3.6 Habitat

MSA provisions call for the description of measures to avoid, mitigate, or offset adverse effects to EFH. EFH is defined in the MSA as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (16 USC 1802 3, 104-297). Consistent with these provisions, this analysis focuses on the following question: Do the alternative management policies result in conditions that offer protection to and minimization of adverse impacts to EFH? For Alaska groundfish, this includes the habitat for all target groundfish species, non-target species, prohibited species, other species, and their prey. When viewed in aggregate, across all species, EFH is all pelagic and benthic habitat in the Alaska EEZ. The EFH definitions for all managed species are currently being reviewed by the NPFMC and NOAA Fisheries through its EFH amendment process. A decision on the Alaska EFH definitions will be made by the end of 2004. For purposes of this Programmatic SEIS, we provisionally defined EFH generally, as all benthic habitat.

As explained above, this analysis focuses on benthic habitat, which is generally believed to be at greater risk to the impacts of fishing than non-benthic habitat in the water column. In addition, much of the analysis focuses on the impacts of bottom trawling. It is recognized that fixed gear (longlines, pots, and jigs) or pelagic trawl gear that comes in contact with the sea floor can disturb benthic habitat. Pelagic trawls are fished “lightly on the bottom,” and fishing on the sand and mud flats of the Bering Sea during daytime tends to involve a higher percentage of limited bottom contact involving the “fishing line” and leading edge of the first row of meshes. In some types of habitat, fixed gear may cause an impact due to its ability to be more easily fished on rougher substrates (e.g., boulders with coral) than bottom trawl gear. However, most scientific studies of gear impacts have dealt with bottom trawls and dredging because this gear is the most controversial (Auster and Langton 1999, Jennings and Kaiser 1998, Hall 1999a, NRC 2002).

In this analysis, benthic habitat is further divided into two categories: living and non-living. Living substrate is composed of biological communities. Non-living substrate is comprised of boulders, cobbles, sand waves and other seabed features organisms may colonize. The primary components of non-benthic habitat include the biological, physical, and chemical properties of the water column. The biological component of non-benthic habitat consists of non-benthic groundfish prey. HAPC is defined as a subset of EFH, described as habitat types or areas that may require extra protection; HAPC is designated using specific criteria (see Section 3.6.2). In Alaska, HAPC is specifically defined as: “living substrate in shallow and deep water, and freshwater areas used by anadromous fish.”

In October 1996, the U.S. Congress reauthorized the MSA through the Sustainable Fisheries Act. The Final Rule EFH provisions of the MSA (50 CFR Part 600) was promulgated in January 2002. The intended effect of the rule is to promote the protection, conservation, and enhancement of EFH. Among other conservation measures, the Final Rule broadly defines EFH as those waters and substrate necessary for fish to spawn, feed or grow to maturity. The Final Rule also includes provisions requiring Regional Fishery Management Councils (RFMCs) to amend their FMPs to describe and protect EFH, and to mitigate for any adverse impacts potentially caused by fishing activities. The Final Rule requires that FMP components include mitigation for the adverse effects of fishing. Fishery management options may include, but are not limited to: fishing equipment restrictions, time area closures, and harvest limits.

At present, environmental and human variables that could affect habitat quality are addressed in the FMPs for both the BSAI and GOA (NPFMC 1999c). However, The EFH EA and FMP Amendments 55/55/8/5/5, along with similar actions prepared by five other RFMCs, were challenged by a coalition of seven environmental groups and two fishermen's associations. The plaintiffs' challenge was twofold. The U.S. District Court for the District of Columbia found that NOAA Fisheries evaluation of fishing gear impacts on EFH in the FMP amendments was in accordance with the MSA. The supporting EAs, however, failed to comply with the requirements of NEPA and the regulations promulgated by the CEQ and NOAA Fisheries. The court determined that the EAs did not consider the full range of relevant alternatives, nor did they fully explain the environmental impact of the proposed action and alternatives. In addition, the EAs failed to address any mitigative efforts to reduce adverse effects from fishing activities.

The Assistant Administrator of NOAA Fisheries determined that NOAA Fisheries would prepare new regional EISs to include all FMPs covered by the EAs. The following are several key areas of guidance provided in his determination:

- The selected range of alternatives should be developed by taking into account comments NOAA Fisheries receives during the scoping process, and that the EIS must evaluate a reasonable range of alternatives for developing the mandatory EFH provisions of the affected FMPs.

- For the designation of EFH, the analysis should include alternative ways of identifying EFH.

- For the identification of HAPC, the analysis should discuss alternative areas or different approaches that could be used to designate HAPCs.

- For the minimization of fishing impacts, the alternatives analysis should identify a range of approaches that could be taken to minimize the adverse effects of fishing on EFH. If information is lacking on the effects of specific fishing practices on EFH, the analysis should examine alternatives that could be taken in the face of uncertainty.

- To the extent feasible, NOAA Fisheries should use the NEPA process as the vehicle for reviewing and revising the information contained in the original EFH FMP amendments. Such a review should include information regarding the description and identification of EFH, threats to EFH from fishing and non-fishing activities, and measures that could be taken to minimize those threats.

The proposed action to be addressed in the EFH EIS is the development of the mandatory EFH provisions of all five FMPs of NPFMC: the BSAI groundfish; GOA groundfish; BSAI king and Tanner crab; scallop fishery off Alaska; and salmon fisheries in the EEZ off the Coast of Alaska. At present NOAA Fisheries and NPFMC are identifying feasible alternatives for analysis in the EIS and for selection of a preferred alternative. The Alaska Groundfish Programmatic SEIS is not intended to replace or supercede the EFH EIS, but will provide overarching policy guidance for EFH and set the stage for future FMP actions.

3.6.1 Identification of Essential Fish Habitat

The 1996 re-authorization of the MSA mandated that NOAA Fisheries and the RFMCs specifically describe and identify EFH within the FMPs. The MSA also required that FMPs minimize to the extent practicable adverse effects on EFH caused by fishing. NOAA Fisheries and NPFMC prepared one EA and a comprehensive set of Habitat Assessment Reports to address the new EFH requirements of the MSA

(NPFMC 1998a, 1998b, and 1998c). EFH FMP amendments for the five FMPs were submitted to the Secretary of Commerce in October 1998; these amendments were reviewed and approved by the Secretary of Commerce and took effect on January 20, 1999 (64 FR 20216). These FMP amendments identified EFH for 80 individual species including target and other fish, and for five species groups incorporating a total of 115 individual species. In cases where information was available, EFH was identified by each particular life stage for a given species (34 of the 80 individual species fell into this category).

According to the Final Rule implementing the EFH provisions of the MSA (50 CFR Part 600), to identify EFH basic information is needed to understand the usage or various habitats by each managed species. Pertinent information includes the geographic range and habitat requirements by life stage, the distribution and characteristics of those habitats, and current and historic stock size as it affects occurrence in available habitats. Temporal and spatial distribution of each life history stage is necessary to understand each species' relationship to, or dependence on, its various habitats. Data summarizing all environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species should be provided.

RFMCs must obtain this information to describe and identify EFH from the best available sources, including peer-reviewed literature, unpublished scientific reports, data files of government resource agencies, fisheries landing reports and other reliable sources. The scientific rigor of the reports, and species-specific data gaps and potential deficits in data quality should be taken into consideration.

In order to analyze habitat information, the EFH Final Rule specifies the following for organizing the data necessary to describe and identify EFH:

- **Level 1:** Distribution data are available for some or all portions of the geographic range of the species. Distribution data may be derived from presence/absence sampling and/or may include opportunistically collected information on species and life stages. In the event that distribution data are available for only portions of the geographic area occupied by a particular life history stage of a species, habitat use can be inferred on the basis of distributions among habitats where the species has been found and on anecdotal information about its habitat requirements and behavior. Habitat use may also be inferred from information on a similar species or another life stage.

- **Level 2:** Habitat-related densities of the species are available. At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species or life history stage. Because the efficiency of sampling methods is often affected by habitat characteristics, strict quality assurance criteria should be used to ensure that density estimates are comparable among methods and habitats. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.

- **Level 3:** Growth, reproduction, or survival rates within habitats are available. At this level, data are available on habitat-related growth, reproduction, and/or survival by life history stage. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).

- **Level 4:** Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species or life history stage to habitat type, quantity, quality, and location. Essential habitats are those necessary to maintain fish production, consistent with a sustainable fishery and the managed species' contribution to a healthy ecosystem.

RFMCs should strive to obtain data sufficient to describe habitat at the highest level of detail (i.e., Level 4). If scientists and managers have no information on a given species or life stage and habitat use cannot be inferred from other means, EFH should not be designated.

The EA for Amendments 55/55/8/5/5 identified EFH information levels for groundfish, crab, scallops, and salmon in the Alaska region. Level 2 data are available for some adult life history stages of groundfish, crabs, and shellfish. Level 2 data are also available for some stocks of red and blue king crab, tanner and snow crab stocks in some regions, at the egg, larval, late juvenile, and adult stages. The remainder of the data for all other crab stocks is either at Level 1 or unknown. Level 1 data are available for the eggs, larvae, early juvenile, and late juvenile stages of pollock, and for the late juvenile stages of most other groundfish species. Even minimal (Level 1) data are not available for forage fish at all life stages, so distribution and habitat use is considered to be unknown. Salmon EFH data are highly variable and crosses Levels 1 through 4 depending on species, stock, and life stage. The majority of the data available for adults in the freshwater stage ranges from Levels 1 to 3. The information levels for all EFH are continually being refined and updated and will be presented in the EIS currently being developed for EFH.

3.6.2 Identification of Habitat Area of Particular Concern

As defined above, HAPC are habitat types or areas that may require extra protection. While HAPC is managed in the non-specified species category (per BSAI and GOA amendment 65), these areas are included with EFH for description and impacts discussions in this Programmatic SEIS. HAPC is defined by the following criteria.

Ecological importance is defined as the value of a habitat type to a species at a particular life stage, based on ecological function. Where there are few studies and observations of ecological function, the ecological importance of a particular habitat type may need to be inferred from the presence of species life stages. When limited data are available about a species presence or absence, ecological importance may need to be inferred from the shelter or food items the habitat is capable of providing.

Sensitivity is defined as the degree to which a habitat feature is susceptible to degradation by exposure to activities, events, or conditions. The sensitivity of a given type of habitat to a disturbance regime depends on its ecological resistance (the ability to resist change during a disturbance) and resilience (the ability to return to its predisturbance condition). Several factors contribute to ecological resistance: 1) redundancy in function of component species; 2) tolerance to environmental fluctuations; 3) physical and chemical buffering capacity or flushing characteristics; and 4) proximity of the system to its ecological limits. Resilience has four components: elasticity, amplitude, hysteresis, and malleability. Elasticity is the time required for recovery, amplitude defines the level of disturbance that allows recovery, hysteresis describes the "path" of recovery, and malleability is a measure of the plasticity of the system (i.e., its capacity to persist in an altered state). Habitat types with low resistance and resilience have high environmental sensitivity, and habitats with high resistance and resilience have low environmental sensitivity.

Exposure is defined as the probability that a habitat feature will be exposed to activities, events, or conditions that may adversely affect it. These activities were discussed in the environmental assessment/regulatory impact review (EA/RIR) to the EFH amendments (NMFS 1998a). In the marine environment, numerous land-based activities expose nearshore habitat to potentially adverse impacts. The most obvious marine activity that affects habitat, and the one activity both NOAA Fisheries and NPFMC are most accountable for, is fishing.

Rarity is defined as how uncommon the habitat feature is relative to other available habitats. In Alaska, little is known of the geographic extent and distribution of many habitat features and types, particularly in the marine environment.

Vulnerability is determined by a combination of the above factors, the area or habitat type and the priority it will be assigned for consultations. Vulnerable habitat can be defined as habitat that is susceptible to perturbation by natural or human events or activities. Such perturbation would include physical damage to or removal of features, or more general degradation of the condition or quality of an area. Physical damage and removal could be caused, for example, by anchors dragging through submerged aquatic vegetation. Degradation of quality could be caused, for example, by activities that negatively affect water quality, which, in turn, could have repercussions such as impeding the reproductive success of submerged aquatic vegetation.

Three habitat types in Alaska that meet all of the above criteria as specified in the interim Final Rule are: living substrates in shallow water, living substrates in deep water; and freshwater areas used by anadromous fish. As such, these three types were adopted as part of the five EFH amendments to Alaska's Fishery Management Plans.

These habitat types have important ecological functions, are sensitive and vulnerable to human impacts, and are relatively rare. The first two types are described below, but given that this Programmatic SEIS is concerned with the groundfish fishery, freshwater areas used by anadromous fish are not discussed further.

3.6.2.1 Living Substrates in Shallow Water

HAPCs 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 for some species, such as Atka mackerel and yellowfin sole, and may have a high potential to be affected by shore-based activities.

Shallow nearshore areas (less than 50 m depth) provide important structural habitat for early juvenile instars of red king crab. Early juvenile instars are cryptic and occupy the protective refuges provided by high-relief habitat or coarse substrate, such as boulders, cobble, shell hash, and living substrates (macroalgae, bryozoans, stalked ascidians, etc.) (Sundberg and Clausen 1977). Adult red king crabs also use highly structured shallow water habitat during the mating period and will use macroalgae as cover during this period (Stone *et al.* 1993).

All nearshore marine and estuarine habitats used by fish, such as eelgrass 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 areas near intensive development activities.

Juvenile rockfish are known to use eelgrass beds (Murphy *et al.* 2000). Herring also require living substrates in shallow water for reproduction. Spawning takes place near the shoreline between the high tide level and 11 m depth. Herring deposit their eggs on vegetation, primarily rockweed (*Fucus spp.*) and eelgrass (*Zostera spp.*). These seaweeds are found along much of the Alaska coastline, but they often occur in discrete patches.

3.6.2.2 Living Substrates in Deep Waters

HAPCs include offshore areas with substrates of high microhabitat diversity that serve as cover for groundfish and other organisms. These can be areas or habitat types with rich epifaunal communities (e.g., coral, sponges, anemones, bryozoans), or with large particle size (e.g., boulders, cobble). Since many deep water areas are characterized as stable environments dominated by long-lived species, the impacts of fishing can be substantial and long-term (Auster and Langton 1999).

Coral, for example, is a living substrate in deep water that has been defined as a type of HAPC. Coral is a common name for a number of diverse invertebrate species within the phylum Coelenterata. Five major taxonomic groups and at least 34 species of coral occur in waters off Alaska (Cimberg *et al.* 1981): Alcyonacea (soft corals), Gorgonacea (sea fans, bamboo corals, and tree corals), Scleractinia (cup corals or stony corals), Stylasterina (hydrocorals), and Antipatharia (black corals). Heifetz (2002) analyzed the distribution and abundance of corals based on trawl survey data collected during 1975-1998. Soft corals were most frequently encountered in the Bering Sea, while in the Aleutian Islands, gorgonian corals were most common; the Aleutian Islands also were found to have the highest diversity and abundance of corals. In the GOA, gorgonian corals and cup corals were dominant.

Some corals grow upright and branch out, whereas other species are low-growing encrusting forms. In Alaska, gorgonian corals, particularly members of the genera *Primnoa* (red tree coral) and *Paragorgia*, may be especially valuable as fish habitat due to their longevity and large size–they grow up to 3 m high and 7 m wide. Heifetz (2002) found certain fish groups to be associated with particular types of coral. For example, rockfish and Atka mackerel were the most common fish captured with gorgonian, cup, and hydrocorals, while flatfish and gadids were the most common fish captured with soft corals.

Gorgonian corals are colonies of animals composed of individual polyps that deposit a tree or fanlike skeleton that supports the colony. In general, corals are very slow-growing organisms. Some species of gorgonians may live to be over 100 years old (Risk *et al.* 1998, Andrews *et al.* 2002). Large *Primnoa* colonies may be hundreds of years old; a 5 cm diameter specimen of *Primnoa reseda* from Nova Scotia, Canada was estimated at 500 years, using isotope dating (Risk *et al.* 1998). The habitat created by these gorgonians may be occupied by communities with high biodiversity and may provide shelter for fish (Risk *et al.* 1998, Fossa *et al.* 1999). Given their size and longevity, gorgonian corals may be especially vulnerable to fishing impacts and may take over 100 years to recover (Andrews *et al.* 2002). Although scientists have limited understanding of its importance as fish habitat, deep water coral clearly provides vertical structure for fish to use for protection and cover. This has been observed in Alaska during submersible dives (Krieger and Wing 2002).

3.6.3 Management History

Passage of the MSA in 1976 marked the beginning of efforts to integrate habitat considerations into the fishery management process. The MSA directs the RFMCs to recommend management plans for commercial and recreational species of fish occurring in the EEZ. For the most part, the individual states have responsibility for managing fisheries within the territorial sea. Although some early efforts were made to address significant fishery habitat issues, the RFMCs and the NOAA Fisheries concentrated largely on ocean harvest during the first decade after passage of the MSA.

In 1983, NOAA Fisheries adopted a National Habitat Conservation Policy, uniting its MSA authority with its advisory responsibilities and authority under the Fish and Wildlife Coordination Act and NEPA. The Habitat Conservation Policy provides guidance to NOAA Fisheries regarding interactions with the RFMCs and with federal and state agencies. It also focuses NOAA Fisheries' habitat conservation efforts on specific habitat impacts potentially affecting fishery resources, marine mammals, and endangered marine species. Although the policy notifies other agencies and the RFMCs of NOAA Fisheries' intent, it does not clarify the RFMCs' role in fishery related habitat issues.

In 1986, Congress amended the MSA, essentially codifying elements of the NOAA Fisheries Habitat Conservation Policy and giving the RFMCs new authority and responsibility to include "readily available" habitat information in all FMPs. The amendments to the MSA direct the RFMCs, with guidance from NOAA Fisheries, to evaluate any effects that habitat changes may have on managed fisheries. Furthermore, the 1986 amendments give the RFMCs the opportunity to recommend habitat management measures for ongoing and proposed federal and/or state activities that could potentially adversely affect fishery resources. Federal agencies are required to respond specifically and substantively to NPFMCs recommendations within 45 days. The amendments also encourage the RFMCs to monitor state activities and to comment on those activities that could adversely affect NPFMC-managed fishery resources.

In September 1988, NPFMC adopted a policy to guide the review of habitat issues:

> *The Council shall assume an aggressive role in the protection and enhancement of habitats important to marine and anadromous fishery resources. It shall actively enter federal decision-making processes where proposed actions may otherwise compromise the productivity of fishery resources of concern to NPFMC Recognizing that all species are dependent on the quantity and quality of their essential habitats, it is the policy of the NPFMC to:*
>
> *Conserve, restore, and maintain habitats upon which commercial, recreational and subsistence marine fisheries depend, to increase their extent and to improve their productive capacity for the benefit of present and future generations. (For purposes of this policy, habitat is defined to include all those things physical, chemical, and biological that are necessary to the productivity of the species being managed.)*
>
> *This policy shall be supported by three policy objectives which are to:*

> *(1) Maintain the current quantity and productive capacity of habitats supporting important commercial, recreational and subsistence fisheries, including their food base. (This objective will be implemented using a guiding principle of no net habitat loss caused by human activities).*
>
> *(2) Restore and rehabilitate the productive capacity of habitats which have already been degraded by human activities.*
>
> *(3) Maintain productive natural habitats where increased fishery productivity will benefit society.*

In light of these policy objectives, NPFMC and NOAA Fisheries have enacted certain measures that are consistent with protecting habitat and ecosystem components from potential negative impacts of fisheries. These measures include gear restrictions, time and area closures, and harvest restrictions. Of these three measures, the most widely used is closure of areas to certain gear types. A chronology of management measures undertaken by NPFMC with the primary intent or secondary effect of protecting habitat is provided in Table 3.6-1. Figure 3.6-1 depicts the groundfish closures presently enacted in Alaska's EEZ.

3.6.4 Effects of Fishing on Habitat

Benthic habitat encompasses seafloor habitat that is generally believed to be at greater risk to the impacts of fishing than non-benthic habitat in the water column. Therefore, the focus of the following analysis of past and present effects is on impacts to benthic habitats. However, discussions concerning the primary components of non-benthic habitat (physical, biological, and chemical properties of the water column) are provided. For example, Section 3.3.1 considers the effects of fishing on the physical and chemical properties of the water column; biological components are discussed in Section 3.5.4, 3.5.5 (discussion forage fish and non-specified species, respectively) and Section 3.10 (ecological relationships including predator-prey relationships and energy removal and flow between target species and other species).

In order to assess the potential effects of fishing gear on benthic habitat it is first important to characterize the type of fishing gear used, the intensity of fishing as determined by trawling patterns, and the type of substrate fished or encountered. The following subsections describe these different factors and their relative importance in predicting effects.

3.6.4.1 Gear Types

Three main classes of fishing gear are used in the Alaskan fisheries: otter trawls, longlines, and pots. Each gear type has several components or characteristics that determine its overall effect on the benthic environment. Effects of the gear are also dependant on the vulnerabilities of the substrate and organisms.

Otter Trawls

Otter trawls pull conical nets through the water; fish that encounter the open forward end are gathered into a restricted bag (codend) at the back of the net. Otter trawls have four main components that can contact the seabed: doors, sweeps, footrope, and netting.

Doors are flattened metal structures that ride vertically in the water column; their weight and force through the water act to horizontally spread the net open and force it down into the water. Some bottom trawl doors use contact with the seafloor to accomplish the spreading and downward pull. On pelagic trawls the net is pulled above the seafloor and the doors are unlikely to contact the bottom. Trawl doors used in Alaska are typically less than 9 ft long.

Sweeps are steel, fiber or combination steel and fiber cables which connect the doors to the trawl net. The cables pass over the bottom at a narrow angle from the direction of travel and herd near-bottom fish toward the net. When used on bottom trawls, these cables commonly contact the seafloor and often have protective disks strung on them. Lengths of the sweeps will vary with target species fished, substrate, and individual vessel preference. A large vessel targeting flatfish on smooth bottom may use 1,000 ft of sweeps, while a small rockfish trawler on rough bottom may only use 100 ft.

The footrope of the trawl is a cable or chain connected along the bottom edge of the trawl net and is designed to contact the seafloor on bottom trawls. The footrope usually has rubber cones, spheres or disks, collectively known as bobbins, strung along its entire length. The bobbins serve to limit damage to the netting and reduce bycatch of crabs and other invertebrates. Alternately, tire gear is used in the center net section, particularly in the Atka mackerel fishery and in the GOA fisheries for cod, rockfish and Dover and rex sole. Tire gear consists of vehicle tires or sections of tires linked side-by-side to form a continuous cylinder. This gear is effective at protecting the netting and allows fishing in areas of rough substrates where fishing would not otherwise be possible.

The netting is the least likely component of bottom trawls to directly contact the seafloor. The bobbins or tire gear act to raise the netting so that only very prominent seafloor features touch the netting without entering the trawl. The codend can contact the seafloor, particularly when it contains rocks, substrate, or numerous fish. In order to allow the net to be pulled up the stern ramp of the vessel, the codend is usually no more that 8 ft in diameter, thereby limiting the amount of bottom potentially impacted by this part of the net. The size of vessel determines the width of the trawl net fished and whether a high opening, or wide, low trawl is selected. Typically bottom trawls range in width from 36 to 90 ft across.

The pelagic trawl is a specially modified otter trawl that is designed for harvesting fish that inhabit the waters above the seabed. These trawls, which are very important in the Alaska groundfish fisheries, have very large mesh opening in the forward sections and the doors are fished above the bottom. By regulation, these trawls must not use bobbins or other protective devises, so the footropes are small in diameter, and typically consist of bare chain. Since they are fished with the doors above the seafloor, the doors have no effects on substrate. The footrope is unprotected; therefore, these trawls are not used on rough or hard substrates and are less likely to contact some of the most vulnerable habitats (Rose In preparation). Night fishing tends to be more “off-bottom” than day fishing, and fishing in high-relief hard bottom areas is all “off bottom.”

Longlines

Demersal longlines consist of two buoy systems that are situated on each end of a mainline to which leaders (gangions) and hooks are attached. The mainline is usually made of sinking line and can be several miles long and have several thousand baited hooks attached. Small weights may be attached to the mainline at intervals. At the bottom of each buoyed end is a weight or an anchor. A vessel may set a number of lines, depending on the area, fishery, and site. The principal components of the longline that can contact the seabed are the anchors or weights, the hooks, and the mainline (ICES 2000 as referenced in NMFS 2001b).

In Alaskan waters, longline gear is fished on the bottom. Some vessels attach weights to the longline, especially on rough or steep bottoms so that the longline stays in place and on the bottom. Average set length in 1996 was 6 miles for the sablefish fishery, 10 miles for Pacific cod, and 4 miles for Greenland turbot. The gear is baited by hand or by machine with smaller boats tending to bait by hand. Circle hooks are usually used; however J-hooks are more common with machine baiters. The gear is deployed from the stern of the vessel while traveling at 5 to 7 knots.

Pots

Pots are enclosures that retain entering fish. Pots used in the Alaska cod fishery are generally modified from the designs developed for the crab fishery and include one-way entrances that are modified to prevent fish escape. The most common design is a rectangular frame approximately 6 ft by 6 ft by 3 ft, constructed of welded steel rods with entrances on opposite walls. Pots weigh between 500 and 700 pounds, and the weight is not greatly reduced by immersion in water. In Alaska, regulations require that each pot have its own buoyed line, so there are no underwater lines connecting adjacent pots. Each pot is sufficiently heavy that no additional anchors are required.

3.6.4.2 Trawling Patterns

Bering Sea

The continental shelf and slope region off the coast of Alaska comprises one of the most extensive fishing grounds in the world (NRC 2002). Bottom trawling in the Bering Sea began in 1929 with a Japanese operation and continued through the 1930s and early 1940s, recommencing in the 1950s after World War II. Soviet and other distant water trawl fishing operations intensely fished the Bering Sea and GOA through the 1960s and 1970s. Domestic bottom trawling began as joint ventures in the Bering Sea in 1978 after passage of the MSA in 1976. These U.S. trawl activities grew rapidly during the 1980s and had displaced foreign fishing by the end of the 1980s. Presently the groundfish fleet is divided into catcher vessels and catcher processors. In 1999, the catch was almost equally divided between the two sectors (NMFS 2001a).

Therefore, virtually all areas of the Bering Sea have experienced some degree of exposure to bottom trawls (Figure 3.6-2). However, the intensity of exposure, measured in trawls made per unit area, varies substantially. These patterns reflect the non-random behavior of fishing fleets, which is based on historical patterns of performance and regulatory restrictions. Relatively heavy trawling has occurred in three places: along the shelf edge, along the Alaska Peninsula near Unimak Island, and in Togiak Bay. The primary composition of the catch in these three areas, respectively, was pollock, Pacific cod and Greenland turbot; Pacific cod and pollock; and yellowfin sole (Fritz *et al.* 1998).

Bottom trawling in the Bering Sea during the early 1990s was most intense on the slope and shelf area north of the Aleutian Islands (NRC 2002). The Alaska peninsula in the area of Unimak Island, east of the Pribilofs west of Bristol Bay and off of Cape Constantine, was also heavily fished. However, large areas of the Bering Sea have no trawling activity because of closed management areas, less productive fishing grounds, or unobserved tows. However, both the spatial extent and intensity of fishing effort decreased in the 1990s. Over large parts of the Bering Sea there were either no observed bottom trawls or only about four tows averaged over two years (NRC 2002). Also see: http://www.afsc.noaa.gov/race/groundfish/habitat/hist_trawldata.htm for additional information.

GOA and Aleutian Islands

Coon *et al.* (1999) described the spatial and temporal patterns of bottom trawl effort in the GOA and Aleutian Islands from 1990 to 1998 by analyzing domestic observer data. The greatest bottom trawl effort in the GOA has taken place in the Kodiak Island region (Figure 3.6-3), where directed fisheries have targeted Pacific ocean perch, Pacific cod, and flatfish. In the Aleutian Islands, intense bottom trawl effort (Figure 3.6-4) has been directed at Atka mackerel and Pacific ocean perch. There has been a significant reduction in the geographic extent and intensity of trawling in the Aleutian Islands and the GOA also. The number of tows in the region was reduced by about half due to management area closures and general reductions in fishing effort associated with fisheries management and reduction of TAC. In considering the fishing effort distribution, it is important to consider that, even within depth-area strata, fishing effort is not evenly distributed. Some areas are rarely fished and some are fished frequently.

3.6.4.3 Type of Substrate Fished

Most bottom fishing off the coast of Alaska takes place on the continental shelf and upper slope in water depths of less than 500 m. The seafloor affected, or potentially affected, covers a wide range of habitats, from relatively featureless sand and mud, to more complex rocky areas, or areas of HAPC. Hard substrates and rocky areas provide the most habitat complexity for the benthic community and are likely to be more vulnerable to fishing disturbance.

NOAA Fisheries and the AFSC are currently conducting research to map limited areas of the Alaska EEZ for geographic characterization. During 2001, 900 km^2 of seafloor near Kodiak were mapped using a high-resolution multi-beam echo-sounder. In July 2002, an additional 500 km^2 of seafloor near Yakutat were mapped. Survey depths ranged from 100 m to 760 m and the seafloor consisted of irregular seabed with mixed sediments (sand, mud, gravel) and high-relief areas consisting of boulders. The mapping of the area allows habitat characterization to be compared to fishing intensity for analysis of impacts. See: http://www.afsc.noaa.gov/Quarterly/jas2002/divrptsABL2.htm for additional information on the results of this study.

Four habitat types in the Bering Sea shelf were defined by (Rose, in preparation) using habitat sediment data in Smith and McConnaughey (1999). Figure 3.6-5 depicts these habitat strata. The first, situated around the shallow eastern and southern perimeter of the shelf and near the Pribilof Islands, consists of sand substrates with a small amount of gravel.

The second lies across the central shelf out to the 500 m contour and is composed of mixtures of sand and mud. This sand/mud habitat of the EBS is subject to a high level of effort from a variety of fisheries, pollock fishing accounts for the largest effort with substantial contributions from trawling for flathead (and other) sole, yellowfin, and rock sole and a lesser proportion from cod trawling (Rose, in preparation).

A third strata, west of a line between St. Matthew and St. Lawrence Islands, is composed primarily of mud (silt) substrates with some sand mixed in. The fourth strata is found north and east of St. Lawrence Island including Norton Sound and consists of a complex mixture of substrates that are not easily separated out or defined; however, this areas is subject to very little fishing effort.

A similar compressive substrate data set does not exist for the GOA and Aleutian Islands. Compared to the Bering Sea, the GOA has relatively weaker currents and tidal action near the seafloor and, therefore, a variety of seabed types such as gravely-sand, silty-mud, and muddy to sandy gravel, as well as areas of hardrock are found there (Hampton *et al.* 1986). For both of these areas, sufficient data to describe the spatial distributions of these substrates does not exist. However, data collected from AFSC groundfish surveys regarding "trawlability" were compiled to approximate percentages of hard substrate in the following depth strata (Rose, in preparation):

- Shallow waters (1-100 m) - 19 percent hard substrate.
- Deeper areas on the shelf (gullies; 100-300 m) - 5 percent hard substrate.
- Upper slope (200-500m) - 10 percent hard substrate.

These areas are also depicted on Figure 3.6-5. However, the percentages of hard bottom substrate as derived from "trawlability" data are limited in interpretation due to several factors:

- A standard trawl may function well on hard substrate consisting of smoother pebbles and cobbles.
- Trawlable bottom may be found in areas of mostly hard substrate.
- Patches of soft bottom may exist in otherwise untrawlable areas.

Investigations of the northeast GOA shelf (less than 200 m) have been conducted between Cape Cleare (148°W) and Cape Fairweather (138°W) (Feder and Jewett 1987). The shelf in this portion of the GOA is relatively wide (up to 100 km). The dominant shelf sediment is clay silt that comes primarily from either the Copper River or from the Bering and Malaspina Glaciers. When the sediments enter the Gulf, they are generally transported to the west. Sand predominates nearshore, especially near the Copper River and the Malaspina Glacier.

Most of the western GOA shelf (west of Cape Igvak) consists of slopes characterized by marked dissection and steepness. The shelf consists of many banks and reefs with numerous coarse, clastic, or rocky bottoms, and patchy bottom sediments. In contrast, in the vicinity of Kodiak Island, the shelf consists of flat, relatively shallow banks cut by transverse troughs. The substrate in the area from Near Strait and the vicinity of Buldir Island, Amchitka, and Amukta Passes is mainly bedrock outcrops and coarsely fragmented sediment interspersed with sand bottoms.

The relative significance of seabed disturbance by mobile and other fishing gear must be considered in light of the magnitude and frequency of seabed disturbance due to natural causes. DeAlteris *et al.* (1999) found that in a shallow, sand substrate where natural processes are disturbing the seabed regularly, recovery of the substrate from gear-related disturbance was almost immediate. However, in deep, mud substrates the analyses indicated that natural processes are rarely capable of disturbing the seabed; therefore recovery from gear-related disturbance was slow. Many studies summarized by NRC (2002) and NMFS (2002c) indicate that more stable, biogenic, gravel and mud habitats experience the greatest impacts from trawling and have the slowest recovery rates. By comparison, those areas with less consolidated, coarse sediments that also typically experience high rates of natural disturbance, show fewer impacts. These habitats tend to be populated by opportunistic species that recolonize the area rapidly, thereby reducing recovery times.

3.6.4.4 Fishing Effects

It is important to distinguish between the direct and indirect effects of trawling and dredging on marine habitat (NRC 2002). Direct and immediate effects of fishing gear potentially include the following:

- Mortality either as part of the catch or incidentally by killing benthic and demersal species or increasing their vulnerability to predators.

- Increased food availability for scavengers due to discarded fish, fish offal and dead benthic organisms.

- Loss of habitat due to scraping and plowing thereby destroying seafloor habitat.

Indirect effects are removed in space and/or time from the actual fishing activity. These effects include post-fishing mortality, and reductions in total biomass of target fish. The reductions in biomass could subsequently affect predators, prey, competitors of the targeted species, and the overall benthic community structure. Indirect effects also could also be realized at the ecosystem level due to potential changes in energy flow and shifts in the processes of primary production, primary consumption, and secondary production (NRC 2002).

Therefore, the following are types of potential effects from fishing gear on habitat:

- Alteration of the physical structure.

- Direct mortality of benthic organisms.

- Sediment suspension.

- Physical and chemical modifications to the water column.

- Benthic community changes.

- Ecosystem changes.

Alteration of Physical Structure

Physical effects of fishing gear such as ploughing, smoothing of sand ripples, removal of stones, and turning of boulders can act to reduce the heterogeneity of the sediment surface. Boulder piles, crevices, and sand ripples can provide fish and invertebrates hiding areas and a respite from the need to swim against currents (Rose, in preparation). Removal of taxa such as worm tubes, corals, and gorgonians that provide relief and the removal or shredding of submerged vegetation can also occur, thereby reducing structures available to biota as habitat (see NMFS 2002c, Kaiser *et al.* 1998, Lindebloom and de Groot 1998, Auster and Langdon 1999).

Any type of fishing gear that is towed, dragged, or dropped on the seabed will disturb the sediment and the resident community to varying degrees. The intensity of disturbance is dependent on the type of gear, sediment type, and frequency of disturbance. Heavy gear such as the shellfish dredge and the flatfish beam trawl disturb the seabed intensely. Lighter gear, such as the otter trawl predominately used in Alaska, also cause disturbance mostly due to the trawl doors and foot ropes which can leave tracks or trenches up to several meters wide and can remove or displace boulders (Hall 1999b). There are no studies of fishing gear effects that use gear directly comparable to Alaskan pelagic trawls.

Penetration into soft mud will be considerably greater than into hard-packed sands, and effects on infauna would occur accordingly. For example, Churchill (1989) estimated that coarse sand was typically penetrated to a depth of 1 cm by otter boards whereas the penetration for fine and muddy sand was as much as 2 cm. In a summary of the effects of bottom trawls in muddy substrates, NMFS (2002c) concluded that tracks made by trawl doors can remain visible for up to 18 months. However, in shallow sandy bottom sites, tracks were no longer visible after a few days. Other researchers have determined that parts of mobile gear can penetrate up to 30 cm into the substrate (Drew and Larson 1994 as referenced in the NMFS 2001b).

Specifically, Freese *et al.* (1999) conducted experimental trawling using an otter trawl over a cobble/boulder (93 percent pebble) habitat in the eastern GOA (water depth 206-274 m). The researchers found tire marks from the trawls to be visible as disturbance to substrate or to overlying silt. On compact substrate with more cobble, the trawl path was visible as a darker band because the layer of lighter colored silt was removed. On less compact substrate the trawl path was visible as furrows ranging from 1-8 cm deep. This work concluded that a single trawl pass can displace boulders and remove or damage large epifaunal invertebrates. In a subsequent study conducted at the same site, Freese (2003) found that furrows in the substrate were still prominent after one year. Boulders that had been moved by the trawl in 1996 were also easily identified.

A number of papers describe trawl marks on substrate, including Gilkinson *et al.* (1998), who describe the scouring process in detail as part of a model door study. It is not known if the trenches might compensate for the sediment smoothing actions of other gear (NMFS 2002c). The actions of roller gear trawls can replace one type of natural sediment structures (hummocks, biogenic features, and sand ripples) with other, anthropogenic forms (door, footrope, and roller tracks). In habitats with an abundance of such natural structures, this can represent a decrease in habitat complexity, while in naturally smooth areas, an increase in complexity would be apparent.

Very little information exists regarding the effects of longlining on benthic habitat. The principal longline components that can produce seabed effects are the anchors weights, hooks and mainline (ICES 2000). Rose (in preparation) If very light weight lines are used with longline gear, effects on substrate and benthic organisms would be limited to the impact of anchors and weights (Rose in preparation). These make up less than 1/500th of the total length of the gear, so effects on the soft bottoms should be very small. However, effects in hard bottom areas could be realized through snagging on smaller boulder piles and other emergent structures.

In a report presented by NPFMC (1992b), the authors determined that setline gear often lies slack and can meander for a considerable distance along the bottom, a phenomenon confirmed by observations of halibut gear made by NOAA Fisheries scientists during submersible dives off southeast Alaska. During the retrieval process, the line sweeps the bottom for considerable distances before ascending. It snags on objects in its path, including rocks and corals. Smaller rocks are upended, hard corals are broken; however, soft corals appear unaffected by the passing line. Invertebrates and other lightweight objects are dislodged and pass over or under the line. Fish, halibut in particular, frequently moved the groundline numerous feet along the bottom and up into the water column during escape runs, disturbing objects in their path. This line motion was noted for distances of 50 ft or more on either side of the hooked fish.

Although little research has been conducted to document the impacts to physical structure from pot gear, it is likely that benthic structures (both living and non-living) could be impacted as the pots are dropped or dragged along the bottom. Eno *et al*. (2001) observed that impacted sea pens were able to recover within 72 to 144 hours of the pots being removed. The study concluded that the use of pots and traps had no lasting effects on three different habitat types. However, this study used gear much smaller and lighter than that used in Alaska waters, so the results are not directly applicable. Alaska pots have mesh bottoms that are suspended 2.5 to 5 cm above the weight rails that initially contact the substrate (Rose in preparation). Therefore, the greater weight of the pots is concentrated in a smaller area beneath the pot. Also of concern is the incidence of bottom disturbance by the weight rails as the pot is dragged across the seafloor by bad weather, currents, or during hauling. Rose (in preparation) assumes that the average pressure applied to the seafloor along the rails would be sufficient to penetrate into most substrates during lateral movement. This effect was speculated to be most similar to the effects of pelagic trawls.

Direct Mortality of Benthic Organisms

In addition to effects on the physical habitat, fishing gear can cause direct mortality to emergent epifauna. In particular, erect, foliose fauna or fauna which build reef-like structures have the potential to be destroyed by towed gear, longlines, or pots (Hall 1999b). Within the trawl tracks that could range up to several meters wide, epifauna such as sponges, corals, or gorgonians are often removed, crushed, or broken (Van Dolah *et al.* 1987). Freese *et al.* (1999) found during experimental trawling studies in the GOA that no motile invertebrates showed reductions in density as a result of trawling. The researchers also note that apparent damage to echinoids, holothurians, molluscs, and arthropods was less than 1 percent. However, substantial quantities of broken sponges and other material were brought up by the trawl, but the numbers of individuals impacted could not be enumerated.

In addition to mobility, the physical structure of the biota determines their ability to withstand and recover from the physical impacts of fishing gear. For example, thinner shelled bivalves and seastars often suffer higher damage than solid shelled bivalves (Rumohr and Krost 1991). Animals that can retract below the penetration depth of the fishing gear and those that are more elastic and can bend upon contact with the gear also fare much better than those that are hard and inflexible (Eno *et al.* 2001).

Specifically, Freese *et al.* (1999) conducted trawling impact studies in the GOA in 1996. A total of 29 taxa were identified from video transects. "Vase" sponges accounted for most of the invertebrate biomass because of their large size and high density. These sponges were especially susceptible to trawl damage. Other sponges were damaged by being knocked over onto the substrate when the cobble and pebbles to which they were attached were rolled by the trawl tire gear; individuals attached to boulders usually escaped damage. The only other large erect sessile invertebrate observed in the transects was the reticulate anemones *Arctinauge verelli* and sea whips *Stylea* sp. Over half of the sea whips were either broken or had been pulled out of the substrate, while there was no evidence of trawl damage to *A. verelli.* In a subsequent study done one year later, Freese (2003) revisited three of the transects observed in 1996. He found no new colonization of sponges to be apparent in any of the observed trawl paths, and that unlike sponge communities in warm shallow waters, communities at this site in the GOA did not appear to have the ability to return to pre-trawl population-levels after one year, nor do individual sponges have the ability to recover quickly from wounds suffered from trawl gear. However, since the study only covered a one-year period, recovery rates for these cold water species may be in excess of several years and not enough information exists at present to predict actual long-term recovery rates.

Sediment Suspension

Resuspension of sediment can occur as fishing gear is pulled along or immediately above the seafloor (NMFS 2002c). The resuspension is not unique to mobile fishing gear and can occur with longlines and pots also. The chronic suspension of sediments and resulting turbidity can affect aquatic habitat by reducing available light for photosynthesis, burying benthic biota, smothering spawning areas, and causing negative effects on feeding and metabolic rates. If occurring over large areas, resuspension can redistribute sediments having implications for nutrient budgets by burying fresh organic matter and exposing deeper anaerobic sediments (Messieh *et al.* 1991, Black and Parry 1994, Mayer *et al.* 1991, and Pilskaln *et al.* 1998).

Species' reactions to turbidity depend on life history characteristics of the organism. Effects are likely to be more significant in waters that are normally clear as compared with areas that typically experience high naturally induced turbidity (Kaiser 2000). Mobile organisms can move out of the affected area and quickly return once the turbidity dissipates (Coen 1995). Even if species experience high mortality within the affected area, those with high levels of recruitment or high mobility can repopulate the affected area quickly. Sessile or slow-moving species would likely be buried and could experience high mortality. If effects are protracted and occur over a large area relative to undisturbed area, recovery through recruitment or immigration will be hampered. Furthermore, chronic resuspension of sediments may lead to shifts in species composition by favoring those species that are better suited to recover or those that can take advantage of the additional nutrient supply as the nutrients are released from the seafloor to the euphotic zone (Churchill 1989).

Chemical Modifications to the Water Column

Disturbance due to fishing gear can cause changes in the chemical composition of the water column overlying impacted sediments. In shallow water, the impacts may not be noticeable relative to mixing effects caused by tidal and storm surges, and wave action. However, in deeper, calmer areas with more stable waters, the changes in chemistry may be evident (Rumohr 1998 as referenced in NMFS 2002c). Increases in ammonia content and decreases in oxygen have been observed in the North Sea waters, along with pulses of phosphate. Although these changes have been documented, it is not clear how they affect fish populations. Increased incidence of phytoplankton blooms could occur during seasons when nutrients are typically low. The increase in primary production could have a positive effect on zooplankton communities and on organisms up the food chain. Eutrophication, often considered a negative effect, could also occur. However, it is important to note that these releases of nutrients to the water act to recycle existing nutrients and thereby make them available to benthic organisms rather than add new nutrients to the system (ICES 1992). The recycling is thought to be less influential in the eutrophication process than the input of new nutrients from rivers and land runoff.

Changes to the Benthic Community and Ecosystem

Benthic community structure can be impacted due to direct mortality of benthic organisms potentially causing a shift in the community from low-productive long-lived species (k-selected species) to highly-productive, short-lived, rapidly-colonizing species (r-selected species). Motile species that exhibit high fecundity and rapid generation times will recover more quickly from trawl-induced disturbance that non-mobile slow-growing organisms leading to a potential community shift in chronically trawled areas (Levin 1984, NMFS 2002c).

Those organisms with long-lived larvae were only available for successful recolonization if the timing of disturbance coincided with periods of peak larval abundance; however, these species were able to colonize over much larger distances.

Specifically, McConnaughey *et al.* (2000) examined the effects of chronic trawling on soft-bottom benthos of the EBS. They found that overall species diversity and niche breadth of sedentary taxa were greater in unfished areas, but there were mixed responses within the motile groups. Lower diversity in heavily fished areas was the direct result of greater dominance by the sea star *Asterias amurensis*. To determine niche breadth for the 36 taxa that co-occurred in the heavily fished and unfished areas, the taxa were placed into three functional groups (motile, n = 16; sedentary, n = 13; infaunal, n = 7). Statistically significant differences were observed between the heavily fished and unfished areas for sedentary and infaunal organisms, but not for motile epifauna. The results indicate a more patchy distribution for the attached or non-motile members of the epibenthic community in the heavily fished area. For infaunal organisms (mainly bivalves), niche breadth was consistently greater in the heavily fished area. The authors conclude that macrofaunal biomass was higher in the heavily fished area, but the differences were not statistically significant.

Freese *et al.* (1999) postulate that reducing the number of sponges and associated invertebrate taxa also reduces the shelter value of the invertebrate community. The authors acknowledge that it is not known whether the change produces a measurable response in recruitment for any taxon and subsequent changes in the overall community. The authors conclude that these species (sponges and sea whips) are especially vulnerable to trawl damage, and extensive trawling over wide areas could impact spatial patterns of invertebrate diversity. Freese *et al.* (1999) also found an increase in the density of scavenging organisms in trawl tracks due to a chumming effect from damaged organisms.

As described above under *Direct Mortality*, the physical structure and/or mobility of biota often determines their ability to avoid, or withstand and recover from, the physical impacts of fishing gear. Therefore, a switch in dominant species based on these avoidance and survival traits could be evident in chronically trawled areas.

A potential problem that does occur with longline gear is ghost fishing of lost gear. Lost longline gear may continue to catch fish as long as bait exists on the hooks. Fish caught on the hook, may itself become a form of bait for subsequent fish. This lost gear will not stop fishing until all of the hooks are bare. The extent to which this occurs and its effects on community structure have not been analyzed.

Increased fishing pressure in a given area can also lead to changes in species distribution; changes could be evident in benthic, demersal, and even pelagic species (i.e., localized depletion). Authors have also speculated that mobile fishing may lead to increased populations of opportunistic feeders in chronically trawled areas.

3.6.5 Past and Present Effects Analysis

This section presents a discussion of the direct and indirect effects, external human controlled and natural events, and internal groundfish fishery events used for the past effects analysis. Table 3.6-2 provides a summary of the past effects analysis conducted specifically for EFH.

The past effects discussion focuses on specific direct and indirect effects of fishing on habitat that will be used to model the predicted effects for each alternative in Chapter 4 (Rose in preparation). The six types of potential effects on habitat as summarized in the literature and discussed in Section 3.6.4 are cross referenced to the effects to be modeled as follows:

Direct/ Indirect Effect Discussed from Literature	Corresponding Direct/Indirect Effect to be Modeled
Alteration of the physical structure	Changes to non-living habitat (1)
Direct mortality of benthic organisms	Changes to living habitat (2)
Sediment suspension	Changes to non-living habitat (1)
Physical and chemical modifications to the water column	Changes to non-living habitat (1)
Benthic community changes	Changes to living habitat (2) Epifaunal and infaunal prey effects (3)
Ecosystem changes.	Changes to living habitat (2) Epifaunal and infaunal prey effects (3)
Not applicable	Changes in distribution of fishing effort (4)

These effects are shown on Table 3.6-2. The following subsections describe the external and internal events and management actions applicable to the effects.

3.6.5.1 Past and Present Events

Events are described as activities or occurrences that have or had the potential to induce one or more of the effects listed above. Events can either be external or internal to the groundfish fishery. In addition, external events can either be human controlled or natural. As shown on Table 3.6-2, the following events which occurred both external to the groundfish fisheries and within these fisheries have been identified:

Dredging The action of bringing up sediment, either to deepen channels for navigation purposes, or to remove shellfish such as clams and scallops has the potential to change non-living and living habitat, and to affect epifaunal and infaunal prey. Dredging activities also resuspend large amounts of sediment and can potentially change the chemical and physical composition of the water column. If widespread and chronic these actions can cause overall changes to the benthic community.

Bottom Trawling The effects of bottom trawling and other mobile fishing gears on the physical structure of the benthos, sediment suspension, the chemical and physical composition of the water column, and benthic biodiversity (community structure) have been documented for Alaska (see Section 3.6.4), thereby changing living and non-living habitats and potentially affecting prey. External events related to bottom trawling include foreign fisheries pre-and post-MSA. These fisheries are described in more detail in Appendix B. There is also a small amount of bottom trawling conducted in the state fisheries (past and present). Internal events include the post-MSA JV fisheries and the domestic groundfish fisheries for pollock, rockfish, Atka mackerel, Pacific cod, and various flatfish.

Longline and Pot (fixed gear) Longline and pot fisheries have impacted living and non-living benthic physical structure, caused direct mortality of benthic organisms, resuspended sediment, and if extensive, could have modified epifaunal and infaunal prey in localized areas. It is unlikely that these fisheries would have caused ecosystem-wide effects. External activities or events employing fixed gear include: the IPHC-managed halibut fishery, State of Alaska managed crab fisheries, state shrimp pot fishery for spot shrimp (mainly in PWS, but was more extensive in the past), and subsistence fisheries. Fixed gear fisheries managed within the FMPs include Pacific cod, sablefish, and rockfish.

Offal Discharge This discharge has occurred both externally to the groundfish fisheries and within these fisheries. Offal discharge can alter physical structure of the benthos, cause direct mortality of benthic organisms through smothering, and resuspend sediment, alter the chemical and physical composition of the water column, and if extensive cause impacts to the benthic community or ecosystem. The latter two effects are more likely in a closed bay or system where water circulation is impeded. Significant amounts of deposition could decrease the oxygen available to benthos, creating anoxic conditions in which only a few species (mainly polychaetes) could survive. Examples of this have been observed in the past at Captain's Bay in Dutch Harbor. However, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions.

Vessel Groundings Within and externally to the groundfish fishery, vessel groundings have impacted the physical structure of the benthos and caused direct mortality of benthic organisms; these impacts if extensive could lead to changes in the benthic community on a very localized scale. It is unlikely that ecosystem impacts would be realized due to vessel groundings, and there are no documented impacts on EFH.

Port Construction and Development The construction and development of ports has occurred in coastal GOA and Aleutian Island regions. Development has likely caused the following impacts on the benthic community: alteration of physical structure, direct mortality, sediment resuspension, chemical and physical modification of the water column, and localized changes in community structure. It is unlikely that the overall ecosystem would not have been affected due to the localized nature of these events.

Petroleum Exploration and Facilities Minimal exploration and development of petroleum facilities has occurred in the GOA. Impacts are likely similar to those described above for Port Construction and Development (particularly in the Port of Valdez). While localized community changes have occurred (i.e., Port of Valdez), extensive ecosystem changes cannot be attributed to these activities.

Oil and/or Hazardous Materials Releases Releases of pollutants into both the BSAI and GOA environments have occurred. These range from small (< 10 gallon) spills to the EVOS incident that impacted areas of the GOA. Large spills cause direct mortality, alter the chemical composition of the water column, and cause changes to the structure of the benthic community. If very large, spills or incidents have the potential to impact the entire ecosystem.

Exotic Species Bilge or ballast water could introduce exotic species to new locations. Should the species survive, community impacts could be realized. It is unlikely that ecosystem impacts could occur unless the introduction was extensive, or other factors are involved. However, impacts on EFH have not been documented and are therefore unknown.

Toxic Algal Blooms These blooms have occurred in localized areas. These external events alter the physical and chemical composition of the water column and can cause mortality to benthic and pelagic organisms. “Toxic algal blooms” applies not only to toxic microscopic algae but also to non-toxic macroalgae (seaweeds) which can grow out of control and cause such ecological impacts as displacing indigenous species, altering habitat suitability, and depleting oxygen. However, long-term community and ecosystem changes are not likely since the community is adapted to their occurrence and unless already stressed by other factors can rebound. If unable to rebound, impacts include: alterations of marine food chains through adverse effects on eggs, young, and adult marine invertebrates (e.g., corals, sponges), sea turtles, seabirds, and mammals.

Storm Surges and Wind Generated Waves These external events have likely impacted EFH through physical alteration of the bottom structure and chemical and physical modification of the water column. Unless these events are long-term and extremely severe, or occur in conjunction with other events to stress the environment, community and ecosystem changes are not expected.

Climate Effects Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific Ocean (NMFS 2001a).

Volcanic Eruptions Impacts to EFH from volcanic eruptions that have occurred in the Aleutian chain, would only be realized if lava or ash reached the water. If so, impacts to the chemical composition of the water column, and indirect impacts to benthic and pelagic communities would have occurred; however, these impacts have not been documented for the BSAI or GOA. Ecosystem changes are only possible if the event was of a long duration or covered an extremely large area.

Earthquakes and Underwater Landslides Earthquakes and landslides have occurred in the GOA and Aleutian Islands. Impacts to benthic community could have occurred through burial and/or changes in the chemical composition of the water column. However, as with volcanic eruptions, impacts have not been documented for the BSAI or GOA. Ecosystem changes are only possible if the event was of a long duration or covered an extremely large area.

3.6.5.2 Past and Present Management Actions

Management actions are specific management decisions that have been determined to have had the potential to mitigate one or more of the direct/indirect effects shown on Table 3.6-2. External management actions are those determinations or regulations that have been enacted by agencies or governments outside of the jurisdiction of NOAA Fisheries and NPFMC. Nevertheless, these actions have been determined to have the potential to affect EFH in either a positive or negative manner. Internal management actions are those regulations internal to the BSAI and GOA FMPs.

External Actions

U.S. Multi- and Bi-Lateral Agreements

A detailed discussion of U.S. fisheries management prior to the MSA is presented in Appendix B. The U.S. had virtually no authority to impose regulations beyond its territorial sea (3 miles prior to 1966, then expanded to 12 miles by public law) and relied primarily on multilateral and bilateral international agreements. For example, in 1973, a bilateral agreement between the U.S. and Japan and the USSR included annual catch quotas, which reduced the catch of walleye pollock to 1.2 million mt by 1976. However, each country was still responsible for monitoring its catch quotas, the only internationally acceptable arrangement at the time. With the passing of the MSA and the increase of U.S. and JV groundfish fisheries, groundfish catch in the Bering Sea had dropped below 1 million mt by 1985 (NPFMC 2002a). Since these fisheries employed bottom trawling for the most part, it can be assumed that impacts to benthic habitat were reduced.

Circa 1980 Closures

The GOA groundfish FMP was implemented in 1978. The BSAI groundfish FMP was implemented in 1980. Both of these management plans were among the first produced under the MSA and reflect an early approach to federal fisheries management. For purposes of this Programmatic SEIS, and to assist in the description of the affected environment, a set of Circa 1980 maps was produced for two gear specific types: trawl gear (Figure 3.6-6) and fixed gear (e.g., hook-and-longline and pot gear; Figure 3.6-7). These figures illustrate a combination of spatial measures that were in effect at around that time.

The trawl map (Figure 3.6-6) is shown with three different closures types:

Blue:	No foreign groundfish fishing
Red:	No foreign groundfish trawling

Red Hatching:	Seasonal no foreign groundfish trawling

Although the seasonal closures are illustrated consistently (with the exception of the darker more restrictive seasonal closures around Kodiak Island) some of these seasonal trawl closures existed for the greater part of the year.

Trawl Gear	Percent of Fishable Area: *11.5%	Percent of EEZ *4.3%

* Does not include seasonal closures

The NOAA Fisheries Reporting Areas were not in affect at this time and are for reference only.

The fixed gear map (Figure 3.6-7) is shown with three different closures types:

Blue:	No foreign groundfish fishing
Green:	No foreign hook and line or pot fishing
Blue Hatching:	Seasonal no foreign hook and line fishing

Fixed Gear	Percent of Fishable Area: *21.0%	Percent of EEZ *7.8%

* Does not include seasonal closures

The NOAA Fisheries Reporting Areas were not in effect at this time and are for reference only.

These measures only regulated the foreign fishery conducted under a Governing International Fishing Agreement in the fishery and conservation zone seaward of the State of Alaska. Domestic vessels were not restricted by these spatial regulations. During the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to restrict foreign fishing areas and times so they would not conflict with domestic fisheries through bycatch of species important to U.S. fishermen and to reduce the potential for grounds preemption and gear conflicts. With the exception of the sablefish longline and pot fishery, and the halibut longline fishery, most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that back in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This again was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds.

Figures 3.6-6 and 3.6-7 only show the spatial restrictions and do not take into account the other regulations affecting the foreign fishery. In 1980, other measures were used including direct allocations of OY to foreign nations and specific gear restrictions. In 1980 the federal and state management of herring was still being developed, but by August 1980 the 35-mile-wide by 30-mile-long ADF&G statistical-reporting areas had been created.

Self-Monitoring of the Foreign Fishery in the EBS

Japan instituted some conservation and management measures independently including a LLP and area restrictions to ease U.S. and Canadian concerns about the Japanese trawl fisheries impact on Pacific halibut (Appendix B). Benthic habitat likely benefitted from these area restrictions.

Industry Self-Imposed Actions: Gear Restrictions

Preliminary FMPs banned bottom trawling in pollock spawning grounds (pre-MSA). Due to intensive bottom trawling by the foreign groundfish and JV groundfish fisheries, a bottom trawling ban was initiated in pollock spawning habitats by the 1977 BSAI Preliminary FMP. Several of the foreign groundfish fisheries also self-imposed regulations in order to reduce their effects on pollock spawning habitats.

Clean Water Act

Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. The Act established the basic structure for regulating discharges of pollutants into the waters of the U.S. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. A goal of the Act is to provide for the protection and propagation of fish, shellfish, and wildlife.

Oil Pollution Act of 1990

In the wake of the spill of the Exxon *Valdez*, Congress passed the Oil Pollution Act of 1990. The Oil Pollution Act of 1990 sets forth an extensive liability scheme that is designed to ensure that, in the event of a spill or release of oil or other hazardous substance, the responsible parties are liable for the removal costs and damages that result from the incident. A responsible party includes an owner, operator, or demise charterer of a vessel. A responsible party may be liable for removal costs and damages to natural resources, real or personal property, subsistence use, revenues, profits and earning capacity, and public services.

International Laws Regarding Marine Pollutants

The International Maritime Organization is the United Nations specialized agency responsible for improving maritime safety and preventing pollution from ships. Pollution of the marine environment by ships of all types, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL 73/78). MARPOL 73/78 is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years.

Any violation of MARPOL 73/78 within the jurisdiction of any party to the Convention is punishable either under the law of that party or under the law of the flag state. In this respect, the term "jurisdiction" in MARPOL 73/74 should be construed in the light of international law in force at the time MARPOL 73/78 is applied or interpreted. With the exception of very small vessels, ships engaged on international voyages must carry on board valid international certificates which may be accepted at foreign ports as evidence that the ship complies with the requirements of MARPOL 73/78.

Internal Actions

Groundfish management measures intended to protect habitat, or that indirectly protect habitat by reducing fishing effort are described below:

<u>Fishing Equipment Restrictions</u>

Seasonal and Areal Restrictions on the Use of Specified Equipment

Many gear types and fisheries are prohibited seasonally or in some areas (see Table 3.6-1). For example, trawl fisheries are closed by regulation from January 1 to January 20 (BSAI Amendment 19, GOA Amendment 24). Longline fisheries for sablefish are prohibited from January 1 to March 15. Nonpelagic trawl (e.g., bottom trawl) gear has been prohibited in the directed pollock fishery in the BSAI (BSAI Amendment 57). Figure 3.6-1 shows existing BSAI and GOA areas closed to groundfish trawling. As shown on Table 3.6-1, both the BSAI and GOA had increased trawl area closures beginning in 1994.

Equipment Modifications

Some modifications have been done to equipment to allow escapement of particular species or life stages. Pots that are used to harvest groundfish are required to have a minimum mesh size or rings to reduce the capture of juveniles and female crabs (BSAI Amendment 16, GOA Amendment 21). Escape panels have been used for trawl gear to reduce the capture of halibut and pollock. Although a proposal for trawl mesh restrictions was evaluated several years ago, it was not implemented due to enforcement difficulties and other concerns. Recent research suggests that because many pollock that escape from trawls may have delayed mortality (Alaska Fisheries Development Foundation 1999), a regulation specifying a minimum mesh size may be counter productive.

Prohibitions on Anchoring or Setting Equipment in Sensitive Areas

No anchoring (or fishing) by vessels holding a Federal fisheries permit or by vessels engaged in commercial or sport halibut fishing is allowed in a 2.5 nm^2 area surrounding the pinnacles off Cape Edgecumbe (GOA Amendment 59). Other sensitive areas have been closed to trawling to protect habitat from potential adverse effects (see Time and Area Closures below).

Prohibitions on Fishing Activities that Cause Physical Damage

Many fishing methods (including chemicals, explosives, hydraulic dredges, bottom gillnets, etc.) have been prohibited to protect habitat from physical damage. By regulation, only specified gear types (pot, longline, trawling, jig) may be used.

Time and Area Closures

Seasonal Closures

Seasonal closures have been primarily adopted to reduce the impacts of fisheries on prohibited species and marine mammals. Seasonal time and area closures also provide added protection to the habitat within the closure area. The following paragraphs describe in detail the existing closure areas summarized in Table 3.6-1.

Area 516 exhibits a seasonal closure (BSAI Amendment 12a 1989) in order to protect red king crabs from trawls when the crabs are molting. Area 516 encompasses about 4,000 nm^2.

The Chum Salmon Savings Area was established to limit the amount of chum salmon that can be taken incidentally by trawl gear (BSAI Amendment 35). This hotspot area is closed during the month of August, and remains closed if a trigger is reached. The area encompasses about 5,000 nm^2.

The Chinook Salmon Savings Areas were designated based on high bycatch rates of chinook salmon taken in the pollock fishery. The total area encompasses about 9,000 nm^2. The areas were first established in 1995 (BSAI Amendment 21b), then later modified when the bycatch limit was reduced in 1999 (BSAI Amendment 58). The trigger limit was reduced as follows: 48,000 salmon in 1999, 41,000 in 2000, 37,000 in 2001, 33,000 in 2002, and 29,000 in 2003. Accounting for the cap begins January 1 and continues year-round. Non-pollock fisheries are exempt from the closure, and those fisheries' chinook PSC bycatch is not counted toward the cap because observer data have shown that few chinook salmon are taken by the other fisheries.

Three herring savings areas were established to limit the amount of herring taken as bycatch in trawl fisheries (BSAI Amendment 16a). Two of these areas are closed in the summer months, and one in the winter. These areas were established based on seasonal abundance of herring in given areas. Together, the herring savings areas encompass about 30,000 nm^2.

Two bycatch limitation zones (Zone 1 and Zone 2) were established to limit the amount of Tanner crab taken incidentally in trawl fisheries. These zones were first established under BSAI Amendment 10, then modified under Amendment 12a. Each zone is closed to trawling in designated target fisheries when a specified amount of bycatch is taken in those fisheries. Tanner crab bycatch zones encompass about 80,000 nm^2.

The Opilio Tanner Crab Bycatch Limitation Zone is closed when a limited amount of these crabs is taken incidentally in specified trawl fisheries (BSAI Amendment 40). This area encompasses about 90,000 nm^2.

During the summer months, all fishing vessels are prohibited within 12 nm of the three major Pacific walrus haulouts in Bristol Bay (BSAI Amendment 17).

On July 19, 2000, all trawl fishing was enjoined by court order within Steller sea lion critical habitat area (as defined in 50 CFR 226.202) in the BSAI and the GOA west of 144°W, pending development of a comprehensive biological assessment. Before this order, a complex set of seasonal and area closures was already in place to reduce the interactions of pollock fisheries and sea lions.

Year-Round Closures

Year-round closure areas have been established to protect habitat, reduce bycatch, and reduce competition with marine mammals (Figure 3.6-8). These closure areas may be considered marine protected areas under common usage, in that the habitat is partially protected from trawl gear impacts. However, the National Research Council (NRC) has adopted a narrower definition (NRC 2001), under which a marine protected area is "a spatially defined area in which all populations are free of exploitation." Under that definition, none of these closure areas would entirely qualify.

The nearshore Bristol Bay closure area encompasses 19,000 nm^2 (BSAI Amendment 37) and expanded upon the area 512 closure enacted under BSAI Amendment 10 in 1987. This area meets all HAPC criteria in that it contains rare habitat types (bryozoans and other living substrates); it is important ecologically, that is, the ecosystem for young-of-the-year red king crab survival structure is necessary for young-of-the-year red king crab survival (McMurray *et al.* 1984, Rounds *et al.* 1989, Rodin 1989); and it is a habitat type thought to be vulnerable and highly sensitive to fishing gear damage (Auster and Langton 1999). The closure area also encompasses areas where red king crab pod, a behavior that occurs when the crabs grow and move away from the epifaunal structure (Dew 1990). For a review of how this area was evaluated as a marine protected area, refer to Ackley and Witherell (1999).

The Pribilof Islands Habitat Conservation Area encompasses 7,000 nm^2 (BSAI Amendment 21a). This area meets all HAPC criteria in that it contains rare habitat types (shell hash); it is important ecologically, and it is needed for juvenile blue king crab survival (Armstrong *et al.* 1985); and it is vulnerable to damage from bottom trawls via crushing, burying, and siltation. Other gear types probably do not significantly alter or impact this habitat.

The Red King Crab Savings Area covers 4,000 nm^2 (BSAI Amendment 37). This area does not meet all HAPC criteria, but contains a known concentration of adult red king crab. It contains primarily a sand/silt substrate, which does not appear as sensitive to the impacts of fishing gear as some other substrates.

The red king crab protection zones around Kodiak Island were established under GOA Amendment 26 to reduce crab bycatch and unobserved crab mortality, and, to a lesser extent, provide habitat protection. Trawling is prohibited in some areas year-round, whereas other areas are closed on a seasonal basis. The year-round areas encompass about 1,000 nm^2.

The southeast Alaska no-trawl area covers about 52,600 nm^2. This area contains a vast amount of deep water living substrates, including red tree coral. This prohibition of trawling east of 140° was adopted as part of the license limitation program (GOA Amendment 41).

The Sitka Pinnacles Marine Reserve covers 2.5 nm^2 (GOA Amendment 59). It is an unusually productive area that contains great concentrations of spawning lingcod and a variety of rockfish species, which find shelter in the algae and anemones along the rock walls. The ADF&G and NOAA Fisheries worked together to close the area to commercial fishing for groundfish and halibut, or anchoring by groundfish or halibut vessels. Commercial and recreational salmon fishing remains open.

Amendment 60 prohibits non-pelagic trawling in Cook Inlet. The purpose is to control crab bycatch mortality and protect crab habitat in an area that has depressed king and Tanner crab stocks. The area to be protected covers about 7,000 nm^2, including state waters, where consistent restrictions have been imposed by the Alaska Board of Fisheries.

Year-round closures to pollock trawling extending out to 10 nm have been implemented around 71 Steller sea lion rookeries and haulouts (46 in GOA, and 25 in the BSAI; Figure 3.6-9). It is assumed that one half of the total closed area indicated in the figure is comprised of land, resulting in approximately 22,000 nm^2 of area covered by water being closed to pollock trawling (NMFS 2001b). These closures were implemented by regulatory amendments in 1992: BSAI Amendment 20 and GOA Amendment 25.

The entire Aleutian Islands management area is closed to pollock fishing year-round to reduce interactions of Steller sea lions and trawl fisheries targeting pollock.

Southeast Trawl Closure Areas - the year round closure, adopted as part of the LLP, prohibits all trawling east of 140°W and closes about 53,000 nm^2, of which about 2,000 nm^2 is located on the shelf.

Internal Management Summary

Adequate habitat is essential for maintaining the productivity of fishery resources, and some species or life stages require particular habitats for food, reproduction, and shelter from predators. Numerous fishery closures and/or limitations that protect benthic habitat exist in the BSAI and GOA (see Table 3.6-1 and Figure 3.6-1). The existing management measures protecting habitat include fishing seasons and area quotas, fishing gear restrictions, time and area closures, and prohibited species restrictions. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear. Some of the trawl closures are in effect year-round while others are seasonal (see Table 3.6-1). In general, year-round trawl closures have been implemented to protect vulnerable benthic habitat. Seasonal closures are used to reduce bycatch by closing areas where and when bycatch rates had historically been high. Additional measures to protect the declining western stocks of the Steller sea lion began in 1991 with some simple restrictions based on rookery and haulout locations, to specific fishery restrictions 2000 and 2001. Most of the areas listed on Table 3.6-1 allow fishing by gear other than trawl gear; however, ten sites shown on Table 3.6-1 lasting protection for part or all of the natural resources on a year-round basis.

Existing closures include three large areas in the Bering Sea (Red King Crab Savings Area, Nearshore Bristol Bay encompassing Area 512, and Area 516), together encompassing 27,000 nm^2. These areas, along with the Pribilof Islands closure area (7,000 nm^2) and the Opilio/Tanner Crab Bycatch Limitation Zone are closed to groundfish trawling and/or other specified fisheries such as scallop dredging on a seasonal or trigger basis to reduce potential adverse impacts on king crabs and crab habitat. The shallow areas in particular contain complex living and non-living substrates, which are essential for juvenile crab survival and are potentially sensitive to bottom trawling. The Chum and Chinook Salmon Savings Areas, the Herring Savings Area, and the Zones 1 and 2 areas are trigger closures that protect EFH for several species. While not year round, they encompass a total of nearly 125,000 nm^2. The Walrus Islands seasonal closures and the Steller sea lion critical habitat and trawl exclusion zones, and state waters (0-3 nm) are also closed to bottom trawling.

In the GOA, several discrete trawl closure areas (Kodiak No-Trawl Zones) covering about 1,500 nm^2 are set around Kodiak Island to reduce crab bycatch, but also serve to protect crab habitat. In addition, fishing with all gear types has been prohibited in an area around two nearshore pinnacles identified as supporting rare, vulnerable, and ecologically important habitat (Sitka Pinnacles Marine Reserve). The year round southeast trawl areas closure adopted as part of the LLP prohibits all trawling east of 140°W and closes about 53,000 nm^2, of which about 2,000 nm^2 is located on the shelf. Steller sea lion critical habitat and trawl exclusion zones are also identified in the GOA and will continue under Alternative 1. A proposal to close Cook Inlet to bottom trawling was approved by NPFMC in September 2000 to protect that area's crab habitat.

Putting the closure in perspective, the areas closed in the Bering Sea encompass more than twice the size of Georges Bank off the east coast of the U.S. The GOA closures encompass about 47,000 nm^2 (140,200 km^2), but a vast majority (80 percent to 90 percent) of this area is off the continental shelf, in extremely deep water.

3.6.6 Essential Fish Habitat Comparative Baseline

In general, the overall comparative baseline for habitat is generally adversely impacted in many areas, but unknown in others. Physical benthic information is limited to site-specific investigations. Existing information includes recent Bering Sea sampling grid efforts, older Outer Continental Shelf Environmental Assessment Program investigations for a portion for the central GOA, and no specific physical mapping effort for the Aleutian Islands. A complete representation of the physical benthic environment for Alaska does not exist. However some comparative conclusions can be drawn for each of the impacts in the three regions.

Non-Living Habitat Baseline

<u>Physical Characteristics: Bering Sea</u>

- Large, relatively shallow (<100m) plain consisting of mud, sand, sand and mud, and gravels. Boulders and smaller rock are scattered.

- Bedrock and gravel shelf break relatively far offshore, as compared to the Aleutian Islands.

- Non-living shell hash is common.

<u>Aleutian Islands</u>

- Volcanic island system consisting of higher relief and vertical rock wall bedrock ledges with numerous rock and gravel passes, canyons, and trenches.

- Shelf break relatively nearshore.

<u>GOA</u>

- Diverse rock, cobble, gravel, sand, and mud slope extending to bedrock shelf break consisting of canyons, banks, and flats. Non-living habitats have been historically exposed to fishing activity.

> Generally, theses habitats can be categorized into hard substrates (bedrock, boulders), coarse substrates (cobble, gravel) and soft substrates (sand, mud). Harder substrates are considered static with some local relocation of smaller boulders. Softer and coarse substrates are thought to be altered in some degree, but the extent of these alterations is not well known.

Living-Habitat Baseline

Bering Sea

- Diverse benthic community consisting of infauna and epifauna such as sponges, soft and hard corals, anemones, and bryozoans.

Aleutian Islands

- Rich, diverse, concentrated benthic bio-structures such as sponges, soft corals, tree corals, and anemones.

GOA

- Diverse benthic community consisting of infauna and epifauna such as sponges, tree corals, soft corals, anemones, and bryozoans.

Benthic habitats have been exposed to fishing in larger areas of the Bering Sea, smaller areas in the GOA, and in more discrete locations in the Aleutian Islands. Benthic community diversity has been altered in these areas. However, the direct association of the fishing intensity and the degree of diversity alteration remains relatively unknown. Information suggests that areas subject to high disturbance notice some change in species diversity, as compared to similar habitats or historical species distribution. For this reason we rate the comparative baseline as conditionally significant adverse.

Habitat impacts modeling indicates that biostrucure has been reduced in these locations. In the Bering Sea, impacts to biostructure range from 1.8 to 9 percent of the fishable EEZ and 8.2 to 41.9 percent of the fished area. In the Aleutian Islands, baseline impacts ranged from 1.1 to 6.8 percent of the fishable EEZ and 5.4 to 32.6 percent of the fished area. In the GOA, baseline effects averaged over the entire fishable EEZ range from 0.9 to 6.9 percent and 3.8 to 29 percent of the fished area.

Long-lived corals and sponges are more prevalent in the Aleutian Islands. These organisms have life history traits that make them very susceptible to fishery-induced mortality. Past fishing practices have likely had lingering effects on these species. Distribution maps of living habitat based on survey data are provided in Heifetz (2001) and Malecha *et al.* (2003).

Distribution of Fishing Effort Baseline

Bering Sea

- Bottom trawl fisheries mainly target shallow and deepwater flatfish, Pacific cod, and rockfish.

- Pelagic fisheries mainly target walleye pollock and Atka mackerel.
- Pot gear fisheries mainly target Pacific cod and sablefish.
- Longline fisheries mainly target sablefish and rockfish.

Aleutian Islands

- Bottom trawl fisheries mainly target Pacific cod, Atka mackerel, and Pacific ocean perch.
- Pelagic fisheries mainly target walleye pollock.
- Pot gear fisheries mainly target Pacific cod, sablefish, and crab.
- Longline fisheries mainly target sablefish and rockfish.

GOA

- Bottom trawl fisheries mainly target Pacific cod, flatfish, and rockfish.
- Pelagic fisheries mainly target walleye pollock and Atka mackerel.
- Pot gear fisheries mainly target Pacific cod, sablefish and crab.
- Longline fisheries mainly target sablefish and rockfish.

FMPs for the BSAI and GOA distribute effort to specific fishery management units with the plan. Areas are seasonally and permanently closed to a particular gear type, during certain times, to afford protection of habitats. In the GOA, there exists a large area permanently closed to a specific gear type and a mixture of seasonal closures. In the Bering Sea there is a mixture of open fishing areas adjacent to areas closed to fishing. In the Aleutian Islands, closure areas exist for a limited number of fishing types and there are no permanent closure areas for all fishing activities.

3.6.7 Essential Fish Habitat Cumulative Effects Analysis Status

Even though at this time it is difficult to state a definitive baseline status for EFH in the BSAI and GOA, the topic will be brought forward for cumulative effects analysis. However, the following external events will not be brought forward since the impacts on EFH have not been directly observed or documented, or are likely to be minimal or have no lingering impacts:

- Vessel groundings.
- Introduction of exotic species.
- Toxic algal blooms.

- Volcanic eruptions.
- Earthquakes/underwater landslides.

All other internal and external events and management actions depicted on Table 3.6-2 will be brought forward for cumulative effects analysis.