock assessments, (4) population dynamics, (5) estimation of biological reference points as harvest controls, and (6) effects of dredge gear on scallop stocks, other invertebrate and fish species, and benthic habitats.

1.3.14 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 for review during the annual SAFE report process. This information could be included in the "Ecosystems Considerations" chapter of the SAFE report.

1.4 Alaska State Management of the Scallop Fishery

1.4.1 Current State management regime

The primary pectinid harvested off Alaska is the weathervane scallop (Patinopecten caurinus). Since the early 1980's, between 4 and 20 vessels annually have participated in the Alaska scallop fishery. Gross earnings experienced by the fleet during this same period of time has ranged from almost $.9 million in 1983 to about $7 million in 1992. Between 1969 and 1991, about 40 percent of the annual landings of scallops from waters off Alaska were comprised of scallops harvested from State waters. Since 1991, however, scallop harvests have increasing occurred in Federal waters. In 1994, only 14 percent of the scallop landing came from State waters, with the remainder harvested in Federal waters off Alaska (Table 1). The State of Alaska has managed the scallop fishery in State and Federal waters, consistent with section 306(a)(3) of the Magnuson Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.), which allows a state to directly regulate any fishing vessel outside state waters if the vessel is registered under the law of that state.

Table 1. Percentage of Alaska scallop landings from State (within 3 miles) and Federal waters (3-200 miles), by year from 1990 through 1994.

Year	*State Waters*	*Federal waters*
1990	46.9	53.1
1991	37.9	62.1
1992	73.6	26.4
1993	23.9	76.1
1994	13.7	86.3

Source: ADF&G.

The Alaska Department of Fish and Game (ADF&G) initiated development of a management plan for the scallop fishery in response to overfishing concerns resulting from recent changes in the weathervane scallop fishery off Alaska. Weathervane scallops possess biological traits (e.g., longevity, low natural mortality rate, and variable recruitment) that render them vulnerable to overfishing. Record landings occurred in the late 1960's (about 1.8 million pounds shucked scallop meat), followed by a significant decline in catch through the 1970's and 1980's when landed catch ranged between 0.2 and 0.9 million pounds. The ADF&G believes this decline is due, in part, to reduced abundance of scallop stocks (Kruse, 1994). Landings since 1989 have increased to near record levels. During this period, the number of vessels fishing for scallops has not increased (about 10 - 15 vessels annually), although an increase in fishing power is evidenced by a substantial increase in average vessel length (from 84 feet registered length in 1981 to 110 feet in 1991), a predominance of full-time scallop vessels, and an increased number of deliveries. Until 1993, the State did not have a data collection program, although some indication exists that overfishing, or at least localized depletion may have occurred. Data voluntarily submitted by participants in the scallop fishery during the early 1990's showed that an increase in meat counts per pound has occurred, indicating that smaller scallops now account for a greater proportion of the harvest. These data also suggest that catch per unit of effort in traditional fishing grounds has decreased.

Limited age data suggest that the scallop stock historically exploited off west Kodiak Island experienced an age-structure shift from predominately age 7 and older scallops in the late 1960's to an age structure predominated by scallops less than age 6 during the early 1970's. This shift indicated that harvest amounts had exceeded sustainable levels. Changes in fleet distribution from historical fishing grounds primarily in State waters to previously unfished grounds in the EEZ compounded management concerns.

In response to these concerns, the ADF&G implemented a management plan for the scallop fishery in 1993-94 that established a total of nine fishery registration areas corresponding to the Southeastern, Yakutat, Prince William Sound, Cook Inlet, Kodiak, Alaska Peninsula, Dutch Harbor, Adak, and Bering Sea portions of the State. To prevent overfishing and maintain reproductive potential of scallop stocks, ADF&G established a guideline harvest range (GHR) for each of the traditional weathervane scallop fishing areas. In the absence of biomass estimates needed to implement an exploitation rate harvest strategy, the upper limit of the GHRs are specified as the long-term productivity (catch) from each of the traditional harvest areas.

The ADF&G may adjust GHRs based on changes in stock status, such as shifts in population size/age structure coupled to changes in area-specific catch-per-unit-effort. If a GHR for a registration area is not specified, ADF&G may authorize fishing for weathervane or other scallop species under special use permits that generally include location and duration of harvests, gear limitations and other harvest procedures, periodic reporting or logbook requirements, requirements for onboard observers, and scallop catch or crab bycatch limits.

The ADF&G also has implemented king and Tanner crab bycatch limits to constrain the mortality of Tanner crab and king crab incidentally taken by scallop dredge gear. Generally, crab limits are set at 1 percent of total crab population for those management areas where crab stocks are healthy enough to support a commercial fishery. In areas closed to commercial fishing for crab, the crab bycatch limits for the scallop fishery are set at 0.5 percent of the total crab population.

Specified waters are closed to fishing for scallops to prevent scallop dredging in biologically critical habitat areas, such as locations of high bycatch of crab or nursery areas for young fish and shellfish. State regulations also require each vessel to carry an observer at all times to provide timely data for monitoring scallop catches relative to GHRs and for monitoring crab bycatch. Observers also collect scientific data on scallop catch rates, size distribution and age composition. This information is required by ADF&G for potential adjustment of GHRs based on changes in stock status and productivity.

Last, ADF&G regulations establish gear specifications to minimize the catch of undersized scallops and efficiency controls to reduce the economic feasibility of harvesting scallops much smaller than sizes associated with optimum yield. Current efficiency controls include a ban on automatic shucking machines and a crew limit of 12 persons.

The 1995 scallop guideline harvest levels and crab bycatch limits, as well as 1994 - 1995 scallop harvest and crab bycatch amounts in each State registration area opened for harvest in 1994-95 are listed in Table 2. In 1994, vessels fished for scallops in the Bering Sea and Alaska Peninsula registration areas under special-use permits. These areas were closed in late summer due to crab bycatch. The 1994 scallop fisheries in other registration areas generally were closed based on the attainment of the guideline harvest level (GHL) (Table 2).

Table 2. Alaska State scallop registration areas from where scallops were harvested in 1994-95[1], Guideline Harvest Range (GHR) (lbs shucked meat), 1995 Tanner and king crab bycatch limits (number of crab), 1994 and 1995 scallop and crab catch amounts and season opening and closure dates.

Registration Area	*Guideline Harvest Range*	*Reported Harvest*	*Crab bycatch limits*		*Crab bycatch*		*1995 season open - closed dates*
			King	*Tanner*	*King*	*Tanner*	
Yakutat							1/10/95 - 2/14/95
1994	0 - 285,000	259,206	no crab limit				
1995	0 - 285,000	245,000[2]	no crab limit				
Prince William Sound							
1994 (no fishery)	0 - 50,000	0		630			1/10/95 - 1/26/95
1995	0 - 50,000	48,000[2]		630		69[2]	
Cook Inlet							8/15/95 -
1994	0 - 20,000	20,431					
Kodiak							7/1/95 -
1994	0 - 400,000	381,850	283	199,500			
Alaska Peninsula							7/1/95 -
1994	permit	66,412	85	52,530	0	26,379	
Dutch Harbor							7/1/95 -
1994	0 - 170,000	1,931	45	50,500			
Bering Sea							7/1/95 -
1994	permit	505,439	17,000	260,000	55	262,500	

Source: ADF&G

[1]The Southeastern registration area is closed to fishing and no harvests were reported from the Adak registration area.
[2]Scallop catch and crab bycatch amounts do not include unreported amounts taken by the catcher/processor vessel fishing in the management area outside of State jurisdiction.

1.4.2 Impact of Federal regulations on State management activities

A primary objective of the FMP is to establish and maintain consistent management efforts at the State and Federal levels. To the extent practicable, NMFS will coordinate with ADF&G to maintain uniform management measures throughout the EEZ that are consistent with the objectives of the FMP and the Magnuson Act. Nothing in this FMP is intended to preempt State of Alaska scallop regulations set out under Chapter 38 of the Alaska Administrative Code for vessels fishing for scallops in Federal waters off Alaska which are registered under the laws of the State.

2.0 PROCEDURES FOR FMP IMPLEMENTATION

The Secretary (through the Council and NMFS) and the State of Alaska have established the following protocol which describes the roles of the Federal and State governments in managing the scallop fishery off Alaska.

1. The Council will maintain the FMP (and develop future amendments) to govern management of the scallop fisheries in Federal waters off Alaska. The FMP prescribes objectives and any management measures found by the Secretary to be necessary for effective management. The State will promulgate regulations applicable to all vessels fishing for scallops in Federal waters that are consistent with the FMP, Magnuson-Stevens Act, and other applicable Federal law. The FMP contains two categories of management measures: (1) General management measures delegated to the State for implementation that may be freely adopted or modified by the State, subject to other Federal law, and (2) Limited access management measures that are fixed in the FMP, implemented by Federal regulation, and require an FMP amendment to change.

2. If at any time the Secretary determines that a State law or regulation applicable to a vessel fishing for scallops in Federal waters is not consistent with the FMP, the Secretary shall promptly notify the State and the Council of such determination and provide an opportunity for the State to correct any inconsistencies identified in the notification. If, after notice and opportunity for corrective action, the State does not correct the inconsistencies identified by the Secretary, the delegating of authority granted to the State under this FMP shall not apply until the Secretary and the Council find that the State has corrected the inconsistencies.

3. ADF&G will have responsibility for developing the information upon which to base State fishing regulations, with continued assistance from NMFS. In carrying out this responsibility, ADF&G will consult actively with the NMFS (Alaska Regional Office and Alaska Fisheries Science Center), NOAA General Counsel, the plan team, and other fishery management or research agencies in order to prevent duplication of effort and assure consistency with the Magnuson-Stevens Act, the FMP, and other applicable Federal law.

4. An annual area management report discussing current biological and economic status of the fisheries, GHL ranges, and support for different management decisions or changes in harvest strategies will be prepared by the State (ADF&G lead agency), with NMFS and scallop plan team input incorporated as appropriate. This report will be available for public review.

5. Federal enforcement agents (NOAA) and the U.S. Coast Guard (DOT) shall work in cooperation with the State to enforce scallop fishing regulations in the EEZ off Alaska.

2.1 Management Objective

The objective of the FMP is to prevent localized overfishing of scallop stocks and protect the long term productivity of the resource to allow for the achievement of optimum yield on a continuing basis. This objective is based on the premise that uncontrolled fishing for scallops in Federal waters could result in irreversible damage to the resource's ability to recover in a reasonable period of time. Fishing on a stock at a level that severely compromises that stock's future productivity is counter to the goals of the Magnuson Act and seriously jeopardizes the opportunity to harvest optimum yield on a continuing basis under a future management regime that would authorize a regulated fishery for scallops in Federal waters. Conservative management of the scallop resource is warranted given (1) unprecedented activity of vessels fishing for scallops in Federal waters outside the jurisdiction of Alaska State regulations, (2) the harvesting and processing capacity of the scallop fleet, which, if allowed to fish unregulated in Federal waters, could exceed State harvest guidelines by several orders of magnitude, (3) inadequate data on stock status and biology, and (4) the vulnerability of the scallop resource to localized depletion.

The management program authorized under this FMP conforms to the Magnuson Act's national standards as listed in Appendix B. Under this FMP, the prevention of overfishing of the Alaska scallop stocks and the maintenance of adequate reproductive potential for the scallop resource takes precedence over other economic, social, management and research considerations.

2.2 Management Areas

For the purpose of managing the scallop fishery, the FMP area is divided into nine scallop registration areas (Figure 4) composed of the Federal waters and adjacent State waters described in each area. These areas are identical to the State of Alaska scallop registration areas set out at 5 AAC 38.076(b). The Yakutat, Cook Inlet, and Kodiak Registration Areas are further divided into districts.

2.3 Registration Areas

Registration Area A (Southeastern Alaska) has as its southern boundary the International Boundary at Dixon Entrance, and as its northern boundary Loran-C line 7960-Y-29590, which intersects the western tip of Cape Fairweather at 58° 47' 58" N. lat., 137° 56' 30" W. long., except for ADF&G District 16 defined as all waters north of a line projecting west from the southernmost tip of Cape Spencer and south of a line projecting southwest from the westernmost tip of Cape Fairweather.

Registration Area D (Yakutat) has as its western boundary the longitude of Cape Suckling (143° 53' W. long.), and as its southern boundary Loran-C line 7960-Y-29590, which intersects the western tip of Cape Fairweather at 58° 47' 58" N. lat., 137° 56' 30" W. long., and ADF&G District 16 defined as all waters all waters north of a line projecting west from the southernmost tip of Cape Spencer and south of a line projecting southwest from the westernmost tip of Cape Fairweather.

Registration Area E (Prince William Sound) has as its western boundary the longitude of Cape Fairfield (148° 50' W. long.), and its eastern boundary the longitude of Cape Suckling (143° 53' W. long.).

Registration Area H (Cook Inlet) has as its eastern boundary the longitude of Cape Fairfield (148° 50' W. long.) and its southern boundary the latitude of Cape Douglas (58° 52' N. lat.).

Northern District: north of a line extending from Boulder Point at 60 46' 23" N. lat., to Shell Platform C, then to a point on the west shore at 60° 46' 23" N. lat.

Central District: all waters between a line extending from Boulder Point at 60° 46' 23" N. lat., to Shell Platform C, to a point on the west shore at 60° 46' 23" N. lat., and the latitude of Anchor Point Light (59° 46' 12" N. lat.).

Southern District: all waters enclosed by a line from Anchor Point Light west to 59° 46' 12" N. lat., 152° 20' W. long., then south to 59° 03' 25" N. lat., 152° 20' W. long., then in a northeasterly direction to the tip of Cape Elizabeth at 59° 09' 30" N. lat., 151° 53' W. long., then from the tip of Cape Elizabeth to the tip of Point Adam at 59° 15' 20" N. lat., 151° 58' 30" W. long.

Kamishak Bay District: all waters enclosed by a line from 59° 46' 12" N. lat., 153° 00' 30" W. long., then east to 59° 46' 12" N. lat., 152° 20' W. long., then south to 59° 03' 25" N. lat., 152° 20' W. long., then southwesterly to Cape Douglas (58° 52' N. lat.). The seaward boundary of the Kamishak Bay District is three nautical miles seaward from the shoreline between a point on the west shore of Cook Inlet at approximately 59° 46' 12" N. lat., 153° 00' 30" W. long., and Cape Douglas at approximately 58° 52' N. lat., 153° 15' W. long., including a line three nautical miles seaward from the shorelines of Augustine Island and Shaw Island, and including the line demarking all state waters shown on National Oceanic and Atmospheric Administration nautical chart number 16640, 21st Ed., May 5, 1990.

Barren Island District: all waters enclosed by a line from Cape Douglas (58° 52' N. lat.) to the tip of Cape Elizabeth at 59° 09' 30" N. lat., 151° 53' W. long., then south to 58° 52' N. lat., 151° 53' W. long., then west to Cape Douglas.

Outer District: all waters enclosed by a line from the tip of Point Adam to the tip of Cape Elizabeth, then south to 58° 52' N. lat., 151° 53' W. long., then east to the longitude of Aligo Point (149° 44' 33" W. long.), then north to the tip of Aligo Point.

Eastern District: all waters east of the longitude of Aligo Point (149° 44' 33" W. long.), west of the longitude of Cape Fairfield (148° 50' W. long.), and north of 58° 52' N. lat.

Registration Area K (Kodiak) has as its northern boundary the latitude of Cape Douglas (58° 52' N lat.), and as its western boundary the longitude of Cape Kumlik (157° 27' W. long.).

Northeast District: all waters northeast of a line extending 168° from the easternmost tip of Cape Barnabas, east of a line from the northernmost tip of Inner Point to the southernmost tip of Afognak Point, east of 152° 30' in Shuyak Strait, and east of the longitude of the northernmost tip of Shuyak Island (152° 20' W. long.).

Southeast District: all waters southwest of a line extending 168° from the easternmost tip of Cape Barnabas and east of a line extending 222° from the southernmost tip of Cape Trinity.

Southwest District: all waters west of a line extending 222° from the southernmost tip of Cape Trinity, south of a line from the westernmost tip of Cape Ikolik to the southernmost tip of Cape Kilokak and east of the longitude of Cape Kilokak (156° 19' W. long.).

Semidi Island District: all waters west of 156° 19' W. long. at Cape Kilokak and east of the longitude of Cape Kumlik at 157° 27' W. long.

Shelikof District: all waters north of a line from the westernmost tip of Cape Ikolik to the southernmost tip of Cape Kilokak, west of a line from the northernmost tip of Inner Point to the southernmost tip of Afognak Point, west of 152° 30' W. long., in Shuyak Strait, and west of the longitude of the northernmost tip of Shuyak Island (152° 20' W. long.).

Registration Area M (Alaska Peninsula) has as its eastern boundary the longitude of Cape Kumlik (157° 27' W. long.), and its western boundary the longitude of Scotch Cap Light. The registration area also includes all waters of Bechevin Bay and Isanotski Strait south of a line from the easternmost tip of Chunak Point to the westernmost tip of Cape Krenitzen.

Registration Area O (Dutch Harbor) has as its northern boundary the latitude of Cape Sarichef (54° 36' N. lat.), as its eastern boundary the longitude of Scotch Cap Light, and as its western boundary 171° W. long., excluding the waters of Statistical Area Q.

Registration Area Q (Bristol Bay-Bering Sea) has as its southern boundary a line from Cape Sarichef (54° 36' N. lat.), to 54° 36' N. lat., 171° W. long., to 55° 30' N. lat., 171° W. long., to 55° 30' N. lat., 173° 30' E. long., as its northern boundary the latitude of Point Hope (68° 21' N. lat.).

Registration Area R (Adak) has as its eastern boundary 171° W. long., and as its northern boundary 55° 30' N. lat.

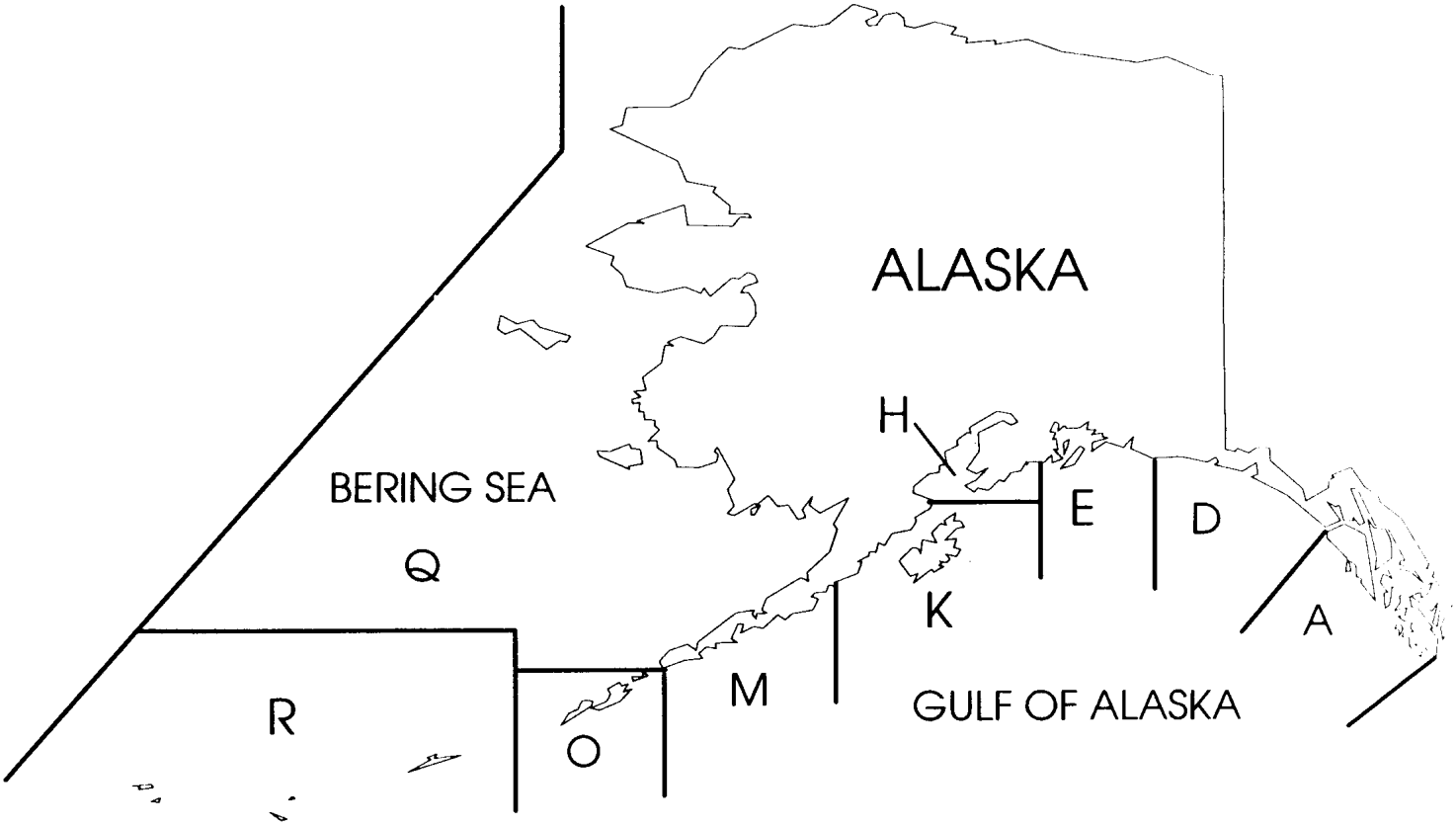

Figure 4. Scallop Registration Areas

2.4 Framework Measures

The Council may control the scallop fishery by quotas, for target and crab bycatch species, fishing seasons, gear restrictions, processing efficiency restrictions, area closures, and observer coverage requirements.. The measures authorized for management of scallops under the FMP fall into two categories: Framework measures and conventional measures. Framework measures often require frequent adjustment on an annual basis, for example, the setting of the annual yield to fall within the OY range or the establishment of crab bycatch limits. 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.

2.4.1 Setting harvest limits

In areas of Alaska where the scallop fishery has traditionally occurred, ADF&G has established annual guideline harvest levels (GHLs) which are equivalent to total allowable catch (TAC) amounts. These areas include all or parts of Scallop Registration Areas A (Southeast), D (Yakutat), E (Prince William Sound), H (Cook Inlet), K (Kodiak) and O (Dutch Harbor). In areas where crab bycatch is of concern, ADF&G has also established bycatch limits for red king crab and Tanner crab species. These areas include all or parts of Scallop Registration Areas K (Kodiak), M (Alaska Peninsula), O (Dutch Harbor), Q (Bering Sea) and R (Adak). In areas where an adequate historic scallop catch record does not exist (areas M, Q and R) ADF&G has not established GHLs and has managed the fishery on the basis of crab bycatch limits alone.

NMFS and the Council will, to the extent possible, coordinate with ADF&G in the establishment of TAC amounts and crab bycatch limits (CBLs) that are consistent with current State harvest limits. TAC amounts and CBLs will apply to both the Federal and State waters within each scallop registration area so that the fishery in each registration area is managed as a unit throughout its range. The following procedure has been established for setting annual harvest levels:

1. The State of Alaska, at the March Board of Fish meeting, will, after notice and opportunity for public testimony and comment, propose scallop TAC amounts and CBLs for review by the Council.

2. After the March Board of Fish meeting, the Council will distribute a summary of the preliminary recommendations and their basis to the public through its mailing list, as well as provide copies of the information at the Council office and to the public upon request. The Council will notify the public of its intent to develop final recommendations at the next Council meeting (usually April) and solicit public comment both before and during its next meeting.

3. Following the April Council meeting, the Council will submit its TAC and CBL recommendations along with the rationale and supporting information to NMFS for review and implementation.

4. As soon as practicable after receiving recommendations from the Council, NMFS will publish in the Federal Register annual specifications of TAC amounts and CBLs for the succeeding 12-month period extending from July 1 through June 30 of the following year.

2.4.2 Total allowable catch (TAC)

2.4.2.1 Registration Areas A, D, E, H, K and O

The annual TAC amounts specified for scallops in registration areas A, D, E, H, K, and O shall be established as a weight in pounds of shucked scallop meats based on a review of the following:

1. Assessments of the biological condition of each scallop species. Assessment will include, where practicable, updated estimates of MSY and ABC; historical catch trends and current catch statistics, assessments of alternative harvesting strategies; and relevant information relating to changes in scallop markets.

2. Socioeconomic considerations that are consistent with the goals and objectives of the FMP.

2.4.2.2 Registration Areas M, R, and Q

The annual TAC amounts of scallops in Registration Areas M, R, and Q shall be equal to the weight in pounds of shucked scallop meats harvested under the CBLs specified for these areas.

2.4.2.3 Time periods

Annual scallop TAC amounts will be specified for the time period extending from July 1 through June 30 of the following year.

2.4.3 Crab bycatch limits (CBLs)

Annual CBLs may be specified for red king crab and Tanner crab species in each registration area or district thereof.

2.4.3.1 Registration Area Q

The annual CBLs in Registration Area Q shall equal the following amounts:

1. The CBL of red king crab caught while conducting any fishery for scallops shall be within the range of 500 to 3,000 crab based on the considerations listed in paragraph 2.4.3.2.

2. The CBL of C. opilio Tanner crab caught while conducting any fishery for scallops is 0.003176 percent of the most recent estimate of C. opilio abundance in Registration Area Q.

3. The CBL of C. bairdi Tanner crab caught while conducting any fishery for scallops is 0.13542 percent of the most recent estimate of C. bairdi abundance in Registration Area Q.

2.4.3.2 All other registration areas

Except as provided for under 2.4.3.1, CBLS will be based on the biological condition of each crab species, historical bycatch rates in the scallop fishery, and other socioeconomic considerations that are consistent with the goals and objectives of the FMP.

2.4.3.3 Time period for CBLs

Annual CBLs will be specified for the time period from July 1 through June 30 of the following year.

2.4.4 American Fisheries Act (AFA) sideboard restrictions

On October 21, 1998, the President signed into law the American Fisheries Act (AFA) which mandated sweeping changes to the conservation and management program for the pollock fishery of the BSAI and to a lesser extent, affected the management programs for the other groundfish fisheries of the BSAI, the groundfish fisheries of the GOA, the king and Tanner crab fisheries of the BSAI, and the scallop fishery off Alaska. With respect to the fisheries off Alaska, the AFA requires a suite of new management measures that fall into four general categories: (1) regulations that limit access into the fishing and processing sectors of the BSAI pollock fishery and that allocate pollock to such sectors, (2) regulations governing the formation and operation of fishery cooperatives in the BSAI pollock fishery, (3) sideboard regulations to protect other fisheries from spillover effects from the AFA, and (4) regulations governing catch measurement and monitoring in the BSAI pollock fishery.

While the AFA primarily affects the management of the BSAI pollock fishery, the Council is also directed to develop and recommend harvesting and processing sideboard restrictions for AFA catcher vessels that are fishing for scallops in the EEZ off Alaska. Section 211 of the AFA addresses sideboard protections for other fisheries off Alaska and this entire section of the AFA is incorporated into the AFA by reference. Scallop harvesting sideboard restrictions that are consistent with Section 211 of the AFA will be implemented through regulation or provided to the Board of Fish as recommendations. Any measure recommended by the Council that supersedes Section 211 of the AFA must be implemented by FMP amendment in accordance with the provisions of Section 213 of the AFA and the Magnuson-Stevens Act.

2.4.4.1 Limits on participation by AFA vessels. NMFS may issue regulations, as approved by the Council, which define the participation criteria for AFA vessels that wish to participate in the scallop fishery off Alaska.

2.4.4.2 Harvest limitations for AFA Vessels. The Council may provide scallop harvesting sideboard recommendations to the Board of Fisheries. The State of Alaska, through the Board if Fisheries, may issue regulations to establish an allowable harvest percentage of the GHL by AFA eligible vessels in any scallop fishery, and to govern the in-season management of any sideboard harvest levels established for AFA eligible vessels.

2.4.5 Notices of closure

If the Regional Director determines that a TAC amount or CBL has been or will be reached, NMFS will publish a notice in the Federal Register declaring that the taking or retention of scallops is prohibited in the area or part thereof where the notice is applicable.

2.4.6 Inseason adjustments

Inseason adjustments may be issued by NMFS to implement the closure, extension, or opening of a season in all or part of a scallop registration area; and the adjustment of TAC amounts and CBLs.

2.5 Conventional Measures

Conventional measures are specific in their application and can only be changed by amendment to the FMP. Conventional measures are not anticipated to require frequent adjustment and include catch restrictions, area closures, seasons, gear restrictions, efficiency limits, and observer requirements.

2.5.1 Catch restrictions

This FMP authorizes the commercial harvest of scallops species listed in Chapter 1.3 of this plan. It is prohibited for a person to take or retain scallops in any registration area unless the season for that species within those waters is open. It is prohibited for a person to possess, purchase, barter, sell, or transport scallops if that person knows or has reason to know that such shellfish were taken or possessed in contravention of this FMP.

2.5.2 Prohibited Species

It is prohibited to retain any species of salmon, halibut, king crab, Tanner crab, and herring. Species identified as prohibited must be avoided while fishing and must be immediately returned to the sea with a minimum of injury when caught and brought aboard.

2.5.3 Gear Limitations

The following gear restrictions apply to the taking of scallops under this FMP:

1. A vessel fishing for weathervane scallops (Patinopectin caurinus) may use or carry only scallop dredges with rings having an inside diameter of four inches (10.16 cm) or larger.

2. A vessel fishing for scallops other than weathervane scallops may use or carry only scallop dredges with rings having an inside diameter of three inches (7.62 cm) or larger.

3. A person may not use chafing gear or other devices that decrease the legal inside ring diameter of a scallop dredge.

4. No more than two scallop dredges may be operated at one time from a vessel, and the opening of a scallop dredge may not be more than 15 feet (4.57 meters) wide.

5. In the Kamishak, Southern, and Central Districts of Scallop Registration Area H, scallops may be taken only with a single dredge. The opening of a dredge may not be more than six feet (1.87 meters) in width.

2.5.4 Efficiency limits

1. Scallops may be shucked by hand only. A mechanical shucking machine must not be on board a vessel that is fishing for scallops.

2. A vessel that is fishing for scallops may have on board no more than 12 persons who are crew members of the vessel. Crew member means a person who is involved with the operations of the

vessel, and includes a captain, mate, engineer, cook, deckhand and processing worker, but does not include an ADF&G or NMFS observer.

2.5.5 Closed areas

Regulations implementing the FMP may include time and area closures designed to minimize crab bycatch and protect crab habitat. Closed areas will be specified in regulations.

2.5.6 Seasons

Scallops may be taken in Scallop Registration Areas D and E from 12 noon A.l.t., January 10 until 12 midnight, December 31, subject to the other provisions of the FMP.

Scallops may be taken in Scallop Registration Areas K, M, O, Q and R from 12 noon A.l.t., July 1 through 12 noon A.l.t., February 15 of the following year, subject to the other provisions of the FMP.

Scallops may be taken in the Kamishak District of Scallop Registration Area H from 12 noon A.l.t., August 15 through 12 noon A.l.t., October 31. In other districts of Scallop Registration Area H, scallops may be taken from 12 noon, January 1 until 12 midnight, December 31, subject to the other provisions of the FMP.

2.5.7 Observer requirements

Scallop vessels fishing in the GOA or BSAI must carry an NMFS or ADF&G-certified scallop observer when required to do so. Observer coverage requirements for these vessels will be specified in regulations. No one shall forcibly assault, resist, impede, intimidate, or interfere with an observer placed aboard a fishing vessel under this FMP.

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3.0 MANAGEMENT GOALS AND OBJECTIVES

The Council, in cooperation with the State, is committed to developing a long-range plan for managing the scallop fishery that will promote a stable regulatory environment for the seafood industry and maintain the health of the resources and environment. The management system conforms to the Magnuson-Stevens Act's national standards as listed in Appendix B.

3.1 Management Goal

The management goal is to maximize the overall long-term benefit to the nation of scallop stocks by coordinated Federal and State management, consistent with responsible stewardship for conservation of the scallop resource and its habitats.

3.2 Management Objectives

Within the scope of the management goal, seven specific objectives have been identified. These relate to stock condition, economic and social objectives of the fishery, gear conflicts, habitat, weather and ocean conditions affecting safe access to the fishery, access of all interested parties to the process of revising this FMP and any implementing regulations, and necessary research and management. Each of these objectives requires relevant management measures. Several management measures may contribute to more than one objective, and several objectives may mesh in any given management decision on a case-by-case basis.

3.2.1 Biological Conservation Objective: Ensure the long-term reproductive viability of scallop populations.

To ensure the continued reproductive viability of each scallop population through protection of reproductive potential, management must prevent overfishing. Management measures also may be adopted to address other biological concerns such as restricting harvest of scallops during spawning periods and maintaining low bycatch of finfish and crab. The maintenance of adequate reproductive potential in each scallop stock will take precedence over economic and social considerations.

3.2.2 Economic and Social Objective: Maximize economic and social benefits to the nation over time.

Economic benefits are broadly defined to include, but are not limited to: profits, income, employment, benefits to consumers, and less tangible or less quantifiable social benefits such as the economic stability of coastal communities. To ensure that economic and social benefits derived for fisheries covered by this FMP are maximized over time, the following will be examined in the selection of management measures:

1. The value of scallops harvested during the season for which management measures are considered,

2. The future value of scallop stocks,

3. Economic impacts on coastal communities.

This examination will be accomplished by considering, to the extent that data allow, the impact of management alternatives on the size of the catch during the current and future seasons and their associated

prices, harvesting costs, processing costs, employment, the distribution of benefits among members of the harvesting, processing and consumer communities, management costs, and other factors affecting the ability to maximize the economic and social benefits as defined in this section.

Social benefits are tied to economic stability and impacts of commercial fishing associated with coastal communities. While social benefits can be difficult to quantify, economic indices may serve as proxy measures of the social benefits which accrue from commercial fishing. In 1984, 7 percent of total personal income or 27 percent of total personal income in the private sector in Alaska was derived from commercial fishing industries. On a statewide basis, shellfish accounted for 21 percent of the total exvessel value of commercial fish harvested in Alaska in 1984, however, the bulk of shellfish harvests were king and Tanner crab.

3.2.3 Gear Conflict Objective: Minimize gear conflict among fisheries.

Management measures developed for the scallop fisheries will take into account the interaction of those fisheries, and the people engaged in them, with other fisheries. To minimize gear conflict among fisheries, the compatibility of different types of fishing gear and activities on the same fishing grounds should be considered. Scallop fisheries are conducted with dredge gear. Many other fisheries in the fishery management unit are conducted with fixed gear (pot and hook-and-line). Fishing seasons, gear storage, and fishing areas may be arranged to eliminate, insofar as possible, conflicts between gear types and preemption of fishing grounds by one form of gear over another.

3.2.4 Habitat Objective: To protect, conserve, and enhance adequate quantities of EFH to support a fish population and maintain a healthy ecosystem

Habitat is defined as the physical, chemical, geological, and biological surroundings the support healthy, self-sustaining populations of living marine resources. Habitat includes both the physical component of the environment which attracts living marine resources (e.g. salt marshes, sea grass beds, coral reefs, intertidal lagoons, and near shore characteristics) and the chemical (e.g. salinity, benthic community) and biological characteristics (e.g. marine and salmonid life stage histories, oceanography) that are necessary to support living marine resources. The quality and availability of habitat supporting the scallop populations are important. Fishery managers should strive to ensure that those waters and substrate necessary to scallops for spawning, breeding, feeding, or growth to maturity are available. It is also important to consider the potential impact of scallop fisheries on other fish and shellfish populations. The essential fish habitat of Alaskan scallops, and the potential effects of changes in that EFH on the fishery, are described in sections 1.3.5 through 1.3.14 of this FMP.

Those involved in both management and exploitation of scallop resources will actively review actions by other human users of the management area to ensure that their actions do not cause deterioration of habitat. Any action by a State or Federal agency potentially affecting scallop habitat in an adverse manner may be reviewed by the Council for possible action under the Magnuson-Stevens Act. The Council will also consider the effect on scallop habitat of its own management decisions in other fisheries.

3.2.5 Vessel Safety Objective: Provide public access to the regulatory process for vessel safety considerations.

Upon request, and when appropriate, the Council and the State shall 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 vessels.

3.2.6 Due Process Objective: Ensure that access to the regulatory process and opportunity for redress are available to all interested parties.

In order to attain the maximum benefit to the nation, the interrelated biological, economic and social, habitat, and vessel safety objectives outlined above must be balanced against one another. A continuing dialogue between fishery managers, fishery scientists, fishermen, processors, consumers, and other interested parties is necessary to keep this balance. Insofar as is practical, management meetings will be scheduled around fishing seasons and in places where they can be attended by fishermen, processors, or other interested parties.

Access to the FMP development and regulatory process is available through membership in a Council work group, testimony on the record before the Council's Advisory Panel or SSC, or before the Council itself, testimony before the Board, conversations with members of the plan team or officials of regulatory agencies, and by commenting on the FMP, any subsequent amendments and any regulations proposed for their implementation.

This FMP defers much of day-to-day scallop management to the State. Means of access to the regulatory process at the State level and of redress of perceived wrongs by the State are necessary. Appendix C describes the State management system and mechanisms for public input.

3.2.7 Research and Management Objective: Provide fisheries research, data collection, and analysis to ensure a sound information base for management decisions.

Necessary data must be collected and analyzed in order to measure progress relative to other objectives and to ensure that management actions are adjusted to reflect new knowledge. Achieving the objective will require new and ongoing research and analysis relative to stock conditions, dynamic feedback to market conditions, and adaptive management strategies.

An annual area management report discussing current biological and economic status of the fisheries, GHL ranges, and support for different management decisions or changes in harvest strategies will be prepared by the State (ADF&G lead agency), with NMFS and scallop plan team input when appropriate. Such information will be made available to the public.

4.0 OPTIMUM YIELD AND OVERFISHING

According to the Magnuson-Stevens Act, a fishery management plan for scallops must specify an optimum yield (OY) for the scallop fishery. The OY for a fishery means the amount of fish which will provide the greatest overall benefit to the nation, with particular reference to food production and recreational activities. The OY is specified on the basis of the maximum sustainable yield from the fishery, as modified by any relevant economic, social, or ecological factors. The national standard 1 guidelines (50 CFR 600.310) state that the most important limitation on the specification of OY is that the choice of OY, and the conservation and management measures proposed to achieve it, must prevent overfishing. If a stock or stock complex becomes overfished, OY provides for rebuilding to the MSY level.

Overfishing is a level of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis. The definition of overfishing for a stock or stock complex may be expressed in terms of maximum level of fishing mortality or minimum stock size threshold. Overfishing must be defined in a way to enable the Council and the Secretary to monitor and evaluate the condition of the stock or stock complex relative to the definition. Overfishing definitions must be based on the best scientific information available and reflect appropriate consideration of risk. Risk assessments should take into account uncertainties in estimating harvest levels, stock conditions, or the effects of environmental factors.

4.1 Assessment of the available scientific data

The State of Alaska's draft fishery management plan for scallops (Kruse, 1994) presents a succinct summary of the best scientific data available on Alaska scallop life history traits and other biological parameters that should be considered in assessing an appropriate concept of MSY, OY, and overfishing for the scallop fishery. Pertinent portions of the State's management plan addressing current management concerns about recruitment overfishing and sustainable yield are incorporated in this FMP and are repeated below as follows:

Recruitment Overfishing

Definition. It is widely accepted that fishery harvest levels should be prescribed in ways to prevent "recruitment overfishing"--the condition that occurs when stocks are reduced to levels too low to produce adequate numbers of young scallops--the future recruits to the fishery (Gulland 1983). Recruitment is a prerequisite for maintenance of a viable population, and is needed for sustainable harvests that support long-term economic benefits from the fishery.

Worldwide History of Scallop Overfishing. Although there are a number of cases of scallop fisheries that have been sustainable over long time periods....overfishing has occurred in many, if not most, scallop fisheries worldwide...Stock recovery has been either slow or non-existent. Attempts to develop aquaculture in many countries ... are largely attributable to the collapse of natural populations [Kruse (1994) provides examples of numerous cases of scallop overfishing that are not repeated here]. . .

Implications of Stock Structure. Prevention of overfishing requires knowledge about a species stock structure and the biological productivity of each stock. For species with populations that are well-connected by extensive larval drift, risk of overfishing is relatively low at least on an area-specific level. In such cases, local depletions can be replenished by settlement of larvae carried by ocean currents from spawning stocks located elsewhere. However, as described in section [1.3.4], a growing body of evidence indicates that many

benthic invertebrates, such as scallops, exist as a number of discrete, self-sustaining populations. To prevent overfishing for species with such a population structure, it is necessary to manage each stock separately (Caddy 1989; Fevolden 1989; Sinclair et al. 1985.)

Unfortunately, the stock structure of weathervane scallops in Alaska is not well understood. Studies of genetic structure and comparative population characteristics (e.g., growth rate, gonadal somatic index) are needed to resolve uncertainties. In the absence of such information, a reasonable and conservative approach is to assume that each major fishing area compromises a separate stock (Caddy 1989; Sinclair et al. 1985). However, even with this approach, the possibility exists that multiple self-sustaining populations exist within a fishing area. For example, the apparent existence of separate self-sustaining populations of sea scallops on the Northern Edge and Northeast Peak of Georges Bank (Tremblay and Sinclair 1992; McGarvey et al. 1993) is somewhat unexpected given ocean currents and proximity of these areas to other scallop fishing grounds on Georges Bank.

Importance of Spawning Stock Biomass. Even after scallop stocks have been defined, overfishing will occur unless fishing mortality is limited to a level commensurate with the productivity of each stock based on life history and other biological characteristics. Worldwide, scallop populations are characterized by recruitment variability....Often, scallop populations are dominated by a few strong year classes that are separated by long periods of poor recruitment... Potential stock-recruitment relationships have not been well studied for scallops. A recent study by McGarvey et al. (1993) provides a rare example with good evidence of a relationship between spawning stock (total egg production) and recruitment for sea scallops on Georges Bank. In that instance, higher egg production was directly related to higher recruitment.

[Conversely], it is commonly assumed that scallop recruitment is linked to environmental conditions (Hanock 1973)... However, even when recruitment of a marine species is primarily driven by environmental effects, it is commonly held that parental spawning biomass affects recruitment, at least at low population sizes...Recently, Peterson and Summerson (1992) showed that the bay scallop (Argopecten irradians concentricus) was recruitment limited due to reduced abundance of adults caused by a red tide (Ptychodiscus brevis) outbreak. In relating their findings to fishery management, the authors noted that a common assumption of shellfish fisheries management was that fishing pressure on adults will not adversely affect subsequent recruitment. Peterson and Summerson (1992) concluded that this assumption was unjustified.

Sustainable Yield

Ideally, an appropriate harvest rate is developed from yield models based on a species' life history traits and other biological parameters. Then, annual catches are specified by applying these harvest rates to annual biomass estimates derived from stock assessment surveys. Unfortunately, limited information on biological productivity is available for weathervane scallops to promote the conservation of stocks and sustained yields of the fishery. Biomass estimates are unavailable and yield models have not been developed.

In Alaska, most available information was collected during the early years of the fishery (Haynes and Powell 1968; Hennick 1970b, 1973), although it has been summarized more recently by Kaiser (1986). In the early 1950's the Bureau of Commercial Fisheries began systematic surveys to determine whether commercial quantities were available. The only assessment survey since 1972 was conducted in 1984 in lower Cook Inlet (Hammarstrom and Merritt 1985). Likewise, until the implementation of [the State's] onboard observer program in 1993, there have been no routine biological or fishery sampling programs conducted on weathervane scallops in Alaska.

Implications of Natural Mortality Rate. Natural mortality is one of the biological reference points commonly used in fisheries management to establish appropriate exploitation rates (Clark 1991). As discussed in section [1.3.3], the longevity (28 years) of weathervane scallops in Alaska implies that this species experiences a very low natural mortality rate (M = 0.13 percent annual mortality). The biological reference point, obtained by setting instantaneous fishing mortality (F) equal to M, implies that scallop harvest rates should not exceed 13 percent annually on any given stock. Unfortunately, other potentially useful benchmarks that would bear on the choice of appropriate exploitation rates for weathervane scallops are not presently available.

The biological reference point, F=M=0.13, implies that weathervane scallop stocks are at greater risk of overfishing than red king crab (Paralithodes camtschaticus) and Tanner crab (Chionoecetes bairdi) for which M=0.2 and M=0.3, respectively (NPFMC 1998). Also, unlike many crab stocks off Alaska, stock assessments of weathervane scallop biomass have not been made. Given these two observations, maintenance of healthy weathervane scallop stocks poses a serious challenge to fishery managers.
Implications of Natural Mortality Rate. Natural mortality is one of the biological reference points commonly used in fisheries management to establish appropriate exploitation rates (Clark 1991). As discussed in section [1.3.3], the longevity (28 years) of weathervane scallops in Alaska implies that this species experiences a very low natural mortality rate (M approximates 0.16 or 15 percent annual mortality). The biological reference point, obtained by setting instantaneous fishing mortality (F) equal to M, implies that scallop harvest rates should not exceed 15 percent annually on any given stock. Unfortunately, other potentially useful benchmarks that would bear on the choice of appropriate exploitation rates for weathervane scallops are not presently available. A study of alternatives in is progress [by the ADF&G].

The biological reference point, F=M=0.16, implies that weathervane scallop stocks are at greater risk of overfishing than red king crab (Paralithodes camtschaticus) and Tanner crab (Chionoecetes bairdi) for which an M=0.3 has been estimated (NPFMC 1990). Also, unlike many crab stocks [off Alaska], there are not stock assessments of weathervane scallop biomass. Given these two observations, maintenance of healthy weathervane scallop stocks poses a serious challenge to fishery managers.

Implications of Recruitment Variability. Large annual fluctuations in recruitment, typical of scallop populations, have management implications. Weathervane scallops spawn annually after reaching maturity at age 3 or 4. This feature of multiple spawning (termed *iteroparity*) is likely to be an evolutionary response to environmentally-induced recruitment variations (Murphy 1968). Iteroparous species, with highly variable recruitment, are particularly vulnerable to overfishing when high levels of harvest create a recruit-only fishery.

Murphy (1967) simulated the effects of fishing on Pacific sardine (Sarinops sagax) age structure so that the population approached a single reproducing age class. Compared to an unfished populations with a protracted age structure, abundance of the fished population was much lower and more variable. The fished population recovered slowly even when fishing was terminated and it had a higher probability of extinction than the unfished population.

These results led Murphy (1967) to assert the need to maintain age structure in populations with long life spans that experience environmentally-driven recruitment. This same advice was advanced by Leaman (1991) for the long-lived rockfishes (Sebastes). By comparison of longevity with other scallop species (Orensanz et al. 1991), weathervane scallops, with a maximum age of 28 (Hennick 1973), may be the longest-

lived scallop species in the world. That is, the advice of Murphy (1967, 1968) and Leaman (1991) is apropos.

Sustainability of Weathervane Scallop Harvests. Changes in the Alaskan scallop fishery through 1992 raised concerns that recent (through 1992) harvests may not be sustainable on a local or regional level for several reasons. First, recent landings were 2-3 times higher than the long-term average harvest taken over a 20-year period during the 1970s and 1980s. In fact, these harvests are at levels comparable to those taken in the late 1960s and early 1970s which proved not to be sustainable by the fishery. Reduced scallop abundance was at least partly responsible for the fishery collapse in the 1970s. Second, high harvests since 1990 were at least partly attributable to shifts in fishing effort to new scallop beds. Third, during 1992 limited inseason catch reports from some areas indicated that small scallops were constituting an increased portion of landings as had occurred prior to the fishery decline in the mid-1970s. Last, misreporting was suspected. If misreporting was widespread, it would seriously compromise the data base of historical catches upon which assessments of sustainable harvests are based.

4.2 Specification of OY and Overfishing

The following definitions are based on the national standard 1 guidelines (50 CFR 600.310).

Maximum Sustainable Yield (MSY). MSY is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions. The long-term average stock size obtained by fishing year after year at this rate under average recruitment may be a reasonable proxy for the MSY stock size, and the long-term average catch so obtained may be a reasonable proxy for MSY

MSY for weathervane scallops is 1.24 million lbs. (562.46 metric tons) of shucked adductor muscles. MSY was estimated based on the average catch from 1990-1997, (1995 data not included as fishery was closed most of the year), which was 1,240,000 lbs. (562.46 metric tons) of shucked meats. The time period from 1990 to 1997 reflects prevailing ecological conditions. The fishery was fully capitalized during this time period, and all areas of the state were where scallops could be harvested were being exploited. Prior to that time period, vessels moved into and out of the scallop fishery, in part in response to economic opportunities available in other fisheries (Shirley and Kruse, 1995). However, since 1993, the fishery has been somewhat limited by crab bycatch limits, closure areas, and season length. As a consequence, a stable period during the history of this fishery does not exist. MSY estimation by averaging catches is problematic, however, a better solution does not exist at this point.

MSY Control Rule (F_{msy}). The MSY control rule is a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY. The MSY control rule establishes a maximum fishing mortality threshold (MFMT), which may be expressed either as a single number or as a function of spawning biomass or other measure of productive capacity. The MFMT is set at the fishing mortality rate or level associated with the relevant MSY control rule. Exceeding the MFMT for a period of 1 year or more constitutes overfishing

In choosing an MSY control rule, Councils should be guided by the characteristics of the fishery, the FMP's objectives, and the best scientific information available. In any MSY control rule, a given stock size is associated with a given level of fishing mortality and a given level of potential harvest, where the long-term average of these potential harvests provides an estimate of MSY. The MSY control rule is based on natural

mortality, using the estimate of M = 0.13, the MSY control rule F_{msy} equals M, or F_{msy} = 0.13. No control rule for spiny, pink, or rock scallops is recommended at this time.

MSY Stock Size (B_{msy}). The MSY stock size is the long term average size of the stock or stock complex, measured in terms of spawning biomass or other appropriate units, associated with the production of MSY. It is the stock size that would be achieved under an appropriate MSY control rule. It is also the minimum standard for a rebuilding target when remedial management action is required.

As noted earlier, MSY for weathervane scallops is established at 1.24 million lbs. (562.46 mt) of shucked adductor muscles. Therefore, MSY stock size is estimated as MSY/M = 9.54 million lbs. (4,326.6 mt) of shucked meat biomass. In terms of whole animals (including shells and gurry) B_{msy} would be 95.4 million lbs. (43,273 mt), as expanded by a product recovery rate of 10%. This assumes that the stock was at B_{msy} and that catches were at MSY during 1990-1997, and that the logistic equation holds.

Minimum Stock Size Threshold (MSST). The minimum stock size threshold (MSST), to the extent possible, should equal whichever is greater: one half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the maximum fishing mortality threshold. Should the actual size of the stock or stock complex in a given year fall below MSST, the stock or stock complex is considered overfished. The MSST should be expressed in terms of spawning biomass or other measure of reproductive capacity. Based on the national standard guidelines, a MSST for weathervane scallops is established based on ½ MSY stock size = $\frac{1}{2}B_{msy}$ = 4.77 million lbs. (2,163.7 mt) of shucked adductor muscles.

Overfishing Control Rule ($F_{overfishing}$). The national standard guidelines define the terms "overfishing" and "overfished" to mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce MSY on a continuing basis. Overfishing is established for weathervane scallop stocks as a fishing rate in excess of the natural mortality rate. Hence, $F_{overfishing}$ = M = 0.13.

Optimum Yield (OY). Optimum yield should be established on the basis of MSY. OY is upper bounded by MSY = F_{msy} B_{msy} = M B_{msy} (= 1,240,000 lbs or 562.46 mt.). Hence, a numerical range for OY of 0-1,240,000 lbs. (562.46 mt) can thus be established for Alaska weathervane scallops. Because MSY cannot be estimated for the other scallop species, OY cannot be quantified for rock scallops, pink scallops, or spiny scallops.

Sufficient conservatism is built into establishing an annual OY cap of 1.24 million lbs. (562.46 mt) for the following reasons:

1. the years of averaging include years when no fishing occurred in the Bering Sea, but obviously some sustainable harvest was possible;
2. the period of averaging includes other areas and years when the harvest was constrained by fishery controls, such as recently by bycatch PSCs, and therefore the resulting catch underestimates the productivity of scallop stocks;
3. substantial areas are closed to scallop dredging due to concerns about bycatch, yet these areas have substantial productivity;
4. closed areas can almost be thought of as marine refuges and potential yields from these areas are not factored into MSY estimates;
5. there are years during the history of the fishery when effort was low due to market (not abundance) conditions;

6. $F_{30\%}$ is probably a better estimator of $F_{overfishing}$ than is F=M, yet $M<F_{30\%}$ so the overfishing rule is conservative; and
7. In years of good recruitment, the stocks are likely greater than B_{msy}, thus we will fish at $F<F_{overfishing}$ to achieve OY=MSY (recall MSY = F_{msy} B_{msy}, so if $B>B_{msy}$, then $F<F_{msy}$).

In the future, better quantitative estimates of appropriate scallop yields by area may be generated based on observer data analysis. Additional information on biomass and long-term potential yield of pink, spiny and rock scallops also may be available in the future. At such time, MSY and OY would be re-estimated and the FMP amended.

Because scallops only have been harvested by U.S. vessels in the past, and effort remains high, it is likely that the OY can be fully harvested by U.S. vessels and fully processed by U.S. processors in future years. In fact, current capacity of the U.S. scallop fleet in Alaska exceeds current guideline harvest levels for scallops. Hence, no considerations have been made to allow a foreign fishery on Alaskan scallops.

5.0 MANAGEMENT MEASURES

This chapter describes management measures that may be used to achieve the FMP's management objectives. Most of these management measures are currently used by the State to manage the scallop fishery. Some measures are appropriate for more than one management objective.

Two categories of management measures are described in the FMP (Table 5.1): Category 1 measures are general management measures delegated to the State for implementation. These measures may be freely adopted or modified by the State, subject to other Federal law. Category 2 measures are limited access management measures that are fixed in the FMP, implemented by Federal regulation and require an FMP amendment to change.

The following description of management measures is not intended to limit the State government to only these measures. However, implementation of other management measures not described in the FMP must be consistent with the FMP, the Magnuson-Stevens Act, and other applicable Federal law. Although specific strategies for attainment of objectives in the FMP are not described, management measures described in this chapter are all derived to attain one or more of those objectives.

5.1 Category 1: Management Measures Delegated to the State

5.1.1 Guideline Harvest Levels

The FMP authorizes the State to set preseason GHLs under State regulations. The term GHL corresponds closely to the term total allowable catch (TAC) used in the groundfish FMPs for the Bering Sea and Aleutian Islands Management Area and the Gulf of Alaska, although GHL is often expressed as a range and TAC is not. A range of harvest levels allows the State to make in-season management decisions based on current data obtained from the fishery. Seasons or areas may be closed when the GHL is reached, or earlier or later based on current in-season information. GHL is used in this FMP in lieu of TAC because the State has used this term and it corresponds with the State's current management program. The sum of all upper ranges of the GHLs for scallops crab must fall within the OY ranges established in this FMP.

The GHL is the result of a process which includes the examination of the effects of different harvesting strategies on the seven objectives of management listed previously in this FMP. While harvest strategies will be evaluated relative to all seven of these objectives, GHL will most frequently be used as a management measure to achieve only the first two objectives. For this reason, the GHL is primarily composed of two interrelated components: a biological component and a socioeconomic component.

In overview, the biological component, acceptable biological catch (ABC), is set to achieve the biological conservation objective of preventing overfishing. Because the maintenance of adequate reproductive potential takes precedence over economic and social considerations, the ABC serves as an upper bound constraint on harvest. A target harvest level is then chosen within ABC to maximize the anticipated discounted benefits to the fishery over the long term. These benefits include: profits, personal income, employment, benefits to consumers, and less tangible or less quantifiable social benefits such as the economic stability of coastal communities. The GHL range represents a confidence interval around the proposed harvest level reflecting the uncertainty in stock status and the uncertainty in estimates of socioeconomic benefits. Ideally, bioeconomic analysis such as Matulich, et al. (1987a, b, c) should be used to determine the GHL. However, such modeling efforts are relatively new and complex; in the future they should be employed along with more conventional means of determining the GHL.

Regardless of the specific approach, the process of determining a GHL which prevents overfishing and maximizes socioeconomic benefits includes the routine collection and analysis of biological, economic, social, and other data. Scallop resources in various registration areas off Alaska vary in the level of scientific information available for management. Consequently, exact procedures for determining appropriate ABCs and GHLs vary due to differences in the quality and quantity of resource data bases.

CATEGORY 1 (Delegated to the State)	CATEGORY 2 (Fixed in FMP, Implemented by Federal Regulation)
Guideline Harvest Levels	Vessel moratorium
Registration Areas, Districts, Subdistricts and Sections	License limitation program
Gear Limitations	
Crew and Efficiency Limits	
Fishing Seasons	
Observer Requirements	
Prohibited Species and Bycatch Limits	
Recordkeeping and Reporting Requirements	
In-season Adjustments	
Closed Areas	
Other	

Table 5.1 Management measures used to manage the scallop fishery off Alaska by category.

As discussed within the Research and Management Objective, an annual area management report will be prepared which describes the determination of GHLs and ABCs for all types of stocks using the best

available information. The GHLs contained in this report will be updated when new information is available. This information will be made available to the public.

5.1.2 Registration Areas, District, Subdistrict, and Section Boundaries

This FMP adopts existing State registration areas. The management unit historically has been divided by the State into nine scallop registration areas composed of the Federal waters and adjacent State waters described in each area (Figure 5.2). Registration areas may be further divided into fishing districts, subdistricts, and sections for purposes of management. For the purpose of scallop management, the State has divided the Yakutat, Cook Inlet, and Kodiak Registration Areas into districts..

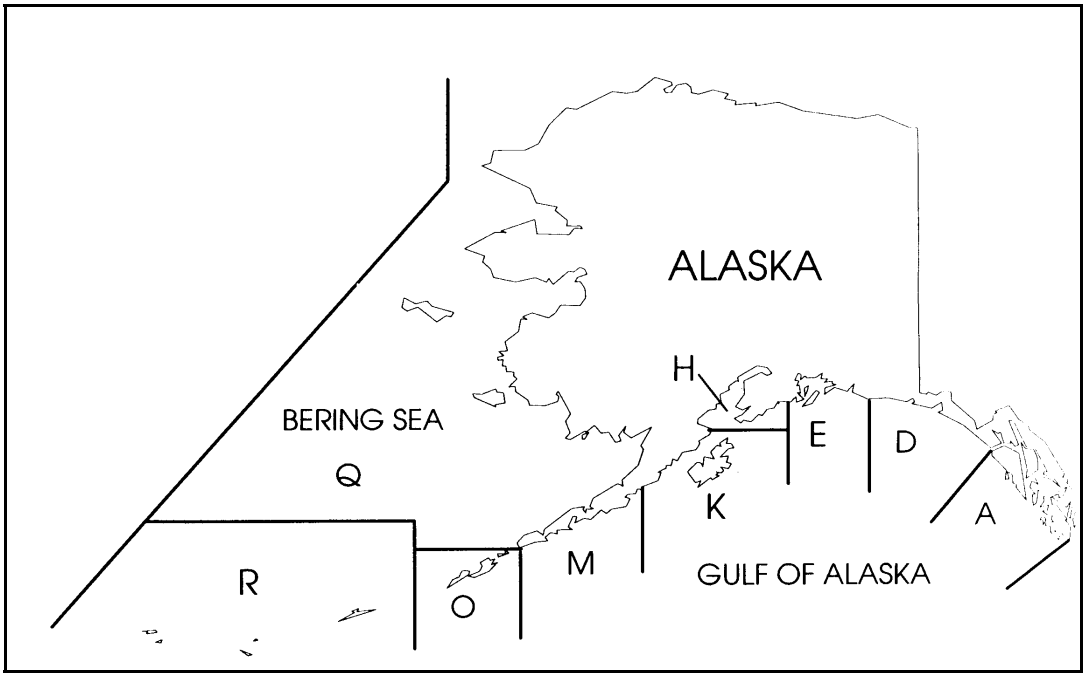

Figure 5.2 Scallop Registration Areas

Registration areas are characterized by relatively homogeneous established fisheries on scallop stocks. State regulations require vessels to register for fishing in these areas, and may require vessels to register for specific fishing districts within a registration area. Registration requirements allow estimation of fishing effort and the rate at which the resource will be harvested. Existing Registration Areas and districts are defined in Appendix D.

5.1.3 Gear Limitations

Gear limitations may include restrictions on the number and width of dredges that may be deployed by vessels fishing in a particular area, and minimum ring sizes for dredges to prevent the taking of undersize scallops. Gear restrictions will be specified in State regulations.

5.1.4 Crew and Efficiency limits

Efficiency limits may be necessary to prevent overcapitalization in the Scallop fishery off Alaska. Efficiency limits may include prohibitions on automatic shucking machines and restrictions on the number of crew that may be on board a vessel when engaged in fishing for scallops. Efficiency limits will be specified in State regulations.

5.1.5 Fishing Seasons

Fishing seasons will be specified in State regulation to achieve various management objectives including (1) limiting fishing during spawning periods, (2) timing fishing seasons during periods when product quality is highest, (3) limiting gear conflicts with other fisheries, (4) and increasing vessel safety.

5.1.6 Observer Requirements

Observer coverage requirements may be specified in State regulations. The State may place observers aboard scallop fishing and/or processing vessels to obtain, for example, catch and effort data; species, and size composition data. Observers provide better scientific and enforcement information than is otherwise available. The State currently has a mandatory observer requirement on all vessels fishing for scallops outside the Cook Inlet Registration Area as a condition to obtaining a processing permit. It is important that the State observer program and any future Federal observer program be coordinated to prevent duplication of effort and reduce costs to industry. No one shall forcibly assault, resist, impede, intimidate, or interfere with an observer placed aboard a fishing vessel under this FMP.

5.1.7 Prohibited Species and Bycatch Limits

State regulations may prohibit vessels fishing under this FMP from retaining certain species identified as prohibited including salmon, halibut, king crab, Tanner crab, and herring. Species identified as prohibited must be avoided while fishing and must be immediately returned to the sea with a minimum of injury when caught and brought aboard. Prohibited species bycatch limits may be established for specified areas or subareas to limit bycatch of prohibited species in the scallop fishery.

5.1.8 Recordkeeping and Reporting Requirements

The State may implement recordkeeping and reporting requirements as necessary to meet the management objectives of the FMP. As the commercial scallop fisheries have grown over recent years, so has our knowledge of this species. Information gained through scientific surveys, research, and fishermen's observations have all led to a better understanding of the biology, environmental requirements, and behavior of the scallop stocks. Since fishery managers monitor harvest rates in-season to determine areas of greatest fishing effort, thereby preventing overharvest of individual scallop stocks, State catch and processing reporting requirements are an important component in achieving the biological conservation, economic, social, research and management objectives of this FMP.

5.1.9 In-season Adjustments

The State may make in-season adjustments to GHLs, fishing seasons, bycatch limits, and to close areas under State regulations. In making such in-season adjustments, the State may consider appropriate factors to the extent in-season data are available on: (1) overall fishing effort, (2) catch per unit of effort and rate of harvest, (3) relative scallop abundance, (4) achievement of GHLs and bycatch limits, (5) general information on stock condition, (6) timeliness and accuracy of catch reporting, and (7) other factors that affect ability to meet objectives of the FMP.

All in-season adjustments must be recorded and justified in writing. These justifications are attached to the emergency order and will be made available for review to the public, the State, NMFS, and other regulatory agencies.

5.1.10 Closed areas

State regulations implementing the FMP may include time and area closures designed to minimize bycatch and protect habitat. Existing State regulations close most areas to that are also closed to bottom trawling to protect crab and other sensitive habitat.

5.1.11 Other

As previously noted, the State government is not limited to only the management measures described in this FMP. However, implementation of other management measures not described in the FMP must be consistent with the FMP, the Magnuson-Stevens Act, and other applicable Federal law.

5.2 Category 2 Measures: Limited Access Management

A system for limiting access, which is an optional measure under section 303(b) of the Magnuson-Stevens Act, is a type of allocation of fishing privileges that may be used to promote economic efficiency or conservation. For example, "*limited access may be used to combat overfishing, overcrowding, or overcapitalization in a fishery to achieve OY*" (50 CFR 600.330(c)). The Magnuson-Stevens Act (Section 3(28)) further defines"... The "optimum" with respect to the yield from a fishery, means the amount of fish which -- (A) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; (B) is prescribed on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant social, economic, or ecological factor; and (C) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery.

5.2.1 Moratorium Permit Program

The vessel moratorium remained in effect until June 30, 2000. A vessel qualified for inclusion in the moratorium program if it made a legal landing of scallops during 1991, 1992 or 1993; or during at least 4 separate years from 1980 through 1990. The moratorium permit program is superceded by the scallop license limitation program.

5.2.2. Scallop License Limitation Program (LLP)

A Federal scallop license is required for vessels participating in all scallop fisheries in the EEZ off Alaska. Any vessel that meets the license programs qualification requirements will be issued a license. The LLP would limit access to the commercial scallop fisheries in the EEZ off Alaska.

5.2.2.1. Elements of the License Limitation Program

1. <u>Qualification Criteria</u>. A license authorizes the license holder to use a vessel from which directed fishing for scallops can be conducted. A license is issued to a moratorium permit holder who made legal landing

of scallops in each of any 2 years in the period from January 1, 1996 through October 9, 1998. Licenses are not vessel specific.

2. License Recipients. Licenses will be issued to U.S. Citizens, or U.S. business (corporation, partnership, or other association) that satisfy the above qualification criteria.

3. 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.

4. Area Endorsements. The licenses will have no area endorsements. All licenses will be statewide. However, some license will be restricted for use with a single 6 ft (1.8 m) dredge when fishing for scallops in all areas as defined in Federal Regulations.

5. Vessel Length. No increases in vessel length will be allowed. A license will be designated with a MLOA that will limit the length of a vessel that could be used by the license holder.

6. License Ownership Caps. No person could hold more than 2 scallop licenses at once unless that person is initially issued more than 2 licenses, in which case the person can hold the number of licenses initially issued. However, a person who has more than 2 scallop licenses could not receive a scallop license by transfer until the number of scallop licenses which that person has is less than 2. After obtaining transfer eligibility by dropping below 2 licenses, the person could not again exceed 2 licenses, regardless of his or her earlier status of being allowed to exceed 2 licenses on initial issuance.

7. Appeals. The appeals process is established in Federal Regulations at 50 CFR part 679.43.

6.0 DATA ASSESSMENT AND COLLECTION

NMFS, in coordination with other management agencies, should initiate efforts to identify and gather the data needed to improve management agency understanding of the dynamics of the scallop resource and the effect of exploitation on the stocks capacity to produce MSY on a continuing basis. The type of information that should be pursued Alaska include (1) stock abundance and size/age structure, (2) scallop biology, life history, and stock production parameters, (3) analyses of population thresholds and recruitment overfishing; (4) estimation of optimum dredge ring size or minimum shell height based on studies of rates of growth and mortality; (5) investigations of exploitation rates and alternative management strategies; (6) genetic stock structure; and (7) new gear designs to reduce bycatch and to minimize adverse effects on bottom habitat. This objective may be attained, in part, with data collected by the Alaska State observer program. However, assessments of the scallop resource off Alaska, as well as the conduct of other scallop research will be dependent on Federal funding, State of Alaska general fund appropriations, or future amendments to the FMP that would authorize experimental fishing under Federal permit conditions.

6.1 At-Sea Catch Sampling

The focus of the State of Alaska's onboard scallop observer program is two-fold. One is to monitor bycatch, and the second is to collect biological and commercial fishing information relating to the weathervane scallop. Onboard sampling is designed to answer questions necessary to the successful management of the resource.

The scallop observer program collects a variety of biological data on a daily basis. The daily goal is to sample a single dredge from one tow for species haul composition and a single dredge from six different tows for crab and halibut bycatch and discarded scallop catch as well as sampling two tows for scallop meat (adductor muscle) recovery data.

Haul composition sampling is used to document all species of bycatch by weight. Dredge contents, including noncommercial species, are sorted into baskets by species and weighed. Observer haul composition samples are summarized and reported by management area and district. Data from each management area and district is then summarized.

From each of the six tows sampled daily for crab and halibut bycatch, one dredge per tow is examined. Observers identify, count, and record the number of crab and halibut encountered as well as examining both the retained and discarded scallop catch. In addition to enumerating crab, carapace measurements, shell age, sex, injuries and mortality are recorded. All Pacific halibut encountered are measured for length and examined for injuries and overall body condition. The discarded scallop catch is collected from the deck and weighed. A subsample is examined to determine the weight and number of broken and intact scallops, and shell heights. From the retained scallop catch; shell height, sex, and gonad development is collected. Shells are collected from both the retained and discarded scallop catch for shell aging.

7.0 ADMINISTRATIVE AND ENFORCEMENT COSTS

Administrative costs will increase as staff resources are required to develop future management measures. Significant costs would result from a meaningful data collection program that, ideally would include a resource assessment of the Alaska scallop stocks. A comprehensive survey of the sea scallop grounds in the Gulf of Alaska and the Bering sea would require a 90-day cruise. Such a cruise probably cannot be part of ongoing groundfish research cruises because a different type of sampling gear, such as a specialized scallop dredge, likely would be required. The estimated cost of such a survey would be about $540,000 (assume a vessel charter with scientific personnel cost at $6,000 per day for a 90-day cruise). There would also be a need for data entry, data workup, and general staffing functions to make the information useable, estimated to be one staff -year. A desirable part of the data collection program would involve collection of fisheries statistics and biological specimens from the fisheries for status of stocks analyses.

8.0 APPENDICES

Appendix A. History of the Alaska Scallop Fishery

Interest in an Alaskan scallop fishery has existed since the early 1950's when the Bureau of Commercial Fisheries began systematic surveys to determine if commercial quantities were available. The first commercial deliveries of weathervane scallops were made in 1967. Since then, the numbers of vessels, numbers of landings and harvest (weight of shucked meats) have varied annually (Table A.1.1). Total commercial harvest of scallops has fluctuated from a high of 157 landings totalling 1,850,187 pounds of shucked meats by 19 vessels in 1969 to no landings in 1978. Prices and demand for scallops have remained high since fishery inception. Harvests in 1990 and 1991 were the highest on record since the early 1970's. The 1992 harvest was even higher at 1,810,788 pounds. On average, about two-thirds of the scallop harvest has been taken off Kodiak Island and about one-third has come from the Yakutat area; other areas have made minor contributions to overall landings. Harvest peaks have occurred as new beds were discovered or old beds recovered and then became depleted (Table A.1.2). From 1969 through 1990, landings from State waters averaged about 39 percent of the total but more recent landings increasingly have been taken mostly from Federal waters (Table A.1.3). Changes in catch-per-unit-effort (CPUE) could not be monitored, as the unit measure of effort (number of days as measured by trips) has not been consistent through the time series. Many vessels switched from landing fresh to frozen product during the late 1980's, extending the average trip from about 10 days to perhaps 20 or more.

The size of the scallop fishing fleet off Alaska has fluctuated since the fishery began in 1967. Since then, up to 19 vessels per year have participated in the fishery. In 1992, only 7 vessels were actively fishing for scallops. Annual variability in the number of participants is due to both scallop abundance and the potential revenues generated by other fisheries (Kaiser 1986; Bourne 1991). Historically, many of the vessels participating in the fishery have dropped out after only one year (Table A.1.4). By 1992, only one vessel had participated for more than four consecutive years. Examination of the number of landings made by vessels in 1994 indicates that 11 out of 16 participants were "full time" scallopers, whereas vessels may have fished part time for scallops in previous years (Table A.1.5). Since the beginning of the fishery, scallops have been harvested by vessels and companies from the East Coast (Browning 1980). The same situation occurred through 1994; of the 16 vessels used to fish for scallops in 1994, 7 were registered to persons living in Alaska, and 9 outside the State, primarily from the mid-Atlantic area. No foreign vessels have ever participated in the scallop fishery in Alaska, and no Indian treaty fishing rights exist for this fishery.

Throughout the history of the Alaska scallop fishery, vessels fished nearly exclusively for weathervane scallops. Although scallop fisheries could potentially target species other than weathervanes, they have not done so. Landings of other scallop species were made by one vessel in 1991 and 1992, but due to confidentiality of the data, total landings of other species cannot be reported. Landings of other scallops may have been made in earlier years, but scallop species were not differentiated on fish tickets prior to 1991. Apparently, some amount of pink scallops were landed in 1979 (Kaiser 1986). Little information on the abundance and distribution of these other species is available. It is not known to what extent the scallop species are harvested by recreational or subsistence fisheries, however based on anecdotal information, some recreational diving for pink scallops occurs in Southeast Alaska.

Currently, the "average" scallop vessel is about 90-110 ft long and carries a crew of 12. In the 1980's, several small (< 50 ft) vessels participated in the fishery. The length distribution of vessels participating in the scallop fishery since 1980 is shown in Table A.1.6. The gear used to catch scallops commercially is the

dredge of a standard design, with a regulated minimum ring size (Figure A.1). This type of fishing gear typically harvests only 5-35 percent of the scallops in their path, depending on dredge design, target species, bottom type, and other factors (McLoughlin et al. 1991). Although dredge width has varied in size through the history of the fishery, recent State regulations have limited dredges to a maximum width of 15 feet. Traditionally, scallops have been processed at sea by manual shucking, with only the meats (adductor muscles) landed. The technology for automated mechanical shucking exists, and apparently can process Alaskan scallops. However, this type of shucking was recently prohibited by the State for weathervane scallops and in the East Coast sea scallop fishery to control effort.

Fishing operations at sea generally involve the following steps: 1) dredge setting, 2) towing for about one hour, 3) dredge retrieval, 4) dumping of the catch on deck, 5) sorting out scallops to be retained, and 6) discarding of debris, small scallops and bycatch of other species. Retained scallops are shucked by the crew, and usually washed, sorted, and frozen (or iced) at sea. DuPaul and Carnegie (1994) reported on scallop fishing procedures during the weathervane scallop fishery off Yakatat in July 1993. They reported that fishermen generally retained most large scallops (> 85 mm SH). Small scallops (< 85 mm SH) comprised a very small percentage (< 5 percent) of the catch, and were not retained. Scallops in the 100-130 mm SH range comprised the vast majority of the catch, corresponding to meat counts of 28 to 48 meats per pound of shucked adductor muscles. In the 1993 scallop fisheries statewide, the largest scallops were taken in the Kodiak Island and Bering Sea areas (Figures A.2 and A.3).

Economic trends of the fishery depend upon the performance measures considered. For example, vessels averaged 212,000 pounds each during the early "fishing-up period" (1970-1973) of the fishery. During 1974-1986, landings per vessel averaged only about one-third (66,000 pounds) of the 1970-1973 average as stocks recovered from high harvest levels, but increased to about one-half (114,000 pounds) of the original level during the 1987-1991 period. Note that the average landings per vessel in 1992 (258,684 pounds) was the highest in the history of the fishery (Table A.1.1). On the other hand, average gross receipts (exvessel value) per vessel reveal a different trend due to price effects during these same three time periods: $234,000, $178,000, and $400,000, respectively.

Average annual exvessel price has increased through the time series, with a distinct break occurring between 1975 and 1980 (Table A.1.1). In the early years of the fishery, 1968-1975, exvessel price per pound ranged from $0.85 to $1.40. Prices in the early 1980's were much higher, with exvessel prices ranging from $3.77 to $4.88. Prices decreased somewhat through the early 1990s, with a range of $3.12 to $3.88 observed from 1985 to 1992. Price increased in 1993 and 1994 to $5.00 and $6.00, respectively (Ken Griffin, ADF&G, personal communication).

Table A.1.1. Historic number of vessels, number of landings, landed weight of shucked meats, price per pound, exvessel value, landings per vessel, and exvessel value per vessel for the weathervane scallop fishery in Alaska during 1967-1994. All data for 1967-1968, and prices and exvessel values for 1967-1975 and 1979 were taken from Kaiser (1986); all other data were summarized from fish tickets (Kruse 1994). The 1994 data are preliminary. In years when only one or two vessels participated in a fishery, the harvest statistics are confidential.

Year	*No. of Vessels*	*No. of Landings*	*Landings Wt. (lbs)*	*Price ($/lb)*	*Exvessel Value ($)*	*(lbs) per Vessel*	*Value ($) per Vessel*
1967	<----------Confidential---------->						
1968	19	125	1,677,268	0.85	1,425,678	88,277	75,036
1969	19	157	1,850,187	0.85	1,572,659	97,378	82,772
1970	7	137	1,440,338	1.00	1,440,338	205,763	205,763
1971	5	60	931,151	1.05	977,709	186,230	195,542
1972	5	65	1,167,034	1.15	1,342,089	233,407	268,418
1973	5	45	1,109,495	1.20	1,331,394	221,881	266,279
1974	<----------Confidential---------->						
1975	4	56	435,672	1.40	609,941	108,918	152,485
1976	<----------Confidential---------->						
1977	<----------Confidential---------->						
1978	0	0	0	-	0	0	0
1979	<----------Confidential---------->						
1980	8	56	632,535	4.32	2,732,551	79,06,7	341,569
1981	18	101	924,441	4.05	3,743,986	51,358	207,999
1982	13	120	913,996	3.77	3,445,765	70,307	265,059
1983	6	31	194,116	4.88	947,286	32,353	157,881
1984	10	61	389,817	4.47	1,742,482	38,982	174,248
1985	8	53	647,679	3.12	2,020,758	80,599	252,595
1986	9	86	682,622	3.66	2,498,397	75,847	277,600
1987	4	55	583,043	3.38	1,970,685	145,761	492,671
1988	4	47	341,070	3.49	1,190,334	85,268	297,584
1989	7	54	525,598	3.68	1,934,201	75,085	276,314
1990	9	144	1,488,64	3.37	5,016,724	165,405	557,414
1991	7	144	1,191,014	3.76	4,478,213	170,145	639,745
1992	7	137	1,810,788	3.88	7,028,702	258,684	1,004,100
1993	15	155	1,428,976	5.00	7,144,880	95,265	476,325
1994	16	118	1,235,267	6.00	7,411,614	77,204	463,226

Table A.1.2. Landings of scallops by year, registration area, and species, 1980-1994. Only landings from areas that contributed substantially to the total annual catch are listed separately. The "All Areas" catch listed for each year includes catch from all registration areas.

		Weathervane scallops		*Pink scallops*		*Annual Totals*	
		Pounds	*Vessels*	*Pounds*	*Vessels*	*Pounds*	*Vessels*
1980	(A) Southeastern Alaska	*	2	0	0	*	2
	(D) Yakutat	**	6	0	0	**	6
	(K) Kodiak	371,018	7	0	0	371,018	7
	All Areas	632,535	8	0	0	632,535	8
1981	(A) Southeastern Alaska	*	1	0	0	*	1
	(D) Yakutat	**	10	0	0	**	10
	(K) Kodiak	460,890	15	0	0	460,890	15
	All Areas	924,441	18	0	0	924,441	18
1982	(A) Southeastern Alaska	*	3	0	0	*	3
	(D) Yakutat	168,353	6	0	0	168,353	6
	(K) Kodiak	435,802	8	0	0	435,802	8
	(M) Alaska Peninsula	205,534	6	0	0	205,534	6
	(O) Dutch Harbor	**	5	0	0	**	5
	All Areas	913,996	13	0	0	913,996	13
1983	(A) Southeastern Alaska	*	1	0	0	*	1
	(K) Kodiak	**	4	0	0	**	4
	(M) Alaska Peninsula	*	1	0	0	*	1
	(H) Cook Inlet	*	1	0	0	*	1
	All Areas	194,116	6	0	0	194,116	6
1984	(D) Yakutat	*	2	0	0	*	2
	(K) Kodiak	309,502	6	0	0	309,502	6
	(H) Cook Inlet	*	3	0	0	*	3
	All Areas	389,817	9	0	0	389,817	9
1985	(D) Yakutat	14,221	4	0	0	14,221	4
	(K) Kodiak	*	3	0	0	*	3
	(M) Alaska Peninsula	*	1	0	0	*	1
	(O) Dutch Harbor	*	3	0	0	*	3
	(H) Cook Inlet	*	1	0	0	*	1
	All Areas	647,679	8	0	0	647,679	8
1986	(D) Yakutat	*	2	0	0	*	2
	(K) Kodiak	180,600	5	0	0	180,600	5
	(O) Dutch Harbor	387,209	5	0	0	387,209	5
	(H) Cook Inlet	*	3	0	0	*	3
	(Q) Adak/Bristol Bay/Bering Sea	*	1	0	0	*	1
	All Areas	682,622	9	0	0	682,622	9

		Weathervane scallops		*Pink scallops*		*Annual Totals*	
		Pounds	*Vessels*	*Pounds*	*Vessels*	*Pounds*	*Vessels*
1987	(D) Yakutat	*	1	0	0	*	1
	(K) Kodiak	*	3	0	0	*	3
	(O) Dutch Harbor	*	2	0	0	*	2
	(H) Cook Inlet	*	1	0	0	*	1
	(Q) Adak/Bristol Bay/Bering Sea	*	2	0	0	*	2
	All Areas	583,043	4	0	0	583,043	4
1988	(D) Yakutat	*	1	0	0	*	1
	(K) Kodiak	*	3	0	0	*	3
	(M) Alaska Peninsula	*	1	0	0	*	1
	(O) Dutch Harbor	*	1	0	0	*	1
	All Areas	341,070	4	0	0	341,070	4
1989	(D) Yakutat	*	1	0	0	*	1
	(K) Kodiak	**	5	0	0	**	5
	(O) Dutch Harbor	*	1	0	0	*	1
	All Areas	534,763	7	0	0	534,763	7
1990	(A) Southeastern Alaska	**	4	0	0	**	4
	(D) Yakutat	442,310	8	0	0	442,310	8
	(K) Kodiak	697,003	7	0	0	697,003	7
	(M) Alaska Peninsula	*	2	0	0	*	2
	(O) Dutch Harbor	*	1	0	0	*	1
	(Q) Adak/Bristol Bay/Bering Sea	*	1	0	0	*	1
	All Areas	1,488,642	9	0	0	1,488,642	9
1991	(A) Southeastern Alaska	*	3	0	0	*	3
	(D) Yakutat	402,571	5	0	0	402,571	5
	(K) Kodiak	514,348	4	0	0	514,348	4
	(M) Alaska Peninsula	*	1	0	0	*	1
	(O) Dutch Harbor	*	1	*	1	*	2
	(Q) Adak/Bristol Bay/Bering Sea	*	3	*	1	125,523	4
	All Areas	1,136,713	7	*	1	1,191,014	8
1992	(A) Southeastern Alaska	*	1	0	0	*	1
	(D) Yakutat	1,020,968	7	0	0	1,020,968	7
	(K) Kodiak	*	3	0	0	*	3
	(O) Dutch Harbor	*	1	*	1	*	1
	(E) Prince William Sound	208,836	4	0	0	208,836	4
	All Areas	1,741,578	7	*	1	1,810,788	7
1993	(Q) Bering Sea	531,668	9	0	0	531,668	9
	(D) Yakutat	256,493	10	0	0	256,493	10
	(K) Kodiak	374,908	10	0	0	374,908	10
	All Areas	1,428,976	15	0	0	1,428,976	15

		Weathervane scallops		*Pink scallops*		*Annual Totals*	
		Pounds	*Vessels*	*Pounds*	*Vessels*	*Pounds*	*Vessels*
1994	(Q) Bering Sea	505,439	9	0	0	505,439	9
	(D) Yakutat	259,206	12	0	0	259,206	12
	(K) Kodiak	381,850	10	0	0	381,850	10
	All Areas	1,235,269	17	0	0	1,235,269	17

* Confidential data
** Data masked to prevent extraction of confidential data

Table A.1.3. Percentage of Alaska scallop landings from State (within 3 miles) and Federal waters (3-200 miles), by year from 1990 through 1994.

Year	*State Waters*	*Federal waters*
1990	46.9%	53.1%
1991	37.9%	62.1%
1992	73.6%	26.4%
1993	23.9%	76.1%
1994	13.7%	86.3%

Table A.1.4. Number of vessels participating in the scallop fishery 1980-1992, the number of years participating.

	Number of Years Participating												
Year	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1980	8	0	0	0	0	0	0	0	0	0	0	0	0
1981	13	5	0	0	0	0	0	0	0	0	0	0	0
1982	4	6	3	0	0	0	0	0	0	0	0	0	0
1983	4	0	1	1	0	0	0	0		0	0	0	0
1984	4		1	1	1	0	0	0	0	0	0	0	0
1985	6	0	1	0	1	1	0	0	0	0	0	0	0
1986	5	2	0	0	0	1	1	0	0	0	0	0	0
1987	0	2	0	1	0	0	0	1	0	0	0	0	0
1988	1	0	2	0	0	0	0	0	1	0	0	0	0
1989	3	2	0	1	0	0	0	0	0	1	0	0	0
1990	2	3	2	0	1	0	0	0	0	0	1	0	0
1991	3	0	2	1	0	1	0	0	0	0	0	1	0
1992	1	2	0	2	1	0	0	0	0	0	0	0	1

Note: No vessels fished in 1978, and only two fished in 1979; of these, one fished for only 1 year, and one fished through 1982.

Table A.1.5 Number of vessels participating in the scallop fishery 1980-1992, by landing category.

	Number of Landings Per Vessel					
Year	***1-5***	***6-10***	***11-15***	***16-20***	***21-25***	***26-30***
1980	4	2	1	0	1	0
1981	12	3	2	1	0	0
1982	5	2	5	0	1	0
1983	5	0	0	0	1	0
1984	6	1	0	0	2	0
1985	7	0	0	2	0	0
1986	3	3	1	2	0	0
1987	1	2	0	0	0	1
1988	2	0	1	0	1	0
1989	3	3	0	1	0	0
1990	1	3	2	1	1	1
1991	1	1	3	1	2	0
1992		1	2	3	1	0

Table A.1.6 Number of vessels participating in the scallop fishery 1980-1992, by vessel length category.

	Length Category (ft)						
Year	***<50***	***50-70***	***71-90***	***91-110***	***111-130***	***131-150***	***>150***
1980	0	1	5	2	0	0	0
1981	0	2	11	4	0	1	0
1982	2	0	8	3	0	0	0
1983	4	0	1	1	0	0	0
1984	4	2	1	2	0	0	0
1985	3	1	1	3	0	0	0
1986	3	0	1	3	1	1	0
1987	1	0	0	2	0	1	0
1988	0	0	1	2	0	1	0
1989	0	1	2	3	1	0	0
1990	0	1	2	5	1	0	0
1991	0	1	1	1	2	1	1
1992	0	1	2	1	1	1	1
1993	0	3	8	2	1	1	0
1994	0	4	8	2	1	1	

Note: Prior to 1980, nearly all vessels were 70-90 ft. One missing vessel in 1987.

Figure A.1. Scallop dredge design used in the U.S. east coast and Alaska sea scallop fishery

Figure A.2. Size frequency of scallops caught in the Yakutat, Prince William Sound, and Kodiak Management Areas during the 1993 scallop fishery. From Urban et al. (1994)

Figure A.3. Size frequency of scallops caught in the Alaska Peninsula, Dutch Harbor, and Bering Sea Management Areas during the 1993 scallop fishery. From Urban et al.(1994)

Appendix B. National Standards of the Magnuson Act

The Magnuson Act (Section 301) sets the national standards for fishery conservation and management. Any fishery management plan prepared, and any regulation promulgated to implement any such plan, pursuant to this title shall be consistent with the following national standards for fishery conservation and management:

(1) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

(2) Conservation and management measures shall be based upon the best scientific information available.

(3) To extend the practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

(4) Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

(5) Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

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

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

Appendix C State of Alaska Management Structure

Institutions: The State Organizational Act of 1959 provided for Alaska Statutes, Title 16, which deals with Alaska Fish and Game Resources. Article 1 provides for a Department of Fish and Game whose principal executive officer is the Commissioner of Fish and Game. The Commissioner is appointed by the Governor for 5 years. The Commercial Fisheries Division was established to manage all commercially harvested fish species in Alaska. The Division is headed by a director who supervises four regional supervisors. The regions are further separated into management areas. Area management biologists are responsible for collecting catch data and monitoring fisheries in their areas. A Subsistence Section within the Commissioner's Office was recently established to document subsistence needs and utilization and to make recommendations for developing regulations and management plans to ensure subsistence use preference.

The enforcement of fish and game laws and regulations is provided by ADF&G and the Alaska Department of Public Safety (ADPS). The fish and wildlife protection officers of the ADPS operate independently of the ADF&G, although communication between the two departments is maintained and activities are coordinated.

Jurisdiction: ADF&G asserts management authority over all migratory fish and shellfish species which enter and leave territorial waters of the State, including the migratory fish and shellfish taken from State waters which are indistinguishable, in most instances, from those taken from adjacent high seas areas. Regulations governing migratory fish and shellfish cover both areas and are enforced by the State's landing laws. These landing laws prohibit the sale or transportation within State waters of migratory fish and shellfish taken on the high seas unless they were taken in accordance with State regulations.

The Fisheries Regulatory Process: The Alaskan system has a seven-member Board, composed of fishermen and other businessmen appointed by the Governor, which considers both public and staff regulatory proposals in deciding on regulatory changes. The Board is required by law to meet or hold a hearing at least once a year in each of the following areas of the State in order to assure all people of the State ready access to the Board: (a) Upper Yukon-Kuskokwim-Arctic, (b) Western Alaska (including Kodiak), (c) South Central, (d) Prince William Sound (including Yakutat), and (e) Southeast. Since the late 1960s, the Board, and before it, the Board of Fish and Game, has usually held a minimum of two meetings annually to adopt changes in the fisheries regulations. The fall Board meeting, usually held in early December, considers proposals for changes in sport fishing regulations and in commercial and subsistence finfish regulations. A spring Board meeting, usually held in late March or early April, considers commercial and subsistence shellfish regulatory proposals (see Chapter 2). Regulations which may be adopted by the Board cover seasons and areas, methods and means of harvesting, quotas, and times and dates for issuing or transferring licenses and registrations.

Advisory committees, composed of people concerned about the fish and game resources of their locality, serve as local clearinghouses and sources of proposals for Board consideration. Following submission of advisory committees and public proposals, ADF&G staff members review the proposals and redraft the wording, when necessary, to conform to the style required. ADF&G also submits proposals for the Board's consideration.

In adopting new regulations, the Board follows Alaska's Administrative Procedure Act. This act has several requirements: At least 30 days prior to the adoption of new regulations, a notice giving the time and place

of the adoption proceedings, reference to the authority under which the regulations are proposed, and a summary of the proposed action, must be published in a newspaper of general circulation and sent to all interested people who have asked to be informed of the proposals. During the proceedings, the public must be given an opportunity to testify on the proposed changes. If a new regulation is adopted, it must be submitted to the Lieutenant Governor through the Attorney General's office. Thirty days after being filed with the Lieutenant Governor, the new regulation becomes effective. Because of these requirements, new regulations usually do not become effective until about 2 months after being adopted by the Board. Regulatory flexibility is given to the Commissioner of Fish and Game and to his authorized designees to adjust seasons, areas, and weekly fishing periods by emergency order.

The requirements outlined in the preceding paragraph do not apply in the case of emergency regulations, which may be adopted if needed for the immediate preservation of public peace, health, safety, or general welfare. An emergency regulation remains in effect 120 days unless it is adopted as a permanent regulation through the procedure described above. Emergency regulations have the same force and effect as permanent regulations. The Board has delegated authority to the Commissioner to adopt emergency regulations where an emergency exists as described in AS 44.62.250.

Appeals to the Board of Fisheries

Reconsideration of issues during a meeting: During a Board meeting, any Board member may move to reconsider an issue regardless of how the member voted on the original issue. Board Policy #80-78-FB requires that the motion be made prior to the adjournment of the meeting, that the motion be supported with new evidence, unavailable at the time of the original vote, and that public notice be given as to when reconsideration will occur.

Petitions to the Board: Under Section AS 44.62.220, an interested person may petition the Board for the adoption or repeal of a regulation. Upon receipt of a petition requesting the adoption, amendment or repeal of a regulation, the Board shall, within 30 days, deny the petition in writing or schedule the matter for public hearing. The Board and the Board of Game adopted a Joint Board Petition Policy which limits the scope of petitions they are willing to act upon outside of the normal regulatory cycle. The Joint Board recognized that in rare instances extraordinary circumstances may require regulatory changes outside this process. Therefore, it is the policy of the Board and the Board of Game that petitions will only be accepted if the problem outlined in the petition results in a finding of emergency. In accordance with State policy (AS 44.62.270), emergencies will be held to a minimum and rarely found to exist. Alaska Statute 44.62.250 specifies that in order to adopt emergency regulations, the agency must find that it is necessary for the immediate preservation of the public peace, health, safety, or general welfare. If such a finding is made, the agency adopting the emergency regulation shall submit a copy to the Lieutenant Governor for filing and for publication in the “Alaska Administrative Register”. Notice of adoption shall be given within five days of the adoption. Failure to give notice within ten days automatically repeals the regulation. For fish and game regulations, the Boards determined that an emergency is an unforeseen, unexpected event that either threatens a fish or game resource, or an unforeseen, unexpected resource situation where a biologically allowable resource harvest would be precluded by delayed regulatory action and such delay would be significantly burdensome to the petitioners since the resource would be unavailable in the future.

In 1995, the Board of Fisheries modified its petition policy for category 2 measures in the BSAI king and Tanner crab FMP (see State Regulation 5 AAC 39.998). The Board of Fisheries recognizes that in rare

instances, circumstances may require regulatory changes outside the process described in 5 AAC 96.625(b) - (d). Notwithstanding 5 AAC 96.625(f), a petition for a regulatory change may be submitted under this section and 5 AAC 96.625(a) for a Category 2 management measure in a Bering Sea/Aleutian Islands king or Tanner crab fishery described in the federal Fishery Management Plan (FMP) for the Commercial King and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands. It is the policy of the Board of Fisheries that a petition submitted under this section will be denied and not scheduled for hearing unless the petition:

(1) addresses a Category 2 management measure and is filed within 30 days from the date that the board adopted that Category 2 management measure;

(2) presents an issue that is not solely allocative; and

(3) presents new legal, biological, or management information that indicates the regulation may not be consistent with the federal FMP."

Appeals to the Commissioner of Fish and Game

Petitions: Board Policy #79-53-FB delegates authority to the Commissioner to adopt emergency regulations, during times of the year when the Board is not in session. The Commissioner may adopt, in accordance with the Administrative Procedure Act (AS 44.62), an emergency regulation where an emergency exists as described in AS 44.62.250. All emergency actions shall, to the full extent practicable, be consistent with Board intent. The Commissioner is further required to consult, if possible, with members of the Board to obtain their views.

In-season Management Actions: Within 5 days after the closure of any registration area, an individual holding a king or Tanner crab permit issued by the Commercial Fisheries Entry Commission or the owner of any vessel registered to that area may formally request the commissioner to reopen the area. The commissioner shall personally review pertinent information on the condition of crab within the area, and shall formally announce his decision within 14 days of the request. 5AAC 34.035(d), 35.035(d).

Judicial Review: The APA in Section 44.62.300 provides for court review of regulatory actions of the Board or commissioner. An interested person may get a judicial declaration on the validity of a regulation by bringing an action for declaratory relief. All actions are to be brought in the Superior Court. The court may declare the regulation invalid for a substantial failure to comply with required administrative procedures (AS 44.62.010-44.62.320) or, in the case of an emergency regulation or order of repeal, upon the grounds that the facts recited in the statement do not constitute an emergency under AS 44.62.250.

Appendix D: Scallop Registration Areas

Registration Area A (Southeastern Alaska) has as its southern boundary the international boundary at Dixon Entrance, and as its northern boundary Loran-C line 7960-Y-29590, which intersects the western tip of Cape Fairweather at 58° 47' 58" N. lat., 137° 56' 30" W. long., except for ADF&G District 16 defined as all waters north of a line projecting west from the southernmost tip of Cape Spencer and south of a line projecting southwest from the westernmost tip of Cape Fairweather.

Registration Area D (Yakutat) has as its western boundary the longitude of Cape Suckling (143° 53' W. long.), and as its southern boundary Loran-C line 7960-Y-29590, which intersects the western tip of Cape Fairweather at 58° 47' 58" N. lat., 137° 56' 30" W. long., and ADF&G District 16 defined as all waters all waters north of a line projecting west from the southernmost tip of Cape Spencer and south of a line projecting southwest from the westernmost tip of Cape Fairweather.

Registration Area E (Prince William Sound) has as its western boundary the longitude of Cape Fairfield (148° 50' W. long.), and its eastern boundary the longitude of Cape Suckling (143° 53' W. long.).

Registration Area H (Cook Inlet) has as its eastern boundary the longitude of Cape Fairfield (148° 50' W. long.) and its southern boundary the latitude of Cape Douglas (58° 52' N. lat.).

> Kamishak Bay District: all waters enclosed by a line from 59° 46' 12" N. lat., 153° 00' 30" W. long., then east to 59° 46' 12" N. lat., 152° 20' W. long., then south to 59° 03' 25" N. lat., 152° 20' W. long., then southwesterly to Cape Douglas (58° 52' N. lat.). The seaward boundary of the Kamishak Bay District is three nautical miles seaward from the shoreline between a point on the west shore of Cook Inlet at 59° 46' 12" N. lat., 153° 00' 30" W. long., and Cape Douglas at 58° 52' N. lat., 153° 15' W. long., including a line three nautical miles seaward from the shorelines of Augustine Island and Shaw Island, and including the line demarking all state waters shown on NOAA chart 16640, 21st Ed., May 5, 1990.
>
> Outer District: all waters enclosed by a line from the tip of Point Adam to the tip of Cape Elizabeth, then south to 58° 52' N. lat., 151° 53' W. long., then east to the longitude of Aligo Point (149° 44' 33" W. long.), then north to the tip of Aligo Point.
>
> Eastern District: all waters east of the longitude of Aligo Point (149° 44' 33" W. long.), west of the longitude of Cape Fairfield (148° 50' W. long.), and north of 58° 52' N. lat.

Registration Area K (Kodiak) has as its northern boundary the latitude of Cape Douglas (58° 52' N lat.), and as its western boundary the longitude of Cape Kumlik (157° 27' W. long.).

> Northeast District: all waters east of a line extending 180° from the easternmost tip of Cape Barnabas, east of a line from the northernmost tip of Inner Point to the southernmost tip of Afognak Point, east of 152° 30' W. long. in Shuyak Strait, and east of the longitude of the northernmost tip of Shuyak Island (152° 20' W. long.).
>
> Semidi Island District: all waters west of the longitude of Cape Kilokak at 156° 19' W. long and east of the longitude of Cape Kumlik at 157° 27' W. long.

Shelikof District: all waters north of a line from the westernmost tip of Cape Ikolik to the southernmost tip of Cape Kilokak, west of a line from the northernmost tip of Inner Point to the southernmost tip of Afognak Point, west of 152° 30' W. long., in Shuyak Strait, and west of the longitude of the northernmost tip of Shuyak Island (152° 20' W. long.).

Registration Area M (Alaska Peninsula) has as its eastern boundary the longitude of Cape Kumlik (157° 27' W. long.), and its western boundary the longitude of Scotch Cap Light. The registration area also includes all waters of Bechevin Bay and Isanotski Strait south of a line from the easternmost tip of Chunak Point to the westernmost tip of Cape Krenitzen.

Registration Area O (Dutch Harbor) has as its eastern boundary the longitude of Scotch Cap Light,(164° 44' W long.), its western boundary 171° W. long, and as its northern boundary the latitude of Cape Sarichef (54° 36' N. lat.).

Registration Area Q (Bristol Bay-Bering Sea) all waters north of a line from Cape Sarichef (54° 36' N. lat.), to 54° 36' N. lat., 171° W. long., to 55° 30' N. lat., 171° W. long., to 55° 30' N. lat., 173° 30' E. long., and west of the U.S.-Russian Convention line of 1867 as depicted on NOAA Chart #513 (5th Ed., November 6, 1982).

Registration Area R (Adak) has as its eastern boundary 171° W. long., as its northern boundary 55° 30' N. lat., and as its western boundary the U.S.-Russian Convention line of 1867 as depicted on NOAA Chart #513 (5th Ed., November 6, 1982).

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