11.10 ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (revised in Public Law 104-267, The Sustainable Fisheries Act [SFA]) requires Councils to include descriptions of Essential Fish Habitat (EFH) in all federal fishery management plans (FMPs), and also potential threats to EFH. In addition, the Magnuson-Stevens Act requires Federal agencies to consult with the National Marine Fisheries Service (NMFS) on activities that may adversely affect EFH. A source document has been prepared that provides a detailed description of each of the 83 groundfish species included in this plan, including information about each life history stage. The following sections describe EFH for each groundfish species, fishing effects on EFH, nonfishing effects on EFH, and options to avoid or minimize adverse effects on EFH or promote conservation and enhancement of EFH.

11.10.1 Magnuson-Stevens Act Directives Relating to EFH

The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." To clarify this definition, the following interpretations are made: "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means "the habitat required to support a sustainable fishery and the managed species" contribution to a healthy ecosystem;" and "spawning, breeding, feeding, or growth to maturity" covers the full life cycle of a species. The definition of EFH may include habitat for an individual species or an assemblage of species, whichever is appropriate to the FMP.

The Magnuson-Stevens Act requires Councils to identify in FMPs any fishing activities that may adversely affect EFH. The Magnuson-Stevens Act also requires that, where fishing-related adverse impacts to EFH are identified, FMPs must include management measures that minimize those adverse effects from fishing, to the extent practicable.

The FMP also identifies potential non-fishing threats to EFH. Upon implementation of the FMP amendment, federal agencies will be required to consult with NMFS on all activities, and proposed activities, authorized, funded, or undertaken by the agency that may adversely affect EFH. NMFS must provide recommendations to conserve EFH to federal agencies on such activities. NMFS must also provide recommendations to conserve EFH to state agencies if it receives information on their actions. The Council may provide EFH recommendations on actions that may affect habitat, including EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH resulting from actions or proposed actions authorized, funded, or undertaken by that agency. The Council will encourage federal agencies conducting or authorizing work that may adversely affect groundfish EFH to minimize disturbance to EFH.

11.10.2 Definition of EFH for Groundfish, and Composite EFH Identification

The Pacific coast Groundfish FMP manages 83 species over a large and ecologically diverse area. Research on the life histories and habitats of these species varies in completeness, so while some species are well-studied, there is relatively little information on certain other species. Information about the habitats and life histories of the species managed by the FMP will certainly change over time, with varying degrees of information improvement for each species. For these reasons, it is impractical for the Council to include EFH definitions for each of the managed species in the body of the FMP. Therefore, the FMP includes a description of a limited number of composite EFHs for all Pacific coast groundfish species. Life histories and EFH designations for each of the individual species are provided as an appendix which will be revised and updated to include new information as it becomes available. Such changes will not require FMP amendment. This framework approach is similar to the Council's stock assessment process, which annually uses the Stock Assessment and Fishery Evaluation (SAFE) document to update information about groundfish stock status without amending the FMP. Like the SAFE document, any EFH updates will be reviewed in a Council public forum.

There are substantial gaps in the knowledge of many Pacific coast groundfish species. This FMP identifies many of those data gaps and makes suggestions regarding future research efforts. The FMP also identifies where research is needed on fishing and non-fishing impacts on groundfish EFH. Protecting, conserving, and enhancing

EFH are long-term goals of the Council, and these EFH provisions of the FMP are an important element in the Council's commitment to a better understanding of Pacific coast groundfish populations and their habitat needs.

The 83 groundfish species managed by this FMP occur throughout the exclusive economic zone (EEZ) and occupy diverse habitats at all stages in their life histories. Some species are widely dispersed during certain life stages, particularly those with pelagic eggs and larvae; the EFH for these species/stages is correspondingly large. On the other hand, the EFH of some species/stages may be comparatively small, such as that of adults of many nearshore rockfishes which show strong affinities to a particular location or type of substrate. As a consequence of the large number of species and their diverse habitat associations, the entire EEZ becomes EFH when all the individual EFHs are taken together.

EFH for Pacific coast groundfish is defined as the aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and for groundfish contributions to a healthy ecosystem. Descriptions of groundfish fishery EFH for each of the 83 species and their life stages result in over 400 EFH identifications. When these EFHs are taken together, the groundfish fishery EFH includes all waters from the mean higher high water line, and the upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon, and California seaward to the boundary of the U.S. EEZ.

This FMP groups the various EFH descriptions into seven units called "composite" EFHs. This approach focuses on ecological relationships among species and between the species and their habitat, reflecting an ecosystem approach in defining EFH. Seven major habitat types are proposed as the basis for such assemblages or "composites". These major habitat types are readily recognizable by those who potentially may be required to consult about impacts to EFH, and their distributions are relatively stationary and measurable over time and space.

The seven "composite" EFH identifications are as follows.

1. **Estuarine** - Those waters, substrates and associated biological communities within bays and estuaries of the coasts of Washington, Oregon, and California, seaward from the high tide line (MHHW) or extent of upriver saltwater intrusion. These areas are delineated from the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) and supplemented from NOAA's Coastal Assessment Framework for the water portion of the Estuarine Drainage Areas for two small estuaries (Klamath River and Rogue River), the Columbia River, and San Francisco Bay. NWI defines estuaries as areas with water greater than 0.5 ppt ocean-derived salt.

2. **Rocky Shelf** - Those waters, substrates, and associated biological communities living on or within ten meters (5.5 fathoms) overlying rocky areas, including reefs, pinnacles, boulders and cobble, along the continental shelf, excluding canyons, from the high tide line (MHHW) to the shelf break (~200 meters or 109 fathoms).

3. **Non-Rocky Shelf** - Those waters, substrates, and associated biological communities living on or within ten meters (5.5 fathoms) overlying the substrates of the continental shelf, excluding the rocky shelf and canyon composites, from the high tide line (MHHW) to the shelf break (~200 meters or 109 fathoms).

4. **Canyon** - Those waters, substrates, and associated biological communities living within submarine canyons, including the walls, beds, sea floor, and any outcrops or landslide morphology, such as slump scarps and debris fields.

5. **Continental Slope/Basin** - Those waters, substrates, and biological communities living on or within 20 meters (11 fathoms) overlying the substrates of the continental slope and basin below the shelf break (~200 meters or 109 fathoms) and extending to the westward boundary of the EEZ.

6. **Neritic Zone** - Those waters and biological communities living in the water column more than ten meters (5.5 fathoms) above the continental shelf.

7. **Oceanic Zone** - Those waters and biological communities living in the water column more than 20 meters (11 fathoms) above the continental slope and abyssal plain, extending to the westward boundary of the EEZ.

These composites are shown graphically in the following figures. There is inadequate Information to produce a map of the rocky shelf composite, so the rocky and nonrocky shelf composites are combined in these figures.

A background resource document has been prepared which identifies and provides extensive descriptions of EFH for each life stage of the 83 species managed by the FMP. This background document provides all the supporting information used for these identifications, including life history descriptions, lists of data sets and references utilized to identify EFH, and a glossary of terms. GIS maps of the distribution of species' life stages in survey and fishery data sets are included as available. For each life stage, tables of known habitat associations, life history traits, reproductive traits and EFH information levels are also provided in the appendix. The four EFH information levels are:

Level 1: Presence/absence distribution data are available for some or all portions of the geographic range of the species.
Level 2: Habitat-related densities of the species are available.
Level 3: Growth, reproduction, or survival rates within habitats are available.
Level 4: Production rates by habitat are available.

The scientific basis for the composite EFHs is rooted in the EFH identifications for individual species' life stages. When Level 1 information is available, EFH for a species' life stage is its general distribution, the geographic area of known habitat associations containing most (e.g., about 95%) of the individuals. If known, areas uncommonly utilized are excluded. Data on West Coast groundfish are not readily available to evaluate the extent of areas most commonly utilized by these species at each life stage. However, for adults of many species, Allen and Smith (1988) report the depth ranges in which about 95% of each species was taken during research surveys in the north Pacific Ocean. When such estimates are available, the EFH is identified as this percentage of its general distribution; otherwise, the general distribution corresponds to the full documented range and habitat associations of the life stage within the EEZ. Rare observations that extend a species range during anomalous environmental conditions are not considered part of its EFH. When no information about the distribution of a species' life stage is available and ancillary information is inadequate to infer its distribution, EFH is not identified for that species' life stage.

When Level 2 information is available, the alternatives of using the general distribution or known concentrations to define EFH for species' life stages may be considered. For adults of a few species, sufficient data are available to evaluate their frequencies of occurrence and densities in all or a portion of their distribution, and areas of known concentrations could be identified. Based on risk-averse and ecosystem approaches and the best scientific information available, EFH is defined as for Level 1 information, (i.e., EFH is the geographic area of known habitat associations [general distribution]), in order to maintain healthy populations and ecosystems and sustain productive fisheries.

Relying on known concentrations alone to designate EFH would not ensure that adequate areas were protected as EFH. Areas of known concentrations based on current information do not adequately address unpredictable annual differences in spatial distributions of a life stage, nor changes due to long-term shifts in oceanographic regimes. There are significant areal (primarily 50 meters to 350 meters on the shelf) and seasonal (chiefly spring and summer) limitations on the survey information upon which descriptions of known concentrations would be primarily based, whereas the general distribution is based on the best available scientific information, as well as fishery and local knowledge of a species' life stage. Also, all habitats occupied by a species contribute to production at some level, and observed concentrations or densities do not necessarily reflect all habitat essential to maintain healthy stocks within the ecosystem. Although contributions from individual locations may be small, collectively they can account for a significant part of total production. A species' long-term productivity is based on both high and low levels of abundance and the entire distribution may be required during times of high abundance. Finally, there is no discrete or definitive basis for the distinction between known concentrations and general distribution of a species' life stage.

References:

Allen, M.J. and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. NOAA, NMFS Tech. Rep. 66: 151p.

Table Legend:

X = The EFH for the particular species and life stage occurs within the EFH composite.

Blank = The EFH for the particular species and life stage is not currently known to occur within the EFH composite or insufficient information is currently available to identify its EFH.

NA = Not applicable. It is used in two ways: when a species does not have a particular life stage in its life history, or when EFH of juveniles is not identified separately for small juvenile and large juvenile stages. For many species, habitats occupied by juveniles differ substantially, depending on the size (or age) of the fish. Frequently, small juveniles are pelagic and large juveniles live on or near the bottom; these life stages are identified separately in the following tables when sufficient information is available to do so. When juvenile habitats do not differ so substantially or when information is insufficient to identify differences, EFH is identified only for the juvenile stage (small and large juveniles combined), and NA (not applicable) is listed in the column for the large juvenile stage in the following tables.

TABLE EFH-1. Species and life stages within the Estuarine Composite EFH.

Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition	Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition
Leopard Shark	X	X	NA	X	NA	X	Kelp Rockfish				X		
Soupfin Shark	X	X	NA	X	NA	X	Longspine Thornyhead			NA			
Spiny Dogfish	X		X	X	NA	X	Mexican Rockfish			NA			
Big Skate			NA		NA		Olive Rockfish			NA			
California Skate	X	X	NA	X	NA	X	Pacific Ocean Perch						
Longnose Skate			NA		NA		Pink Rockfish			NA			
Ratfish	X	X	NA	X	NA		Quillback Rockfish	X		X	X	X	X
Finescale Codling			NA				Redbanded Rockfish			NA			
Pacific Rattail			NA				Redstripe Rockfish			NA			
Lingcod	X	X	X	X	X	X	Rosethorn Rockfish			NA			
Cabezon	X	X	X	X	X	X	Rosy Rockfish			NA			
Kelp Greenling	X	X	X	X	X	X	Rougheye Rockfish			NA			
Pacific Cod	X	X	NA	X	X	X	Sharpchin Rockfish			NA			
Pacific Whiting (Hake)	X	X	NA	X	X	X	Shortbelly Rockfish						
Sablefish				X			Shortraker Rockfish			NA			
Jack Mackerel	X		NA	X			Shortspine Thornyhead			NA			
Aurora Rockfish							Silverygray Rockfish			NA			
Bank Rockfish							Speckled Rockfish			NA			
Black Rockfish	X			X			Splitnose Rockfish			NA			
Black-and-yellow Rockfish							Squarespot Rockfish			NA			
Blackgill Rockfish							Starry Rockfish			NA			
Blue Rockfish							Stripetail Rockfish			NA			
Bocaccio				X	X		Tiger Rockfish			NA			
Bronzespotted Rockfish			NA				Treefish			NA			
Brown Rockfish	X	X	NA	X		X	Vermilion Rockfish			NA			
Calico Rockfish	X		NA	X			Widow Rockfish						
California Scorpionfish						X	Yelloweye Rockfish			NA			
Canary Rockfish							Yellowmouth Rockfish			NA			
Chilipepper							Yellowtail Rockfish						
China Rockfish			NA				Arrowtooth Flounder			NA			
Copper Rockfish	X		X	X		X	Butter Sole			NA			
Cowcod			NA				Curlfin Sole			NA			
Darkblotched Rockfish							Dover Sole			NA			
Dusky Rockfish							English Sole	X	X	NA	X	X	X
Flag Rockfish			NA				Flathead Sole			NA			
Gopher Rockfish			NA				Pacific Sanddab			NA	X	X	X
Grass Rockfish			NA				Petrale Sole			NA			
Greenblotched Rockfish			NA				Rex Sole	X		NA			
Greenspotted Rockfish			NA				Rock Sole			NA			
Greenstriped Rockfish			NA				Sand Sole			NA			
Harlequin Rockfish							Starry Flounder	X	X	NA	X	X	X

Honeycomb Rockfish			NA									

TABLE EFH-2. Species and life stages within the Rocky Shelf Composite EFH.

Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition	Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition
Leopard Shark	X	X	NA	X	NA	X	Kelp Rockfish	X		X			X
Soupfin Shark	X	X	NA	X	NA		Longspine Thornyhead			NA			
Spiny Dogfish	X	X	X		NA		Mexican Rockfish	X		NA			
Big Skate			NA		NA		Olive Rockfish	X		NA	X		X
California Skate			NA		NA		Pacific Ocean Perch	X		X			
Longnose Skate			NA		NA		Pink Rockfish	X		NA			
Ratfish	X	X	NA	X	NA	X	Quillback Rockfish	X		X			X
Finescale Codling			NA				Redbanded Rockfish			NA			
Pacific Rattail			NA				Redstripe Rockfish	X		NA			X
Lingcod	X	X	X			X	Rosethorn Rockfish	X		NA			X
Cabezon	X	X	X			X	Rosy Rockfish	X		NA	X		X
Kelp Greenling	X	X	X			X	Rougheye Rockfish	X		NA			
Pacific Cod			NA				Sharpchin Rockfish	X		NA			X
Pacific Whiting (Hake)			NA				Shortbelly Rockfish	X					X
Sablefish	X						Shortraker Rockfish	X		NA			
Jack Mackerel			NA				Shortspine Thornyhead			NA			
Aurora Rockfish							Silverygray Rockfish	X		NA			
Bank Rockfish	X		NA	X			Speckled Rockfish	X		NA	X		X
Black Rockfish			X				Splitnose Rockfish			NA			
Black-and-yellow Rockfish	X	X	X	X		X	Squarespot Rockfish	X		NA			X
Blackgill Rockfish			X				Starry Rockfish	X		NA			X
Blue Rockfish	X	X	X				Stripetail Rockfish			NA			
Bocaccio	X		X				Tiger Rockfish	X		NA			
Bronzespotted Rockfish			NA				Treefish	X		NA			
Brown Rockfish	X	X	NA	X		X	Vermilion Rockfish	X		NA	X		
Calico Rockfish	X		NA	X			Widow Rockfish	X	X	X			X
California Scorpionfish	X	X	NA	X			Yelloweye Rockfish	X		NA			X
Canary Rockfish	X					X	Yellowmouth Rockfish	X		NA			X
Chilipepper	X		X			X	Yellowtail Rockfish	X	X	X			X
China Rockfish	X		NA	X		X	Arrowtooth Flounder			NA			
Copper Rockfish	X		X				Butter Sole			NA			
Cowcod	X		NA	X			Curlfin Sole			NA			
Darkblotched Rockfish	X	X	X			X	Dover Sole			NA			
Dusky Rockfish							English Sole	X	X	NA	X		
Flag Rockfish	X		NA			X	Flathead Sole			NA			
Gopher Rockfish	X	X	NA	X		X	Pacific Sanddab			NA			
Grass Rockfish	X		NA	X		X	Petrale Sole			NA			
Greenblotched Rockfish	X		NA	X		X	Rex Sole			NA			
Greenspotted Rockfish	X		NA	X		X	Rock Sole	X	X	NA	X		X

Greenstriped Rockfish	X		NA			X	Sand Sole			NA			
Harlequin Rockfish							Starry Flounder			NA			
Honeycomb Rockfish	X		NA	X		X							

TABLE EFH-3. Species and life stages within the Non-Rocky Shelf Composite EFH.

Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition	Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition
Leopard Shark	X	X	NA	X	NA	X	Kelp Rockfish						
Soupfin Shark	X	X	NA	X	NA	X	Longspine Thornyhead			NA			
Spiny Dogfish	X		X		NA	X	Mexican Rockfish	X		NA			
Big Skate	X	X	NA	X	NA	X	Olive Rockfish			NA			
California Skate	X	X	NA	X	NA	X	Pacific Ocean Perch	X		X			
Longnose Skate	X	X	NA	X	NA	X	Pink Rockfish	X		NA			
Ratfish	X	X	NA	X	NA	X	Quillback Rockfish						
Finescale Codling			NA				Redbanded Rockfish	X		NA			
Pacific Rattail	X	X	NA	X			Redstripe Rockfish			NA			
Lingcod	X		X				Rosethorn Rockfish	X		NA			X
Cabezon							Rosy Rockfish			NA			
Kelp Greenling							Rougheye Rockfish	X		NA			
Pacific Cod	X	X	NA	X		X	Sharpchin Rockfish	X		NA			X
Pacific Whiting (Hake)			NA				Shortbelly Rockfish	X					X
Sablefish	X		X				Shortraker Rockfish	X		NA			
Jack Mackerel			NA				Shortspine Thornyhead	X		NA			
Aurora Rockfish	X	X	X				Silverygray Rockfish	X		NA			
Bank Rockfish	X		NA	X			Speckled Rockfish			NA			
Black Rockfish			X				Splitnose Rockfish	X		NA	X		X
Black-and-yellow Rockfish							Squarespot Rockfish			NA			
Blackgill Rockfish							Starry Rockfish			NA			
Blue Rockfish			X				Stripetail Rockfish	X		NA			X
Bocaccio	X		X				Tiger Rockfish			NA			
Bronzespotted Rockfish			NA				Treefish			NA			
Brown Rockfish			NA				Vermilion Rockfish			NA	X		
Calico Rockfish	X		NA	X			Widow Rockfish	X	X	X			X
California Scorpionfish	X	X	NA	X			Yelloweye Rockfish			NA			
Canary Rockfish							Yellowmouth Rockfish			NA			
Chilipepper	X		X			X	Yellowtail Rockfish	X	X	X			X
China Rockfish			NA				Arrowtooth Flounder	X	X	NA	X		
Copper Rockfish							Butter Sole	X	X	NA			
Cowcod			NA	X			Curlfin Sole	X	X	NA			
Darkblotched Rockfish	X	X	X			X	Dover Sole	X	X	NA	X		
Dusky Rockfish							English Sole	X	X	NA	X		
Flag Rockfish			NA				Flathead Sole	X	X	NA	X		
Gopher Rockfish	X	X	NA	X		X	Pacific Sanddab	X	X	NA	X		
Grass Rockfish			NA				Petrale Sole	X		NA	X		
Greenblotched Rockfish	X		NA	X		X	Rex Sole	X	X	NA			
Greenspotted Rockfish	X		NA	X		X	Rock Sole	X	X	NA	X		X
Greenstriped Rockfish	X		NA			X	Sand Sole	X	X	NA	X		
Harlequin Rockfish							Starry Flounder	X	X	NA	X		
Honeycomb Rockfish			NA										

TABLE EFH-4. Species and Life Stages within the Canyon Composite EFH.

Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition	Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition
Leopard Shark			NA		NA		Kelp Rockfish						
Soupfin Shark	X	X	NA	X	NA		Longspine Thornyhead			NA			
Spiny Dogfish	X				NA		Mexican Rockfish			NA			
Big Skate			NA		NA		Olive Rockfish	X		NA			X
California Skate			NA		NA		Pacific Ocean Perch	X					
Longnose Skate			NA		NA		Pink Rockfish			NA			
Ratfish			NA		NA		Quillback Rockfish						
Finescale Codling	X		NA				Redbanded Rockfish			NA			
Pacific Rattail			NA				Redstripe Rockfish			NA			
Lingcod							Rosethorn Rockfish			NA			
Cabezon							Rosy Rockfish			NA			
Kelp Greenling							Rougheye Rockfish			NA			
Pacific Cod			NA				Sharpchin Rockfish			NA			
Pacific Whiting (Hake)			NA				Shortbelly Rockfish	X					X
Sablefish	X		X				Shortraker Rockfish			NA			
Jack Mackerel			NA				Shortspine Thornyhead			NA			
Aurora Rockfish							Silverygray Rockfish			NAA			
Bank Rockfish	X		NA	X			Speckled Rockfish	X		NA			X
Black Rockfish							Splitnose Rockfish			NA			
Black-and-yellow Rockfish							Squarespot Rockfish	X		NA			X
Blackgill Rockfish							Starry Rockfish			NA			
Blue Rockfish							Stripetail Rockfish			NA			
Bocaccio			X				Tiger Rockfish			NA			
Bronzespotted Rockfish			NA				Treefish			NA			
Brown Rockfish			NA				Vermilion Rockfish	X		NA			
Calico Rockfish			NA				Widow Rockfish	X	X	X			X
California Scorpionfish							Yelloweye Rockfish			NA			
Canary Rockfish							Yellowmouth Rockfish			NA			
Chilipepper							Yellowtail Rockfish						
China Rockfish			NA				Arrowtooth Flounder			NA			
Copper Rockfish							Butter Sole			NA			
Cowcod			NA				Curlfin Sole			NA			
Darkblotched Rockfish							Dover Sole			NA			
Dusky Rockfish							English Sole			NA			
Flag Rockfish			NA				Flathead Sole			NA			
Gopher Rockfish			NA				Pacific Sanddab			NA			
Grass Rockfish			NA				Petrale Sole			NA			
Greenblotched Rockfish	X		NA	X		X	Rex Sole			NA			
Greenspotted Rockfish			NA				Rock Sole			NA			
Greenstriped Rockfish			NA				Sand Sole			NA			
Harlequin Rockfish							Starry Flounder			NA			
Honeycomb Rockfish			NA	X									

TABLE EFH-5. Species and life stages within the Continental Slope/Basin Composite EFH.

Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition	Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition
Leopard Shark			NA		NA		Kelp Rockfish						
Soupfin Shark			NA		NA		Longspine Thornyhead	X	X	NA	X		
Spiny Dogfish	X	X			NA		Mexican Rockfish			NA			
Big Skate	X	X	NA		NA		Olive Rockfish			NA			
California Skate	X	X	NA	X	NA	X	Pacific Ocean Perch	X					X
Longnose Skate	X	X	NA	X	NAA	X	Pink Rockfish	X		NA			
Ratfish	X	X	NA	X	NA	X	Quillback Rockfish	X					X
Finescale Codling	X		NA				Redbanded Rockfish	X		NA			
Pacific Rattail	X	X	NA	X			Redstripe Rockfish	X		NA			X
Lingcod	X						Rosethorn Rockfish	X		NA			X
Cabezon							Rosy Rockfish			NA			
Kelp Greenling							Rougheye Rockfish	X		NA			
Pacific Cod	X	X	NA			X	Sharpchin Rockfish	X		NA			X
Pacific Whiting (Hake)			NA				Shortbelly Rockfish	X					X
Sablefish	X	X					Shortraker Rockfish	X		NA			
Jack Mackerel			NA				Shortspine Thornyhead	X	X	NA			
Aurora Rockfish	X	X	X				Silverygray Rockfish	X		NA			
Bank Rockfish	X		NA	X			Speckled Rockfish	X		NA			X
Black Rockfish							Splitnose Rockfish	X		NA			X
Black-and-yellow Rockfish							Squarespot Rockfish			NA			
Blackgill Rockfish	X		X				Starry Rockfish	X		NA			X
Blue Rockfish							Stripetail Rockfish	X		NA			X
Bocaccio	X		X				Tiger Rockfish	X		NA			
Bronzespotted Rockfish	X		NA				Treefish			NA			
Brown Rockfish			NA				Vermilion Rockfish	X		NA			
Calico Rockfish			NA				Widow Rockfish	X	X				X
California Scorpionfish							Yelloweye Rockfish	X		NA			X
Canary Rockfish	X					X	Yellowmouth Rockfish	X		NA			X
Chilipepper	X		X			X	Yellowtail Rockfish	X	X				X
China Rockfish			NA				Arrowtooth Flounder	X	X	NA	X		
Copper Rockfish							Butter Sole	X		NA			
Cowcod			NA				Curlfin Sole	X	X	NA			
Darkblotched Rockfish	X	X				X	Dover Sole	X	X	NA	X		
Dusky Rockfish							English Sole	X		NA			
Flag Rockfish			NA				Flathead Sole	X	X	NA	X		
Gopher Rockfish			NA				Pacific Sanddab			NA			
Grass Rockfish			NA				Petrale Sole	X	X	NA			
Greenblotched Rockfish	X		NA			X	Rex Sole	X	X	NA			
Greenspotted Rockfish			NA				Rock Sole	X	X	NA	X		X
Greenstriped Rockfish			NA				Sand Sole			NA			
Harlequin Rockfish							Starry Flounder			NA			
Honeycomb Rockfish			NA										

TABLE EFH-6. Species and life stages within the Neritic Composite EFH.

Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition	Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition
Leopard Shark	X	X	NA	X	NA	X	Kelp Rockfish				X		
Soupfin Shark	X	X	NA	X	NA	X	Longspine Thornyhead			NA			
Spiny Dogfish	X		X	X	NA		Mexican Rockfish			NA		X	
Big Skate			NA		NA		Olive Rockfish			NA			
California Skate			NA		NA		Pacific Ocean Perch				X		
Longnose Skate			NA		NA		Pink Rockfish			NA			
Ratfish			NA		NA		Quillback Rockfish				X	X	
Finescale Codling			NA				Redbanded Rockfish			NA			
Pacific Rattail			NA				Redstripe Rockfish			NA			
Lingcod				X	X		Rosethorn Rockfish			NA			
Cabezon				X	X		Rosy Rockfish			NA			
Kelp Greenling				X	X		Rougheye Rockfish			NA			
Pacific Cod	X	X	NA	X	X		Sharpchin Rockfish			NA			
Pacific Whiting (Hake)	X	X	NA	X	X	X	Shortbelly Rockfish						
Sablefish				X	X		Shortraker Rockfish			NA			
Jack Mackerel	X		NA	X		X	Shortspine Thornyhead			NA			
Aurora Rockfish							Silverygray Rockfish			NA			
Bank Rockfish							Speckled Rockfish			NA			
Black Rockfish	X			X			Splitnose Rockfish			NA			
Black-and-yellow Rockfish					X		Squarespot Rockfish			NA			
Blackgill Rockfish				X	X		Starry Rockfish			NA			
Blue Rockfish				X	X		Stripetail Rockfish			NA			
Bocaccio				X	X		Tiger Rockfish			NA			
Bronzespotted Rockfish			NA				Treefish			NA			
Brown Rockfish			NA				Vermilion Rockfish			NA			
Calico Rockfish			NA				Widow Rockfish				X	X	
California Scorpionfish						X	Yelloweye Rockfish			NA			
Canary Rockfish				X	X		Yellowmouth Rockfish			NA			
Chilipepper				X	X		Yellowtail Rockfish						
China Rockfish			NA		X		Arrowtooth Flounder			NA		X	X
Copper Rockfish				X		X	Butter Sole			NA		X	X
Cowcod			NA		X		Curlfin Sole			NA			X
Darkblotched Rockfish							Dover Sole			NA		X	X
Dusky Rockfish							English Sole			NA		X	X
Flag Rockfish			NA				Flathead Sole			NA		X	X
Gopher Rockfish			NA				Pacific Sanddab			NA		X	X
Grass Rockfish			NA				Petrale Sole			NA		X	X
Greenblotched Rockfish			NA				Rex Sole			NA			X
Greenspotted Rockfish			NA				Rock Sole			NA		X	
Greenstriped Rockfish			NA				Sand Sole			NA		X	X
Harlequin Rockfish							Starry Flounder			NA		X	X
Honeycomb Rockfish			NA										

TABLE EFH-7. Species and life stages within the Oceanic Composite EFH.

Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition	Species	Adults	Spawning/Mating	Large Juveniles	Juveniles/Small Juveniles	Larvae	Eggs/Parturition
Leopard Shark			NA		NA		Kelp Rockfish						
Soupfin Shark	X		NA		NA		Longspine Thornyhead			NA		X	X
Spiny Dogfish	X				NA		Mexican Rockfish			NA		X	
Big Skate			NA		NA		Olive Rockfish			NA			
California Skate			NA		NA		Pacific Ocean Perch				X	X	
Longnose Skate			NA		NA		Pink Rockfish			NA			
Ratfish			NA		NA		Quillback Rockfish						
Finescale Codling			NA				Redbanded Rockfish			NA			
Pacific Rattail			NA		X		Redstripe Rockfish			NA			
Lingcod							Rosethorn Rockfish			NA			
Cabezon				X	X		Rosy Rockfish			NA			
Kelp Greenling				X	X		Rougheye Rockfish			NA			
Pacific Cod	X	X	NA	X	X		Sharpchin Rockfish			NA		X	
Pacific Whiting (Hake)	X	X	NA		X	X	Shortbelly Rockfish						
Sablefish				X	X	X	Shortraker Rockfish			NA			
Jack Mackerel	X	X	NA	X	X	X	Shortspine Thornyhead			NA		X	X
Aurora Rockfish					X		Silverygray Rockfish			NA			
Bank Rockfish							Speckled Rockfish			NA			
Black Rockfish	X						Splitnose Rockfish			NA			
Black-and-yellow Rockfish							Squarespot Rockfish			NA			
Blackgill Rockfish				X	X		Starry Rockfish			NA			
Blue Rockfish							Stripetail Rockfish			NA			
Bocaccio							Tiger Rockfish			NA			
Bronzespotted Rockfish			NA				Treefish			NA			
Brown Rockfish			NA				Vermilion Rockfish			NA			
Calico Rockfish			NA				Widow Rockfish				X	X	
California Scorpionfish							Yelloweye Rockfish			NA			
Canary Rockfish				X	X		Yellowmouth Rockfish			NA			
Chilipepper							Yellowtail Rockfish				X		
China Rockfish			NA				Arrowtooth Flounder			NA		X	X
Copper Rockfish							Butter Sole			NA			
Cowcod			NA				Curlfin Sole			NA			X
Darkblotched Rockfish				X	X		Dover Sole			NA		X	X
Dusky Rockfish							English Sole			NA			
Flag Rockfish			NA				Flathead Sole			NA		X	X
Gopher Rockfish			NA				Pacific Sanddab			NA		X	X
Grass Rockfish			NA				Petrale Sole			NA		X	X
Greenblotched Rockfish			NA				Rex Sole			NA		X	
Greenspotted Rockfish			NA				Rock Sole			NA			
Greenstriped Rockfish			NA				Sand Sole			NA			
Harlequin Rockfish							Starry Flounder			NA			
Honeycomb Rockfish			NA										

11.10.3 Adverse Impacts on EFH From Fishing Gear and Practices, and Measures to Manage Them

11.10.3.1 Identification of Adverse Impacts of Fishing Gear on EFH

There is little information on the effects of fishing gears on the habitat of Pacific coast groundfish, although there are numerous theories and a great deal of speculation about the effects of various fishing gears on structural habitat. A major challenge the Council will face in addressing gear effects on EFH is the lack of information, and if the Council chooses to impose restrictions in the short term, such decisions would likely have to be based on the assumption that general information about the effects of gear in other environments is applicable to the specific case of the Pacific coast environment.

The available information on the effects of fishing gear on marine fish habitat comes from research that has been concentrated in heavily fished areas off the east coast of Canada and the United States, and in the North Sea. There are substantial differences in sea floor topography, other physical features, and biological characteristics between those regions and the Pacific coast of the United States. In addition, most research in those areas focused on trawl and dredge gears, with little information on the effects of non-mobile (fixed) gears. There is ongoing debate about the applicability of that research to the Pacific coast environment, however information from those areas will be used by the Council as appropriate. Pacific coast trawl adaptations, such as tire roller gear for improving gear performance in rocky areas, have only recently been explored outside of tropical habitats. Habitat protection will be considered as a tool in groundfish stock restoration.

A marine ecosystem in a "virgin" or unfished state would support a specific number and complexity of fish species. As a marine area is fished, the qualities of the ecosystem change in relation to the number of fish of each species removed from the ecosystem and the effects of fishing gear on the habitat(s) of species using that area. After a number of years of fishing, the habitat quality and nature of that marine ecosystem might be significantly different from the virgin ecosystem. Habitat modified by fishing pressure would support a different set of fish species from those supported by virgin habitat for that same area. In general, marine habitats that have been less altered by fishing and other activities are more complex in structure and more productive in lower level organisms such as worms and crustaceans than highly altered habitats. Marine habitats with greater complexity at lower trophic levels and with greater structural complexity tend to support a more complex mix of fish species in greater abundances than altered habitats. In some cases, however, activities that add nutrients to the system can increase total productivity but reduce complexity. Thus, productivity alone should not be used as a measure of environmental integrity.

It is likely there are few, if any, large virgin marine habitats off the Pacific coast. Due to the high relief, rocky nature of Pacific coast bottom habitat, however, there may be pockets of habitat that have undergone few alterations by trawl gear. High relief rock piles that are not accessible to trawl gear are usually accessible to commercial longline and recreational hook-and-line gear. Similarly, marine canyons that have not been trawled may be used by commercial longliners. The Pacific coast groundfish species mix, with a high proportion of rockfish, is evidence that there are several remaining complex habitat areas. The numerous, long-lived rockfish species have evolved to take advantage of varied rock habitats along the length of the coast. As rockfish stocks have been fished down to lower levels, there is little evidence of new increases in stocks of short-lived species that do not rely on high habitat complexity. Thus, alterations to rockfish habitat may not be accompanied by improvements in stocks that are better adapted to the altered habitat. For this reason, protection of rockfish and rockfish habitat is extremely important to long-term sustainability of the groundfish fishery.

Trawl gear, particularly doors and foot ropes, can alter marine habitat complexity. Changes to physical characteristics of the sea floor would include leveling of rock formations, re-suspending sediments, and other disturbances. These effects depend on towing speed, substrate type, strength of tides and currents, and gear configuration (Jones 1992). it has been found that otter doors tend to penetrate the substrate one cm to 30 cm; one cm on sand and rock substrates, and 30 cm in some mud substrates (Krost et al. 1990; Jones 1992; Brylinsky et al. 1994). Another factor that will cause variation in the depth of the troughs made by the otter doors is the size (weight) of the doors (i.e., the heavier the doors the deeper the trough) (Jones 1992). These benthic troughs can disappear in as little as a few hours or days in mud and sand sediments over which there is strong tide or current action (Caddy 1973; Jones 1992), or they can last much longer, from between a few months to over five years in seabeds with a mud or sandy-mud substrate at depths greater than 100 m with weak or no current flow (Krost et al. 1990; Jones 1992; Brylinsky et al. 1994). Footropes that are designed to roll over the sea floor cause little physical alteration other than smoothing the substrate and minor compression (Brylinsky et al. 1994; Kaiser and Spencer 1996). However, since a trawler may re-trawl the same area several times, these minor compressions can cause a “packing” of the substrate (Schwinghammer et al. 1996). Further compression of the substrate can occur as the net becomes full and is dragged along the bottom. Trawl gear used off the Pacific coast is often modified with a “roller gear” footrope, where rubber tires are packed together along the footrope, allowing the base of the net to bounce along the bottom, or to drag over obstructions without snagging the net. Development of roller gear has allowed trawlers to work in formerly inaccessible rocky areas. New research in the Gulf of Alaska on the impacts of roller gear on bottom habitat may soon provide documentation on the effects of this gear on bottom habitat (Heifetz, 1997). Whatever the direct habitat impacts of roller gear may be, roller gear is effective in allowing trawlers to work in formerly inaccessible, rocky areas.

Similarly, longline gear has been seen to disturb or remove marine plants, corals, and sessile organisms. Observations of halibut longline gear made by NMFS scientists during submersible dives off Southeast Alaska provide some information (NPFMC 1992): "Setline gear often lies slack on the sea-floor and meanders considerably along the bottom. During the retrieval process the line sweeps the bottom for considerable distances before lifting off the bottom. It snags on whatever objects are in its path, including rocks and corals. Smaller rocks are upended, hard corals are broken, and soft corals appear unaffected by the passing line. Invertebrates and other light weight objects are dislodged and pass over or under the line. Fish, notably halibut, frequently moved the groundline numerous feet along the bottom and up into the water column during escape runs disturbing objects in their path. This line motion was noted for distances of 50 feet or more on either side of the hooked fish." Further observations by scientist divers monitoring longline gear off Alaska noted that longlines swept the sea floor, entangling scallops and corals, bringing those animals to the surface during line retrieval (High, 1998).

Although there has been no research conducted on pot gear effects on habitat along the Pacific coast, pot gear may damage demersal plants and animals as it settles, and longlined pots may drag through and damage bottom fauna during gear retrieval. Similarly, anchoring the pot lines or the ends of the longlines may have crushing or dragging effects. In addition to direct bottom habitat alteration, fishing gear that is lost at sea and left to "ghost fish" may cause changes to habitat. Pacific coast groundfish regulations include trap gear restrictions that require trap construction with biodegradable escape panels, so that traps will no longer ghost fish after the escape panels have degraded. Depending on the number of pots that are lost each year and where they are fished, lost pots may alter marine habitat simply by providing a different type of relief than the natural habitat.

Setnets (or gillnets) and trammel nets, which are only used in this fishery south of 38° N latitude, are also known to ghost fish. Ghost fishing gillnets have been observed entangling fish, seabirds, mammals, crabs, and other invertebrates (High 1998). Unlike trap gear, however, gillnets do not biodegrade and likely do not change the relief of marine habitat other than acting as a constant entangling force in areas where they are lost.

Beyond bottom habitat, there may also be fishing impacts to the water column. Although there are presumably few, if any, direct effects from mid-water trawling on EFH, this fishery may alter species complexity in the water column. Off the Pacific coast, there is a large mid-water trawl fishery for Pacific whiting north of 42° N latitude. There may be negative effects from the offal and processing slurry discard associated with these fisheries. Prolonged offal discards from some large-scale fisheries have redistributed prey food away from mid-water and bottom feeding organisms to surface-feeding organisms, usually resulting in scavenger and seabird population increases (Hill and Wassenberg 1990, Evans et al. 1994). Conversely, large offal discards in low-current environments, when not preyed upon by surface scavengers, can also collect and decompose on the ocean floor, creating anoxic bottom conditions. Pacific coast marine habitat is generally characterized by strong current and tide conditions, but there may be either undersea canyons affected by at-sea discard, or bays and estuaries affected by discard from shoreside processing plants (Stevens and Haaga, unpublished). As with bottom trawling off the Pacific coast, little is known about the environmental effects of mid-water trawling and processing discards on habitat conditions.

11.10.3.2 Measures to Minimize Fishing Effects on Groundfish EFH

The interim final rule implementing the EFH provisions of the Magnuson-Stevens Act states that “fishery management options may include, but are not limited to:

> Fishing gear restrictions. These options may include, but are not limited to: seasonal and area restrictions on the use of specified equipment; equipment modifications to allow escapement of particular species or particular life stages (e.g., juveniles); prohibitions on the use of explosives and chemicals; prohibitions on

anchoring or setting equipment in sensitive areas; and prohibitions on fishing activities that cause significant physical damage in EFH.

> Time/area closures. These actions may include, but are not limited to: closing areas to all fishing or specific equipment types during spawning, migration, foraging, and nursery activities; and designating zones for use as marine protected areas to limit adverse effects of fishing practices on certain vulnerable or rare areas/species/life history stages, such as those areas designated as habitat areas of particular concern.

> Harvest limits. These actions may include, but are not limited to, limits on the take of species that provide structural habitat for other species assemblages or communities, and limits on the take of prey species."

The Council concurs with this general guidance, and this FMP authorizes two general measures to mitigate fishing effects on EFH in this FMP. The Council may use any of the following management measures to minimize adverse effects on EFH from fishing, if there is evidence that a fishing activity is having an identifiable adverse effect on EFH. Such management measures shall be implemented under the Points of Concern Framework, Section 6.2.2.

Fishing Gear Restrictions
Time/Area Closures
Harvest Limits

In determining whether it is practicable to minimize an adverse effect from fishing, the Council will consider whether, and to what extent, the fishing activity is adversely impacting EFH, the nature and extent of the adverse effect on EFH, and whether management measures are practicable. The Council will consider the long and short term costs and benefits to the fishery and EFH, along with other appropriate factors, consistent with national standard 7.

Restrictions on fishing equipment could include limitations on the amount, type or configuration of legal gear. Time/area closures could include seasonal and areal restrictions on the use of specified equipment, prohibitions on anchoring or setting equipment in sensitive areas, and prohibition or limitation of fishing activities that cause significant physical damage in EFH (including groundfish harvest limits). The Council may also consider developing harvest limits on species that provide structural habitat for other species assemblages or communities (such as kelps or corals). Currently, the groundfish FMP does not manage harvest of any structural species; adding such species to the management unit would require amendment to the FMP.

There is a growing body of research on the effects of fishing gear on marine habitat and general conclusions about the effects of some gear types on marine habitat may be drawn from this body of research. However, as noted above, there has been little research on Pacific coast groundfish EFH and fishing effects on habitat. While restrictions that target a specific gear type may be useful, there is concern within the fishing industry that gear restrictions for EFH without more complete information could fuel unnecessary conflict between gear groups. The Council may considered developing gear performance standards for all gears used in the groundfish fisheries. Gear performance standards might require that all fishing gear used off the Pacific coast avoid defined levels of habitat alteration. For example, performance standards for bottom gear might require that the gear not move rocks larger than a certain size. Performance standards for setnets and gillnets might require net construction of degradable material to decrease ghost fishing. Any gear performance standards would apply to all participants in the Pacific coast groundfish fishery. In developing gear performance standards, the Council would seek industry advice on a few selected gear configurations that have a high potential to impact habitat, and pursue restricting their use where habitat is most vulnerable to disturbance.

In addition to measures restricting fishing gears and methods, the Council may consider time/area closures to protect EFH. Such measures might include, but would not be limited to: closing areas to all fishing or specific equipment types to protect spawning, migration, foraging, and nursery habitat; and designating zones for use as marine protected areas to limit adverse effects of fishing practices on certain vulnerable or rare areas/species/life history stages.

Because much of the habitat in the EEZ off the Pacific coast is high relief habitat characterized by numerous rock piles interspersed with sandy bottom plains, there are patches of habitat along the coast that are less accessible to trawling. Species of *Sebastes* are particularly associated with such rocky areas. Because these are long-lived rockfish species with slow maturity rates, they may be more vulnerable to overfishing than shorter-lived, more fecund groundfish species. Investigations into gear effects on habitat should particularly look at gear or vessel modifications that may allow more access to formerly hazardous or entangling rock piles. The EFH Technical Team discussed whether any "natural" or defacto reserves exist as areas inaccessible to all fishing. Team members agreed that while there are some high relief areas that are inaccessible to trawl gear, those areas can usually be used by commercial and recreational hook-and-line gear. Older rockfish associating with rock piles that are inaccessible to trawlers are not protected from capture in other fisheries. However, the actual rock piles will be protected from trawl damage until trawl fishers devise new gear modifications that allow them to fish closer in to the rocks. Areas that are currently inaccessible to trawl nets could be protected against further gear modifications with gear performance standards.

One species that might benefit from limited time/area closures is lingcod. Male lingcod are known to guard nests of incubating eggs during January to early March, and when male lingcod are removed from the nests, the eggs quickly become prey to demersal scavengers. Restrictions to prevent fishing on lingcod during nest guarding months would not protect lingcod habitat directly, unless EFH for egg stage were expanded to include adult male lingcod. In the absence of such a definition, restrictions of this type would be a move towards fishery management that is more closely linked with the life stages of managed species. Cabezon and kelp greenling species also exhibit nest guarding behavior that could be protected by time/area closures. There may be times and areas when a fishing closure could benefit a significant cross-section of managed species during vulnerable life stages.

Beyond protecting trawl-inaccessible areas and time/area closures for particular species, the Council may consider reserves closed to all fishing. Relatively small research reserves could be established to provide information on possible effects of larger or more extensive reserves, with the understanding larger reserves may be useful in habitat and depleted stock protection. The primary goal of no-fishing zones, or regulated marine reserves, would be to allow long-lived species to grow undisturbed to ages and sizes of greater fecundity, with the expectation that a population bank of more productive spawners would put more eggs and more juveniles into the overall ecosystem and the associated fishery. Reserves may also benefit more migratory species by improving the integrity of habitat those species use. Habitat protection and improving habitat integrity would be secondary benefits of reserves. If fishing gear has negative effects on habitats used by vulnerable species, reserves of those habitats would allow long-term recovery from gear effects.

Potential benefits of marine protected areas were discussed in a report by Fujita, et al. (1997) entitled *Can No-Take Marine Reserves Help Rebuild and Sustain the Pacific Coast Groundfish Fishery?* The report envisions a network of marine reserves designed to protect mature adult populations of depleted groundfish stocks in areas of core abundance. The authors suggest that a network of reserves might serve to protect a range of habitat types, with expected improvement in the stock status of those species that depend on the protected habitat. This kind of system would go beyond ensuring that naturally inaccessible areas remain inaccessible in spite of any improvements in gear and vessel maneuverability. With a reserve system of this nature, areas that are now commonly fished may be placed within reserve boundaries.

Also in 1997, NMFS scientists convened a workshop to explore the possible benefits of marine reserves for Pacific coast rockfish populations. In considering the marine reserves as a management tool, workshop conclusions note, "Marine reserves provide one of the few management tools for implementation of multiple provisions of the Magnuson-Stevens Act that traditional management tools cannot address, including protection of essential fish habitats, incorporating ecosystem principles in fisheries management, and taking a precautionary approach to management." (Yoklavich, 1998) Workshop participants discussed how reserves might be designed to accomplish different research and management goals. They concluded that the available information on rockfish habitats is sufficient to at least create no-fishing research areas. No-fishing research areas off the Pacific coast would provide information on habitat protection and on restoring depleted stocks. Future reserve programs to provide population and habitat banks against overfishing, or for use as fishery management tools, could be based on design principles developed through a no-fishing research areas program.

Section 303 (b) of the Magnuson-Stevens Act gives Councils discretion to include no-fishing or limited fishing zones in their FMPs.

> "Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, may . . . (2) designate zones where, and periods when, fishing shall be

limited, or shall not be permitted, or shall be permitted only by specified types of fishing vessels or with specified types and quantities of fishing gear."

The individual EFH descriptions in the EFH source document will be helpful when the Council and its advisory bodies consider how to site reserves to most benefit depleted stocks. Design and siting of marine reserves should be undertaken with full participation from the fishing industry, environmental interests, university and agency scientists, as well as tribal, state, and federal managers. Enforcing the boundaries of a no-fishing zone would be impossible if marine reserves were designed without the cooperation of the fishing industry.

NMFS has recommended the Council appoint an advisory body to design gear performance standards for groundfish habitat protection, and to work on siting and design of no-fishing research reserves. The Council may establish one or more advisory bodies to respond to this recommendation. Any regulatory measures developed through this process would be approved and implemented in accordance with the Points of Concern framework of this FMP.

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11.10.4 Adverse Impacts of Nonfishing Related Activities, Gear, and Practices, and Measures to Manage Them

In accordance with Section 600.815 (a) (5) of the EFH regulations, the Council has identified the following non-fishing activities that have the potential to adversely affect groundfish EFH quantity or quality, or both. Broad categories of such activities include, but are not limited to: dredging, fill, excavation, mining, impoundment, discharge, water diversions, thermal additions, actions that contribute to non-point source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. This section describes the EFH most likely to be adversely affected by these or other activities. For each activity, known and potential adverse impacts to EFH are described. The descriptions explain the mechanisms or processes that may cause the adverse effects and how these may affect habitat function. GIS and other mapping systems are used to support analyses of data and to present these data in order to geographically depict impacts.

This section also suggests, in an advisory, not mandatory, capacity, proactive conservation measures that would help minimize or avoid the adverse effects of these non-fishing activities on groundfish EFH. These measures should be viewed as options to avoid, minimize, or compensate for adverse impacts and promote the conservation and enhancement of groundfish EFH. Generally, non-water dependent actions should not be located in EFH if such actions may have adverse impacts on EFH. Activities that may result in significant adverse affects on EFH should be avoided where less environmentally harmful alternatives are available. If there are no alternatives, the impacts of these actions should be minimized. Environmentally sound engineering and management practices should be employed for all actions which may adversely affect EFH. Disposal or spillage of any material (dredge material, sludge, industrial waste, or other potentially harmful materials) which would destroy or degrade EFH should be avoided. If avoidance or minimization is not possible, or will not adequately protect EFH, compensatory mitigation to conserve and enhance EFH should be recommended. The Council may recommend proactive measures to conserve or enhance EFH. When developing proactive measures, the Council may develop a priority ranking of the recommendations to assist Federal and state agencies undertaking such measures.

A variety of options to conserve or enhance EFH are available, including, but not limited to:

Enhancement of rivers, streams, and coastal areas. Groundfish EFH located in estuaries that are influenced by rivers, streams, and coastal areas may be enhanced by reestablishing appropriate native vegetation, restoring natural bottom characteristics, or removing unsuitable material from areas affected by human activities. Adverse effects stemming from upland areas that influence EFH may be avoided or minimized by employing measures such as, but not limited to, erosion control, upgrading culverts, removal or modification of operating procedures of dikes or levees to allow for creation of estuarine habitat. Initiation of Federal, state, or local government planning processes to restore watersheds associated with such rivers, streams, or coastal areas may also be recommended.

Water quality and quantity. The Council recommends use of best land management practices for ensuring compliance with water quality standards at state and Federal levels, improved treatment of sewage, proper disposal of waste materials, and providing appropriate in-stream flow to prevent adverse effects to estuarine areas.

Habitat creation. Under appropriate conditions, habitat creation (converting non-EFH to EFH) may be considered as a means of replacing lost or degraded EFH. However, habitat conversion at the expense of other naturally functioning systems must be justified within an ecosystem context.

Established policies and procedures of the Council and NMFS provide the framework for conserving and enhancing essential fish habitat. Components of this framework include avoidance and minimization of adverse impacts; provision of compensatory mitigation whenever the impact is significant and unavoidable; and incorporation of enhancement. New and expanded responsibilities contained in the Magnuson-Stevens Act will be met through appropriate application of these policies and principles. In assessing the potential impacts of proposed projects, the Council and NMFS will be guided by the following general considerations:

- The extent to which the activity would directly and indirectly affect the occurrence, abundance, health, and continued existence of fishery resources.

- The extent to which the potential for cumulative impacts exists.

- The extent to which adverse impacts can be avoided through project modification, alternative site selection or other safeguards.

- The extent to which the activity is water dependent if loss or degradation of groundfish EFH is involved.

- The extent to which mitigation may be used to offset unavoidable loss of habitat functions and values.

Significance of Groundfish Habitats

Pacific coastal waters are some of the most productive in the United States (Resources Agency of California, 1995). The waters and substrate that comprise the EFH under jurisdiction of the Council are diverse, widely distributed, and closely affiliated with other aquatic and terrestrial environments. These characteristics make them susceptible to human activities.

From a broad perspective, fish habitat is the geographic area where the species occurs at any time during its life. This area can be described in terms of ecological characteristics, location, and time. Ecologically, essential habitat includes waters and substrate that focus distribution (e.g., rocky reefs, intertidal salt marshes, or submerged aquatic vegetation) and other characteristics that are less distinct (e.g., turbidity zones, salinity gradients). Spatially, habitats and their use may shift over time due to climatic change, human activities and impacts. The type of habitat available, its attributes, and its functions are important to species productivity, diversity, health, and survival.

For the purposes of determining and evaluating non-fishing impacts to groundfish EFH, the area was partitioned into seven composites based on major habitat types (estuarine, rocky shelf, nonrocky shelf, canyons, continental slope, neritic zone and oceanic zone.) Of these composites, the estuarine, rocky shelf and nonrocky shelf are probably the most susceptible to deleterious impacts from nonfishing activities.

Estuaries are the bays and inlets influenced by both the ocean and a river and serve as the transitional zone between fresh and salt water (Botkin et al. 1995). Estuaries support a community of plants and animals that are adapted to the zone where fresh and salt waters mix (Zedler et al. 1992). Estuaries are naturally dynamic and complex, and human actions that degrade or eliminate estuarine conditions have the effect of stabilizing and simplifying this complexity (Williams et al. 1996), reducing their ability to function in a manner beneficial to anadromous and marine fish. Habitat degradation and loss adversely affect inshore and riverine ecosystems critical to living marine resources (Chambers 1992). In addition, the cumulative effects of small changes in many estuaries may have a large systematic impact on estuarine and coastal oceanic carrying capacity (Monaco et al. 1990).

Fox (1992) states: "The ability of habitats to support high productivity levels of marine resources is diminishing, while pressures for their conversion to other uses are continuing." Point and nonpoint discharges, waste dumps, eutrophication, acid rain, and other human impacts reduce this ability (Fox 1992). Population growth and demands for international business trade along the Pacific Rim exert pressure to expand coastal towns and port facilities, resulting in net estuary losses (Kagan 1991, Fawcett and Marcus 1991). Carefoot (1977), discussing Pacific seashores, states "Estuaries are complex systems which can succumb to humankind's massive and pervasive assaults."

Estuarine habitats fulfill fish and wildlife needs for reproduction, feeding, refuge, and other physiological necessities (Simenstad et al. 1991, Good 1987, Phillips 1984). Coastal fish populations depend upon both the quantity and quality of the available habitat (Peters and Cross 1992). Almost all marine and intertidal waters, wetlands, swamps and marshes are critical to fish (Fedler and Crookshank 1992). For example, seagrass beds protect young fish from predators, provide habitat for fish and wildlife, improve water quality, and control sediments (Lockwood 1990, Thayer et al. 1984, Hoss and Thayer 1993, Phillips 1984). In addition, seagrass beds are critical to nearshore food web dynamics (Wyllie-Echeverria and Phillips 1994).
Studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993, Hoss and Thayer 1993, Emmett et al. 1991). This primary production, combined with other nutrients, provide high rates of secondary production in the form of fish (Herke and Rogers 1993, Good 1987, Sogard and Able 1991, Emmett et al. 1991).

Other estuarine habitats such as mud flats, high salt marsh, and saltmarsh creeks also provide productive shallow water habitat for epibenthic fishes and decapods (Sogard and Able 1991). Simenstad et al. (1990) found that coarse sediment tidal flats were productive benthic infauna areas.

Woody debris plays a significant role in salt marsh ecology (Maser and Sedell 1994). Reductions in woody debris input to the estuaries may affect the ecological balance of the estuary. Large woody debris also plays a significant role in benthic ocean ecology, where deep-sea wood borers convert the wood to fecal matter providing terrestrial based carbon to the ocean food chain (Maser and Sedell 1994). Dams and commercial in-river harvest of large woody debris have dwindled the supply of wood, jeopardizing the ecological link between the forest and the sea (Maser and Sedell 1994).

Estuarine zone fisheries are of great economic importance across the Nation (Herke and Rogers 1993). Three-fourths of the fish species caught in the United States are supported by estuarine habitats (Hinman 1992, Fox 1992). Clams, crabs, oysters, mussels, scallops, and estuarine and nearshore small commercial fishes contributed an average dockside revenue of $389 million nationally from 1990 to 1992 (National Marine Fisheries Service 1993). Using NMFS data, Chambers (1992) determined that seventy-five percent of all commercial fish and shellfish landings are of estuarine-dependent species. At least 31 groundfish species inhabit estuaries and nearshore kelp forests for part, or all, of their life cycle.

Of the habitats associated with the rocky shelf composite, kelp forests are of primary importance. Lush kelp forest communities (e.g., giant kelp, bull kelp, elk kelp, and feather boa kelp) are found relatively close to shore along the open coast. These subtidal communities provide vertically-structured habitat through the water column on the rocky shelf, made up of a canopy of tangled stipes from the water line to a depth of 10 feet, a mid-kelp, water-column region and the bottom, holdfast region. The stands provide nurseries, feeding grounds and/or shelter to a variety of groundfish species and their prey (Feder et al. 1974; Ebeling et al. 1980). Giant kelp communities are highly productive; relative to other habitats including wetlands, shallow and deep sand bottoms and rock bottom artificial reefs, kelp habitats are substantially more productive in the fish communities they support (Bond et al., 1998). Their net primary production is an important component to the energy flow within food webs. Foster and Schiel (1985) reported that the net primary productivity of kelp beds may be the highest of any marine community. The net primary production of seaweeds in a kelp forest is available to consumers in three forms: living tissue on attached plants; drift in the form of whole plants or detached pieces; and, dissolved organic matter exuded by attached and drifting plants (Foster and Schiel, 1985).

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11.10.4.1 Adverse Nonfishing Impacts and Recommended Conservation Measures

The following is a general description of non-fishing related activities that directly or cumulatively, temporarily or permanently may threaten the physical, chemical and biological properties of the habitat utilized by Pacific coast groundfish species and their prey. The direct result of these threats is that the function of EFH may be eliminated, diminished or disrupted. The list includes common and not so common activities that all have known or potential impacts to EFH. The list is not prioritized nor is it all-inclusive. The potential adverse effects described below, however, do not necessarily apply to the described activities in all cases, as the specific circumstances of the proposed activity or project just be carefully considered on a case-by-case basis. Furthermore, some of the activities described below may also have beneficial effects on habitat, which need to be considered in any analysis of an action's net effect by agencies conducting adverse effects analysis.

If the Council believes a proposed activity appears to have the potential to adversely impact EFH, it may advise the action agency and NMFS of its belief. In response, the action agency may need to undertake an EFH assessment to determine whether the proposed activity or activities will impose an adverse impact to the quality and quantity of the habitat. Section 600.905 of the EFH regulations delineates consultation requirements for activities that adversely impact EFH. The following measures are suggested, in an advisory, not mandatory, capacity, as proactive conservation measures that would aid in minimization or avoidance of the adverse effects of these nonfishing activities on EFH.

The potential impacts below are germane to the EFH of 83 species of Pacific coast groundfish and their prey.

1. **DREDGING:** Dredging navigable waters is a continuous impact primarily to benthic habitats, but also to adjacent habitats in the construction and operation of marinas, harbors, and ports. Routine dredging, that is, the excavation of soft bottom substrates, is required to provide or create ship (e.g., ports) and boat (e.g., marinas) navigational access to docking facilities. Dredging is used to create deepwater navigable channels or to maintain existing channels that periodically fill with sediments that flow into these channels from rivers or move by wind, wave, and tidal dynamics. In the process of dredging, excessive quantities and associated qualities of the sea floor are removed, disturbed and re-suspended. Turbidity plumes may arise. Legal mandates covering dredging are the Federal Water Pollution Control Act of 1972 (33 U.S.C. 1251 et seq.) and the River and Harbor Act of 1899 (33 U.S.C. 401 et seq.).

   Adverse Impacts: Dredging may adversely affect infaunal and bottom-dwelling organisms at the site by removing immobile organisms such as polychaete worms and other prey types or forcing mobile animals such as fish to migrate. Benthic plants and animals present prior to a discharge are unlikely to re-colonize if the composition of the deeper layers of sediment are drastically different.

   Dredging events using certain types of dredging equipment can result in greatly elevated levels of fine-grained mineral particles, usually smaller than silt, and organic particles in the water column. These turbidity plumes of suspended particulates may reduce light penetration and lower the rate of photosynthesis (e.g., in adjacent eelgrass beds) and the primary productivity of an aquatic area if suspended for extended periods of times. If suspended particulates persist, fish may suffer reduced feeding ability and sensitive habitats such as submerged aquatic vegetation beds which provide source of food and shelter may be damaged. The contents of the suspended material may react with the dissolved oxygen in the water and result in short-term oxygen depletion to aquatic resources. Toxic metals and organics, pathogens, and viruses absorbed or adsorbed to fine-grained particulates in the material may become biologically available to organisms either in the water column or through food chain processes.

   Dredging as well as the equipment used in the process such as pipelines may damage or destroy spawning, nursery habitat and other sensitive habitats such as emergent marshes and subaquatic vegetation including eelgrass beds and kelp beds. Dredging may also modify current patterns and water circulation of the habitat by changing the direction or velocity of water flow, water circulation, or otherwise changing the dimensions of the water body traditionally utilized by fish for food, shelter or reproductive purposes.

Recommended Conservation Measures:

1. To the maximum extent practicable, new, as opposed to maintenance, dredging should be avoided. Activities that would likely require dredging (such as placement of piers, docks, marinas, etc.) should instead be sited in deep water areas or designed in such a way as to alleviate the need for maintenance dredging. Projects should be permitted only for water dependent purposes, and only when no feasible alternatives are available.

2. Where the dredge equipment employed could cause significant long term impacts due to entrainment of groundfish or prey species, dredging in estuarine waters shallower than 20' in depth should be performed during the time frame when groundfish and prey species are least likely to be entrained. Dredging, except for maintenance dredging, should be avoided in areas with submerged aquatic vegetation.

3. All dredging permits should reference latitude-longitude coordinates of the site so information can be incorporated into geographical information system format. Inclusion of aerial photos may also be required to identify precise locations for long term evaluation.

4. Sediments should be tested for contaminants as per Environmental Protection Agency and U.S. Army Corps of Engineers requirements.

5. The cumulative impacts of past and current dredging operations on EFH should be addressed by Federal, state, and local resource management and permitting agencies and considered in the permitting process.

6. If dredging needs are caused by excess sedimentation in the watershed, those causes should be identified and appropriate management agencies contacted to assure action is done to curtail those causes.

7. Post-dredging bottom surface contours should remain as close as feasible to the pre-dredging condition

8. The bankward slopes of the dredged area should be left so that sloughing would not occur. To show that no sloughing is occurring, long-term monitoring via bathymetric sounding should be conducted.

9. Pipelines and accessory equipment used in conjunction with dredging operations should, to the maximum extent possible, avoid kelp beds, eelgrass beds, estuarine marshes and areas of subaquatic vegetation.

10. Where a dredging equipment type is used that is expected to create significant turbidity (e.g., clamshell) dredging should be conducted using adequate control measures to minimize turbidity.

11. Compensation for significant impacts (short-term, long-term and cumulative) to benthic environments from dredging should be provided where appropriate.

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2. **DREDGE MATERIAL DISPOSAL/FILLS:** The discharge of dredged materials subsequent to dredging operations or the use of fill material in the construction/development of harbors results in sediments (e.g., dirt, sand, mud) covering or smothering existing submerged substrates. Usually these covered sediments are of a soft-bottom nature as opposed to rock or hard-bottom substrates.

   Adverse Impacts: The disposal of dredged or fill material can result in varying degrees of change in the physical, chemical, and biological characteristics of the substrate. Discharges may adversely affect infaunal and bottom-dwelling organisms at the site by smothering immobile organisms (e.g., prey invertebrate species) or forcing mobile animals (e.g., benthic-oriented fish species) to migrate from the area. Infaunal invertebrate plants and animals present prior to a discharge are unlikely to re-colonize if the composition of the discharged material is drastically different. Erosion, slumping, or lateral displacement of surrounding bottom of such deposits can also adversely affect substrate outside the perimeter of the disposal site by changing or destroying benthic habitat. The bulk and composition of the discharged material and the location, method, and timing of discharges may all influence the degree of impact on the substrate.

   The discharge of dredged or fill material can result in greatly elevated levels of fine-grained mineral particles, usually smaller than silt, and organic particles in the water column (i.e., turbidity plumes). These suspended particulates may reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area if suspended for lengthy intervals. Aquatic vegetation such as eelgrass beds and kelp beds may also be affected. Groundfish and other fish species may suffer reduced feeding ability leading to limited growth and lowered resistance to disease if high levels of suspended particulates persist. The contents of the suspended material may react with the dissolved oxygen in the water and result in oxygen depletion. Toxic metals and organics, pathogens, and viruses absorbed or adsorbed to fine-grained particulates in the material may become biologically available to organisms either in the water column or through food chain processes.

   The discharge of dredged or fill material can change the chemistry and the physical characteristics of the receiving water at the disposal site by introducing chemical constituents in suspended or dissolved form. Reduced clarity and excessive contaminants can reduce, change or eliminate the suitability of water bodies for populations of groundfish, other fish species and their prey. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as polychaetes or algae to the detriment of other types.

   The discharge of dredged or fill material can modify current patterns and water circulation by obstructing flow, changing the direction or velocity of water flow, changing the direction or velocity of water flow and circulation, or otherwise changing the dimensions of a water body. As a result, adverse changes can occur in the location, structure, and dynamics of aquatic communities; shoreline and substrate erosion and deposition rates; the deposition of suspended particulates; the rate and extent of mixing of dissolved and suspended components of the water body; and water stratification.

Disposal events may lead to the full or partial loss of habitat functions due to extent of the burial at the site. Loss of habitat function can be temporary or permanent.

Recommended Conservation Measures:

1. Upland dredge disposal sites should be considered as an alternative to offshore disposal sites.

2. The cumulative impacts of past and current fill operations on EFH should be addressed by Federal, state, and local resource management and permitting agencies and considered in the permitting process.

3. Any disposal of dredge material in EFH should meet applicable state and/or federal quality standards for such disposal.

4. When reviewing open water disposal permits for dredged material, state and Federal agencies should identify the direct and indirect impacts such projects may have on groundfish EFH. Benthic productivity should be determined by sampling prior to any discharge of fill material. Sampling design should be developed with input from state and Federal resource agencies.

5. The areal extent of any disposal site in groundfish EFH should be minimized. However, in some cases, thin layer disposal may be less deleterious. All non-avoidable adverse impacts (other than insignificant impacts) should be mitigated.

6. All spoil disposal permits should reference latitude-longitude coordinates of the site so information can be incorporated into GIS systems. Inclusion of aerial photos may also be required to identify precise locations for long term evaluation.

7. Further fills in estuaries and bays for development of commercial enterprises should be curtailed.

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3. OIL/GAS EXPLORATION/PRODUCTION: Offshore exploration and production of natural gas and oil reserves has been and will continue to be an important aspect of the U. S. economy as demand for energy resources grows. Oil exploration/production occurs in varying water depths and usually over soft-bottom substrates although hard-bottom habitats may be present in the general vicinity. Oil exploration/production areas are vulnerable to an assortment of physical, chemical, and biological disturbances resulting from activities used to locate oil and gas deposits such as high energy seismic surveys to actual physical disruptions resulting from the use and/or installation of anchors, chains, drilling templates, dredging, pipes, platform legs and biofouling communities associated with the platform jacket. During actual operations, the predominant emissions from oil platforms are drilling muds and cuttings, produced water and sanitary wastes.

Adverse Impacts: The impacts of oil exploration-related seismic energy release may interrupt and cause fish to disperse from the acoustic pulse with possible disruption to their feeding patterns. The uses of these high energy sound sources may also disrupt or damage marine life. While available data on fish species does limit concerns regarding potential effects on marine life to sensitive egg and larval stages within a few meters of the sound source, whether this data pertains to all groundfish species is questioned.

Adjacent hard-bottom habitats can be severely impacted by anchoring operations during exploratory operations resulting in the crushing, removal or burial of substrate used for feeding or shelter purposes. Disturbances to the associated epifaunal communities may also result.

The discharge of exploratory drill muds and cuttings can result in varying degrees of change on the sea floor and affect the feeding, nursery and shelter habitat for various life stages of groundfish and shellfish species that are important to commercial and recreational fishers. Drilling muds and cuttings may adversely affect bottom-dwelling organisms (e.g, prey) at the site by burial of immobile forms or forcing mobile forms to migrate. Exploratory activities may also result in resuspension of fine-grained mineral particles, usually smaller than silt in the water column. These suspended particulates may reduce light penetration and lower the rate of photosynthesis and the primary productivity of the aquatic area especially if suspended for lengthy intervals. Groundfish and other fish species may suffer reduced feeding ability leading to limited growth if high levels of suspended particulates persist. The contents of the suspended material may react with the dissolved oxygen in the water and result in oxygen depletion.

Benthic forms, especially prey species, present prior to the oil/gas operations may be unlikely to re-colonize if the composition of the substrate is altered drastically. This may be especially true during actual oil/gas production operations when filter-feeding organisms such as mussel colonies may periodically become dislodge from the oil platform and form biological debris mounds on the bottom. This alteration to the sea floor may affect naturally occurring feeding opportunities and spawning habitat.

The discharge of oil drilling muds can change the chemistry and physical characteristics of the receiving water at the disposal site by introducing toxic chemical constituents. Changes in the clarity and the addition of contaminants can reduce or eliminate the suitability of water bodies for habituation of fish species and their prey.

Recommended Conservation Measures:

1. Avoid anchoring exploratory vessels over hard bottom areas as much as possible.

2. Benthic productivity should be determined by sampling prior to any exploratory operations. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and Federal resource agencies.

3. Mitigation should be provided for areas impacted.

4. Containment equipment and sufficient supplies to combat spills should be on-site at all facilities that handle oil or hazardous substances.

5. Each facility should have a "Spill Contingency Plan" and all employees should be trained in how to respond to a spill.

6. To the maximum extent practicable, storage of oil and hazardous substances should be located in an area that would prevent spills from reaching the aquatic environment.

7. Construction of roads and facilities adjacent to aquatic environs should include a storm water treatment component that would filter out oils and other petroleum products. Road construction in estuaries should be bridged or adequately culverted to prevent blockage to migrating fish. Culverts should be installed at sufficient intervals to prevent blockage of surface drainage or tidal flow.

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4. WATER INTAKE STRUCTURES: The withdrawal of ocean water by offshore water intakes structures is a common coastwide occurrence. Water may be withdrawn for providing sources of cooling water for coastal power generating stations or as a source of potential drinking water as in the case of desalinization plants. If not properly designed, these structures may create unnatural and vulnerable conditions to various fish life stages and their prey. In addition, freshwater withdrawals from riverine systems to support industrial and agricultural operations is also occurs.

Adverse Impacts: The withdrawal of seawater can create unnatural conditions to the EFH of many species. Various life stages can be affected by water intake operations such as entrapment through water withdrawal, impingement on intake screens, and entrainment through the heat-exchange systems or discharge plumes of both heated and cooled effluent.

High approach velocities along with unscreened intake structures can create an unnatural current making it difficult for fish species and their prey to escape.. These structures may withdraw most larval and post-larval marine fishery organisms, and some proportion of more advanced life stages. Periods of low light (e.g, turbid waters, nocturnal periods) may also entrap adult and subadult species many of which are either utilized by commercial or recreational fishers or serve as the prey of these species. Freshwater withdrawal also reduces the volume and perhaps timing of freshwater reaching estuarine environments, thereby potentially altering circulation patterns, salinity and the upstream migration of the saltwater wedge.

Recommended Conservation Measures:

1. New facilities that rely on surface waters for cooling should not be located in areas such as estuaries, inlets, heads of submarine canyons, rock reefs or small coastal embayments where fishery organisms are concentrated. New discharge points should be located in areas that have low concentrations of living marine resources, or they should incorporate cooling towers that employ sufficient safeguards to ensure against release of blow-down pollutants into the aquatic environment in concentrations that exceed state and/or federal limits established pursuant to state and/or federal NPDES regulations.

2. All intake structures should be designed to minimize entrainment or impingement of prey species. Power plant intake structures should be designed to meet the "best technology available" requirements as developed pursuant to Section 316b of the Clean Water Act.

3. Discharge temperatures should comply with applicable temperature limits established pursuant to state and/or federal NPDES regulations.

4. Mitigation should be provided for the net loss of habitat from placement of the intake structure and delivery pipeline.

References:

Helvey, M. 1985. Behavioral factors influencing fish entrapment at offshore cooling-water intake structures in southern California. Marine Fisheries Review 47(1) 18-26.

5. AQUACULTURE: The culture of estuarine, marine, and freshwater species in coastal areas can reduce or degrade habitats used by native stocks. The location and operation of these facilities will determine the level of impact on the marine environment.

Adverse Impacts: Aquaculture operations may discharge organic waste and/or antibiotics from the farms into the marine environment. Wastes are composed primarily of feces and excess feed and the buildup of waste products into the receiving waters will depend on water depths and circulation patterns. The release of these wastes may introduce nutrients or organic materials into the surrounding water body and lead to a high biochemical oxygen demand (BOD) which may reduce dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms in the area. Nutrient overloads at the discharge site can also favor one group of organisms to the detriment of other more desirable prey types such as polychaete worms.

In the case of cage mariculture operations, cultured organisms may escape into the environment. Such operations may also impact the sea floor below the cages or pens. The composition and diversity of the bottom-dwelling community (e.g., prey organisms) due to the build-up of organic materials on the sea floor may be impacted. Growth of submerged aquatic vegetation, which may provide shelter and nursery habitat for a number of fish species and their prey, may be inhibited by shading effects.

Recommended Conservation Measures:

1. Facilities should be close-circuited and located in upland areas as often as possible. Tidally influenced wetlands should not be enclosed or impounded for mariculture purposes. This includes hatchery and grow-out operations. Siting of facilities should also take into account the size of the facility, the presence or absence of submerged aquatic vegetation, proximity of wild fish stocks, migratory patterns, competing uses, hydrographic conditions, and upstream uses. Benthic productivity should be determined by sampling prior to any operations. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and Federal resource agencies.

2. Water intakes should be designed to avoid entrainment and impingement of native fauna.

3. Water discharge should be treated to avoid contamination of the receiving water, and should be located only in areas having good mixing characteristics.

4. Where cage mariculture operations are undertaken, water depths and circulation patterns should be investigated and should be adequate to preclude the buildup of waste products, excess feed, and chemical agents.

5. The rearing of non-native, ecologically undesirable species may pose a risk of escape or accidental release into areas adversely affecting the ecological balance. A thorough scientific review and risk assessment should be undertaken before any non-native species are allowed to be introduced.

6. Any net pen structure should have small enough webbing to prevent entanglement.

7. Mitigation should be provided for the areas impacted by the facility.

References:

British Columbia Ministry of Environment, Victoria, (Canada). Water Management Branch. 1990. Environmental management of marine fish farms.28 pp NTIS Order No.: MIC-91-00496/GAR.

6. WASTEWATER DISCHARGE: The discharge of wastewater from commercial activities including municipal wastewater treatment plants, power generating stations, industrial plants (e.g., pulp mills, desalination plants) and storm water from drains into open ocean waters, bay or estuarine waters can introduce chemical constituents or salinities potentially detrimental to estuarine and marine habitats. These constituents include pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, hydrocarbons, and toxics. Historically, wastewater discharges have been one of the largest sources of contaminants into coastal waters. However, whereas wastewater discharges have been regulated under increasingly more stringent requirements over the last 25 years, non-point source/stormwater runoff has not been regulated to the same degree and continues to be a significant remaining source of pollution to the coastal areas and ocean. Changes in community structure and function, health and abundance may result due to these discharges. Many of these changes can be long-lasting.

Adverse Impacts: Wastewater effluent and non-point source/stormwater discharges may affect the growth and condition of groundfish, other species of fish, and prey species if high contaminant levels are discharged (e.g., chlorinated hydrocarbons; trace metals; polynuclear aromatic hydrocarbons, pesticides, and herbicides). If contaminants are present, their effects may be manifested by absorption across the gills or through bioaccumulation as a result of consuming contaminated prey. Outfall sediments may alter the composition and abundance of benthic community invertebrates living in or on the sediments. Due to bioturbation, diffusion, and other upward transport mechanisms that move buried contaminants to the surface layers and eventually to the water column, pelagic and nektonic biota may also be exposed through mobilization into the water column.

The use of biocides (e.g., chlorine, heat treatments) to prevent biofouling or the discharge of brine as a byproduct of desalinization can reduce or eliminate the suitability of water bodies for populations of fish species and their prey in the general vicinity of the discharge pipe. The impacts of chlorination and heat treatments, if any, are minimized due to their intermittent use and regulation pursuant to state and/or federal NPDES permit requirements. These compounds may change the chemistry and the physical characteristics of the receiving water at the disposal site by introducing chemical constituents in suspended or dissolved form. In addition to chemical and thermal effects, discharge sites may also create adverse impacts to sensitive areas such as emergent marshes, sea grasses, and kelp beds if located improperly.

Extreme discharge velocities of the effluent may also cause scouring at the discharge point as well as entrain particulates and thereby create turbidity plumes. These turbidity plumes of suspended particulates may reduce light penetration and lower the rate of photosynthesis (e.g., adjacent eelgrass beds or kelp beds) and the primary productivity of an aquatic area if suspension persists. Groundfish and other fish may suffer reduced feeding ability, especially if suspended particulates persist. The contents of the suspended material may react with the dissolved oxygen in the water and result in oxygen depletion.

Mass emissions of suspended solids, contaminants and nutrient overloading from these outfalls may also affect submerged aquatic vegetation sites including eelgrass beds and kelp beds. These beds are frequently utilized by groundfish and other fish species for shelter and protection from predators and for food by consuming organisms associated with these beds.

The byproduct of desalinated seawater is brine with a salinity about double that of seawater. The waste brine may be discharged directly to the ocean or discharged through sewage outfalls (where it may be diluted). Because of the short duration of operation, little is known about the toxicity of waste brine, but its potential impacts to early life stages of fish and their prey should be considered .

Storm water runoff, which can include both urban and agricultural runoff, is also a large source of particular contaminants to the marine environment affecting both water column and benthic habitats. These contaminants may find their way into the food web through benthic infaunal communities and subsequently bioaccumulate in numerous fish species.

Recommended Conservation Measures:

1. New outfall structures should be placed offshore sufficiently far enough to prevent discharge water from affecting eel grass or kelp beds. Discharges should be managed to comply with applicable state and/or federal NPDES permit requirements, including compliance with applicable technology-based and water quality-based effluent limits.

2. Benthic productivity should be determined by sampling prior to any construction activity related to installation of new or modified facilities. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and Federal resource agencies.

3. Mitigation should be provided for the degradation or loss of habitat from placement and operation of the outfall structure and pipeline.

References:

Bay, S. and D. Greenstein. 1994. Toxic effects of elevated salinity and desalination waste brine. *In:* J. Cross (ed.) Southern California Coastal Water Research Project, Annual Report 1992-93, pp. 149-153. SCCWRP, Westminster, CA.

Environmental Protection Agency; Department of Commerce, National Oceanic and Atmospheric Administration. 1995. Coastal Nonpoint Pollution Control Program. EPA number: 950298D, 100 pages, July 7, 1995.

Ferraro, S. P., R.C. Swartz, F. A. Cole, and D.W. Schults. 1991. Temporal changes in the benthos along a pollution gradient: discriminating the effects of natural phenomena from sewage-industrial wastewater effects. Estuarine Coastal Shelf sei. 33:383-407.

Leonard, J.N. 1994. Ocean outfalls for wastewater discharges -- meeting Clean Water Act 403C requirements. Marine Technology Soc. '94, Conference Proceedings. Challenges and Opportunities in the Marine Environment, Washington, DC, 7-9 Sept. pp. 115-120.

Stull, J. K. and C. I. Haydock. 1989. Discharges and environmental responses: the Palos Verdes case. *In* Managing inflows in California's bays and estuaries. The Bay Institute, Sausalito, Calif. Pp. 44-49.

USEPA. 1993. Guidance for specifying management measures for sources of nonpoint pollution in coastal waters. Office of Water. 840-B-92-002. 500+p.

Raco-Rands, V. E. 1996. Characteristics of effluents from power generating stations in 1994. *In* M. J. Allen (ed.) Southern California Coastal Water Research Project, Annual Report 1994-95. SCCWRP, Westminster, CA, pp29-36.

7. DISCHARGE OF OIL OR RELEASE OF HAZARDOUS SUBSTANCES: Accidental spills of oil or the release of a hazardous substance into estuarine and marine habitats can create significant pollution events. These inadvertent releases occur during the production, transportation, refining and utilization of hazardous materials from both facilities and vessels.

Adverse Impacts: Exposure to petroleum products and hazardous substances from spills or other unauthorized releases can have both acute and chronic effects on groundfish, other fish species, and prey organisms, and also potentially reduce the marketability of target species. Direct physical contact with discharged oil or released hazardous substances (e.g., toxics such as oil dispersants and mercury) or indirect exposure resulting from food chain processes can produce a number of biological responses in fish resources and their prey. Exposure can occur in a variety of habitats including the water column, sea floor, bays, and estuaries. Depending on the biological pathway involved, these biological responses may include death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations of fish that are important to commercial and recreational fishers.

Other issues related to the category include efforts to cleanup spills or releases that in themselves can create serious harm to the habitat. For example, the use of potentially toxic dispersants to break up an oil spill may adversely effect the egg and larval stages of most groundfish species.

Recommended Conservation Measures:

1. Containment equipment and sufficient supplies to combat spills should be on-site at all facilities that handle oil or hazardous substances.

2. Facilities should have a "Spill Contingency Plan" where required by applicable local, state or federal requirements, and employees identified in the plan as having responsibility for responding to a spill should receive appropriate training.

3. To the maximum extent practicable, storage of oil and hazardous substances should be located in an area that would prevent spills from reaching the aquatic environment.

4. Construction of roads and facilities adjacent to aquatic environs should include a stormwater treatment component that would filter out oils and other petroleum products.

References:

Armstrong, D. A., P. A. Dinnel, J. M. Orensanz, J. L. Armstrong, T. L. McDonald, R. F. Cusimano, R. S. Nemeth, M. L. Landolt, J. R. Skalski, R. F. Lee, and R. J. Huggett. Status of Selected Bottomfish and Crustacean Species in Prince William Sound Following the Exxon Valdez Oil Spill. IN: Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219, pp. 485-547, Peter G. Wells, James N. Butler, and Jane S. Hughes, Eds., American Society for Testing and Materials, Philadelphia, 1995.

California Department of Fish and Game. Quick approval process for dispersant use in waters off California. Unpublished, undated document. Person. Comm. from Michael Sowby, CDFG, Oil Spill Prevention and Response Office to Mark Helvey, NMFS, March, 1998.

Southern California Coastal Water Research Project. 1992. Hazardous spills in the Southern California Bight. *In:* J. Cross (ed.) Annual Report 1990-91 and 1991-92, pp. 29-38. SCCWRP, Westminster, CA. 92683.

8. FISH ENHANCEMENT STRUCTURES: The construction of fish enhancement structures, or the more common term of "artificial reefs", are a popular management tool employed by state and Federal governments and private groups. These structures have been used for centuries to enhance fishery resources and fishing opportunities and usually entail placing miscellaneous materials in ocean or estuarine environments void of physical or "hard-bottom" relief. While scientists still debate the unsettled argument of whether reefs attract and/or produce fish biomass, the proliferation of artificial reefs continues. This popularity results from increased demands on fish stocks by both commercial and recreational fishermen and losses of habitat productivity due to development and pollution. However, the introduction of artificial reef material into the marine or estuarine environment can also produce negative impacts.

Adverse Impacts: The use of artificial reefs can adversely impact the aquatic environment in at least two ways. The first deals with the loss of habitat upon which the reef material is placed. Usually, reef materials are set upon flat, relatively barren sandy sea floor; such placement may bury or smother faunal and bottom-dwelling organisms at the site or even preventing mobile forms (e.g., benthic-oriented fish species) from utilizing the area. This effect has been shown in Hawaii.

The second potential adverse impact results from use of inappropriate materials such as automobile tires or compressed incinerator ash that may degrade the marine habitat degradation. For example, automobile tires may release toxic substances into the marine environment and may cause physical damage to existing habitat if they break free of their anchoring systems.

Recommended Conservation Measures:

1. Benthic productivity should be determined by sampling prior to any construction activity. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and Federal resource agencies.

2. Prior to construction, an evaluation of the impact resulting from the change in habitat (sand bottom to rocky reef, etc.) should be performed.

3. Post-construction monitoring should be conducted to determine the effectiveness of the structures in actually increasing productivity of the targeted species.

References:

Buckley, R. M. 1989. Habitat alterations as a basis for enhancing marine fisheries. Calif. Coop. Oceanic Fish. Invest. Rep. 30:40-45.

Livingston, R. J. 1994. Environmental implications of establishment of a coal--ash reef near Cedar Key, Florida, United States. Bull. Mar. Sci. 55(2-3): 1344.

McGurrin, JM, R. B. Stone, and R. J. Sousa. 1989. Profiling United States artificial reef development. Bull. Mar. Sci. 44(2): 1004-1013.

Nelson, W. G., T. Neff, P. Navratil and J. Rodda. 1994. Disturbance effects on marine infaunal benthos near stabilized oil-ash reefs: Spatial and temporal alteration of impacts. Bull. Mar. Sci. 55(2-3): 1348.

Polovina, J. J. 1989. Artificial reefs: Nothing more than benthic fish aggregators. Calif. Coop. Oceanic Fish. Invest. Rep. 30:37-39.

9. COASTAL DEVELOPMENT IMPACTS: Coastal development involves changes in land use by the construction of urban, suburban, commercial, and industrial centers and the corresponding infrastructure. Vegetated areas are removed by cut-and-fill activities for enhancing the development potential of the land. Portions of the natural landscape are converted to impervious surfaces resulting in increased runoff volumes. Runoff from these developments may include heavy metals, sediments, nutrients and organics, including synthetic and petroleum hydrocarbons, yard trimmings, litter, debris, and pet droppings. As residential, commercial and industrial growth continues, the demand for water escalates. As ground water resources become depleted or contaminated, greater demands are placed on surface water through dam and reservoir construction or other methods of freshwater diversion. The consumptive use and redistribution of significant volumes of surface freshwater causes reduced river flows that can affect salinity regimes as saline waters intrude further upstream.

Impacts: Development activities within watersheds and in coastal marine areas often impact habitat of groundfish and other fish species on both long-term and short-term scales. Runoff from development sites of toxics reduces the quality and quantity of suitable fish habitat by the introduction of pesticides, fertilizers, petrochemicals, construction chemicals (e.g., concrete products, seals and paints). Sediment runoff can also restrict tidal flows tidal elevations resulting in losses of important fauna and flora (e.g., submerged aquatic vegetation). Shoreline stabilization projects that affect reflective wave energy can impede or accelerate natural movements of sand and thereby impacting intertidal and sub-tidal habitats. Wetlands serve an important function for exporting nutrients and energy, as well as serving as fish nursery areas, and loss or reduction of this function results from both reduction of geographic size and by input material exceeding processing capacity. Reduced freshwater flow into estuaries and wetlands can reduce productivity and habitat quality for fish by impacting the extent and location of the mixing (or entrapment) zone.

Recommended Conservation Measures:

1. Prior to installation of any piers or docks, the presence or absence of submerged aquatic vegetation should be determined. Vegetated areas should be avoided. Benthic productivity should also be determined and areas

with high productivity avoided. Sampling design should be developed with input from state and federal resource agencies.

2. The use of dry stack storage is preferable to wet mooring of boats. If that method is not feasible, construction of piers, docks and marinas should be designed to minimize impacts to the substrate and subaquatic vegetation.

3. Bioengineering should be used to protect altered shorelines. Natural stable shorelines should not be altered.

4. Filling of estuaries, wetlands, and bays for commercial enterprises should be curtailed.

References:

Baird, RC. 1996. Toward new paradigms in coastal resource management: Linkages and institutional effectiveness. Spagnolo, RJ; Ambrogio, E; Rielly, FJ Jr (eds). Estuaries, 19(2A): 320-335.

Drinkwater, KF and K.T. Frank. 1994. Effects of river regulation and diversion on marine fish and invertebrates. Aquat. Conserv.: Mar. Freshwat. Ecosyst. 4(2): 135-151.

McLusky, D.S., D. M. Bryant, and M. Elliot. 1992. The impact of land-claim on macrobenthos, fish and shorebirds on the Forth Estuary, eastern Scotland. Aquat. Conserv.: Mar. Freshwat. Ecosyst. 2 (3): 211-222.

Paul, J.F., K. J. Scott, A. F. Holland, S. B. Weisberg, J. K. Summers and A. Robertson. 1992. The estuarine component of the US E.P.A.'s Environmental Monitoring and Assessment Program. Papers from the First International Ocean Pollution Symposium, 28th April 1991--2nd May 1991. University of Puerto Rico, Puerto Rico, (Part Two). Chem. Ecol.7 (1-4): 93-116.

Rozengurt, M.A., I. Haydock, and B.P. Anderson. 1994. Running on entropy: The effect of water diversion on the coastal zone. 37th Conference of the International Association for Great Lakes Research and Estuarine Research Federation: Program and Abstracts., Buffalo, NY (USA). 166pp.

Turek, J. G., T. E. Bigford, and J. S. Nichols. 1987. Influence of freshwater inflows on estuarine productivity. NOAA Tech. Memo. NMFS-F/NEC-46. 26p.

U.S. Environmental Protection Agency. 1993. Guidance for specifying management measures for sources of nonpoint pollution in coastal waters. Office of Water. 840-B-92-002. 500+p.

10. INTRODUCTION OF EXOTIC SPECIES: Over the past two decades, there has been an increase in introductions of exotic species into marine habitats. Introductions can be intentional (e.g., for the purpose of stock or pest control) or unintentional (e.g., fouling organisms).

Adverse Impacts: Exotic species introductions create five types of negative impacts (1) habitat alteration, (2) trophic alteration; (3) gene pool alteration, (4) spatial alteration; and, (5) introduction of diseases. Habitat alteration includes the excessive colonization of exotic species (e.g., San Diego bivalve and *Spartina* grass) which preclude endemic organisms (e.g., eelgrass). The introduction of exotic species may alter community structure by predation on native species (e.g., Japanese oyster drill, Chinese mitten crab, *Tilapia,* Oriental goby, striped bass) or by population explosions of the introduced species (e.g., Asian clam, green crab). Spatial alteration occurs when territorial introduced species compete with and displace native species. Although hybridization is rare, gene pool deterioration may occur between native and introduced species. One of the most severe threats to a native fish community is the introduction of bacteria, viruses, and parasites that reduce the quality of the habitat.

Recommended Conservation Measures:

1. Vessels should discharge ballast water far enough out to sea to prevent introduction of non-native species to bays and estuaries.

2. Exotic species should not be introduced for aquaculture purposes unless a thorough scientific evaluation and risk assessment is performed (see section on aquaculture).

3. Effluent from public aquaria displays, and laboratories and educational institutes using exotic species should be treated prior to discharge.

4. Avoid, to the extent practical, livestock grazing in areas with invasive, non-indigenous vegetation and the subsequent movement of such livestock to other areas.

References:

Kohler, C.C. and W. R. Courtenay, Jr. 1986. Introduction of aquatic species. Fisheries 11(2): 39-42. Proceedings of the Seventh International Zebra Mussel and Aquatic Nuisance Species Conference. 1997

11. AGRICULTURAL PRACTICES: Agricultural operations can result in the introduction of fertilizers, herbicides, insecticides, and other chemicals into the aquatic environment from the uncontrolled nonpoint source runoff draining agricultural lands. Additionally, agricultural runoff transports animal wastes and sediments into riverine, estuarine, and marine environments. Excessive uncontrolled or improper irrigation practices often exacerbate contaminant flushing.

Adverse Impacts: The introduction of fertilizers, herbicides, insecticides, animal wastes and other chemicals into the aquatic environment, especially estuaries, can affect the growth of aquatic plants, which in turn affects groundfish and other fish, invertebrates and the general ecological balance of the water body. Pollutants associated with these products include oxygen demanding substances, nitrogen, phosphorous, and other nutrients; organic solids; bacteria, viruses, and other microorganisms and salts. Runoff transporting these pollutants and wastes may reduce habitat quality to the extent of creating unsuitable habitats for shelter, feeding, spawning and if conditions are extreme, result in fish kills.

Recommended Conservation Measures:

1. The use of pesticides, herbicides, and fertilizers in areas that would allow for their entry into the marine environment should be avoided.

2. Avoid, to the extent practicable, impacts to tidal wetland areas resulting from livestock.

References:

U.S. Environmental Protection Agency. 1993. Guidance for specifying management measures for sources of nonpoint pollution in coastal waters. Office of Water. 840-B-92-002. 500+p.

12. LARGE WOODY DEBRIS REMOVAL: Natural events (e.g., storms) and timber practices create situations where fallen trees end up in river systems and eventually work their way into estuaries and subsequently into coastal systems. This timber or “woody debris” plays a significant role in salt marsh ecology.

Adverse Impacts: Woody debris is often removed before reaching estuarine and coastal destination for a variety of reasons including dam operations, aesthetics and commercial use of the wood. Reductions in woody debris inputs to estuarine and coastal ecosystems may affect the ecological balance. For example, large woody debris plays a significant role in benthic ocean ecology, where deep-sea wood borers convert the wood to fecal matter providing terrestrial based carbon to the ocean food chain. The continued dwindling supply of wood may jeopardize the ecological link between the forest and the sea.

Recommended Conservation Measures:

1. Remove woody debris only when it presents a threat to life or property. Leave large woody debris wherever possible. Reposition, rather than remove woody debris which must be moved.

2. Encourage appropriate state agencies to prohibit commercial removal of woody debris from rivers, estuaries and beaches.

3. Encourage appropriate state and Federal agencies to aid in the downstream movement of large woody debris around dams, rather than removal from the system.

References:

Maser, C. and J.R. Sedell. 1994. From the forest to the sea: the ecology of wood in streams, estuaries and oceans. St. Lucie Press, Delray Beach, Florida. 200 pp.

13. COMMERCIAL RESOURCE HARVESTING: The giant kelp forest canopy serves as nursery, feeding grounds and/or shelter to a variety of groundfish species and their prey. In addition, when kelp plants are naturally broken free of their holdfasts, the kelp (i.e., drift kelp) is carried by waves and currents along the bottom and down submarine canyons to deep-water habitats and in surface waters to beaches and rocky intertidal areas. Kelp detritus supports high secondary production and prey for many fishes the commercial harvest of giant kelp forests has been a thriving industry in California since 1910. Harvesting is undertaken by ships designed specifically for cutting the surface canopy no lower than 1.2 meters below the surface in a strip eight meters wide, much like a lawn mower. Regulations are imposed by the State of California to ensure that harvesting activities have a minimal impact on kelp forests. Kelp canopies cut according to this regulation generally grow back within several weeks to a few months.

Adverse Impacts: Kelp harvesting can have a variety of possible impacts on kelp forests and nearshore communities. For example, giant kelp is a source of food for other marine communities and unregulated harvest of kelp can potentially remove a substantial portion of this source. The kelp canopy also serves as habitat for canopy-dwelling invertebrates and has may have an enhancing effect on fish recruitment and abundance; these functions can be severely impeded by unregulated harvesting operations. Removal of the canopy can displace fish species such as young-of-the-year rockfishes. Extensive or permanent loss of kelp canopy could have adverse impacts on local fish recruitment and abundance.

Recommended Conservation Measures:

1. Continue regulation of kelp harvesting by appropriate state agencies to ensure minimal impacts on kelp forests.

2. Encourage research into the timing of fish recruitment to kelp canopies and the response of canopy dwelling juvenile groundfish to kelp harvesting operations in order to appropriately modify kelp harvesting regulations, to minimize potential adverse impacts to canopy habitat function.

3. Encourage development of harvesting methods to minimize impacts on kelp canopies such as the destruction of canopy-dwelling invertebrates and the loss of food and/or habitat to fish populations during harvesting operations.

4. Mitigation for unavoidable extensive or permanent loss of kelp canopy should be provided.

5. Creation of artificial reefs with attached kelp should be considered in cases where reefs are used for compensatory mitigation.

6. With the primary requirement for the existence of a kelp forest being hard substrata, efforts to prevent sedimentation and burial of this substrata by man-induced activities should be emphasized.

References:

California Department of Fish and Game 1995. Giant and Bull Kelp Commercial and Sport Fishing Regulations. Final Environmental Document.

Cross, J. N. And L. G. Allen. 1993. Fishes. *In* M. D. Dailey, D. J. Reish, and J. W. Anderson (eds.). Ecology of the Southern California Bight, Univ. Calif. Press, Berkeley, CA., pp.459-540.

Feder, H. M., C. H. Turner, and C. Limbaugh. 1974. Observations on fishes associated with kelp beds in southern California. California Department of Fish and Game, Fish Bull. 160. 144 pp.

Foster, M. S. And D. R. Schiel. 1985. The ecology of giant kelp forests in California: A community profile. U. S. Fish Wildl. Serv. Biol. Rep. 85(7.2) 152 pp.

Vetter, E. W. 1995. Detritus based patches of high secondary production in the nearshore benthos. Mar. Ecol. Prog. Ser. 120:251-262.

TABLE 1. Adverse Nonfishing Activities, Impacts and Conservation/Enhancement Measures for Pacific Groundfish EFH.

ACTIVITY	**IMPACTS** (Potential)	**CONSERVATION MEASURES** (Advisory)
1. Dredging	• Infaunal and bottom-dwelling organisms • Turbidity plumes • Bioavailability of toxics • Damage to sensitive habitats • Modify water circulation	• Curtail/minimize new dredging activities as practicable • Take actions to prevent impacts to flora/fauna • Geo-reference all dredge sites • Contaminant assays • Reference past/current dredging operations • Curtail sources of excessive sedimentation • Maintain seafloor contours as practicable • Curtail sloughing events • Avoid impacts of accessory equipment • Minimize turbidity • Compensatory mitigation obligations for significant impacts
2. Dredge Material Disposal/fills	• Infaunal and bottom-dwelling organisms • Turbidity plumes • Toxics becoming biologically available • Damage sensitive habitats • Modify current patterns/ water circulation • Loss of habitat function	• Consider upland: avoid fills in productive areas • Address cumulative impacts • Offshore disposal of dredge material in EFH to meet applicable quality standards • Identify direct and indirect impacts on EFH • Minimize areal extent of the disposal site • Geo-reference the site • Explore beneficial use of clean dredged material
	• Seismic energy release	• Avoid anchoring impacts

TABLE 1. Adverse Nonfishing Activities, Impacts and Conservation/Enhancement Measures for Pacific Groundfish EFH.

ACTIVITY	IMPACTS	CONSERVATION MEASURES
3. Oil/Gas Exploration/Production	• Crushing, removal or burial of substrate • Discharge of exploratory drill muds and cuttings • Resuspension of fine-grained mineral particles • Composition of the substrate altered	• Avoid areas of high productivity • Provide mitigation • On-site containment equipment • Maintain "spill contingency plan" • Keep oil and hazardous substances from reaching the aquatic environment • Adequate shoreline barriers and passages
4. Water Intake Structures	• Entrapment, impingement, and entrainment • Loss of prey species	• Locate new facilities away from productive areas • Minimize entrainment or impingement of prey species per CWA 316b. • Discharge temperatures to meet applicable discharge limits • Mitigate net habitat losses
5. Aquaculture	• Discharge of organic waste from the farms • Impacts to the seafloor below the cages or pens	• Minimize water/habitat quality impacts • Avoid entrainment and impingement losses • Treat and mix water discharges • Preclude waste product buildups • Undertake risk assessment prior to introducing non-native species • Prevent entanglement of prey species. • Mitigate impacts
6. Wastewater Discharge	• Wastewater effluent with high contaminant levels • High nutrient levels downcurrent of these outfall • Biocides to prevent biofouling • Thermal effects • Turbidity plumes	• Avoid areas of high productivity • Mitigate as required for net habitat losses

TABLE 1. Adverse Nonfishing Activities, Impacts and Conservation/Enhancement Measures for Pacific Groundfish EFH.

	• Affect submerged aquatic vegetation sites • Stormwater runoff	
7. Oil Discharge/ Hazardous Substances Release	• Direct physical contact • Indirect exposure resulting • Cleanup	• Maintain on-site containment equipment and supplies • On-site "Spill Contingency Plan" • Prevent spills from reaching the aquatic environment
8. Fish Enhancement Structures	• Loss of habitat • Inappropriate materials • Aggregation vs. production	• Avoid areas of high productivity • Evaluate impacts to existing habitat • Determine productivity of structures after construction
ACTIVITY	**IMPACTS**	**CONSERVATION MEASURES**
9. Coastal Development Impacts	• Contaminant runoff • Sediment runoff • Shoreline stabilization projects	• Shoreline construction should avoid productive areas • Use dry stack storage over wet mooring • Curtail fills in estuaries, wetlands and bays
10. Introduction of Exotic Species	• Habitat alteration • Trophic alteration • Gene pool alteration • Spatial alteration • Introduction of disease	• Vessels should take precautions to prevent non-native species introductions • Undertake risk assessment prior to introducing non-native species for aquaculture purposes • Effluents should be treated prior to discharge. • Avoid livestock grazing in areas with invasive, non-indigenous vegetation
11. Agricultural Practices	• Introduction of chemicals • Introduction of animal wastes	• Avoid migration of pesticides, herbicides and fertilizers aquatic environments

TABLE 1. Adverse Nonfishing Activities, Impacts and Conservation/Enhancement Measures for Pacific Groundfish EFH.

		• Avoid livestock impacts to tidal wetland areas
12. Large Woody Debris Removal	• Removal affects estuarine ecological balance • Removal affects benthic ocean ecology	• Leave or reposition large woody debris wherever possible • Eliminate commercial removal of woody debris from rivers, estuaries and beaches • Allow for downstream movement of large woody debris around dams
13. Commercial Resource Harvesting	• Permanent or temporary destruction to habitat • Impacts to organisms	• Avoid harvesting during periods of larval fish recruitment • Mitigate loss of kelp canopy functions • Monitor juvenile fish population response to harvesting • Prevent degradation of kelp beds • Create kelp reefs

11.10.5 Consultation Procedures - Nonfishing Impacts

The Magnuson-Stevens Act requires federal agencies undertaking, permitting or funding activities that may adversely affect EFH to consult with NMFS. Under section 305 (b)(4) of the Magnuson-Stevens Act, NMFS is required to provide EFH conservation and enhancement recommendations to federal and state agencies for actions that adversely affect EFH. However, state agencies and private parties are not required to consult with NMFS. EFH consultations will be combined with existing interagency consultations and environmental review procedures that may be required under other statutes such as the Endangered Species Act, Clean Water Act, the National Environmental Policy Act, the Fish and Wildlife Coordination Act, the Federal Power Act, or the Rivers and Harbors Act.

EFH consultation may be at either a broad programmatic level or project-specific level. Programmatic is defined as "broad" in terms of process, geography, or policy (e.g., "national level" policy, a "batch" of similar activities at a "landscape level", etc.). Where appropriate, NMFS will use a programmatic approach designed to reduce redundant paperwork and to focus on the appropriate level of analysis whenever possible. The approach would permit project activities to proceed at broad levels of resolution so long as they conform to the programmatic consultation. The wide variety of development activities over the extensive range of EFH, and the Magnuson-Stevens Act requirement for a cumulative effects analysis warrants this programmatic approach.

11.10.6 Research Needs

Many data gaps and research needs are readily apparent as a result of the efforts to identify EFH, fishing and nonfishing impacts to EFH, and conservation measures to protect, restore and enhance EFH. These findings reinforce and complement habitat research needs previously identified in the FMP and other documents such as the Council's Research and Data Needs document. For example, a very comprehensive list of research needs has been identified as a significant component of Oregon's Ocean Resources Management Plan (State of Oregon 1991); they often are applicable throughout the EEZ and most have not been met. Several recommended research needs for EFH are taken from this list and contributions received from the technical team and others interested in marine fish, fishery and habitat issues.

The following recommendations for research needs directly support implementation of the proposed recommendations in this amendment and provide for improved protection, restoration and enhancement of EFH for a healthy ecosystem and productive fisheries over the long term. The Council will integrate these recommendations into the Research and Data Needs document. The Council will emphasize research needs to better identify and preserve EFH for populations whose productivity may be seriously impaired as a result of habitat loss or degradation and for populations whose habitat needs are very poorly or not known. These recommendations are also based on the assumption that ongoing EFH activities will continue to gather and incorporate existing information that could not be incorporated to date. Also, research studies often can address multiple needs simultaneously and the list below is not intended to represent independent research efforts. Further, habitat is meant in the broad context of its physical, chemical and biological characteristics.

- Specifically identify habitat areas of particular concern: those rare, sensitive and vulnerable habitats (to adverse fishing and nonfishing effects). Identify associated life stages and their distributions, especially for species and life stages with level 1 (or no) information. Develop appropriate protection, restoration, and enhancement measures.

- Identify any existing areas that may function as "natural" reserves and protection measures for these areas.

- Map benthic habitats on spatial scales of the fisheries and with sufficient resolution to identify and quantify fish/habitat associations, fishery effects on habitat, and the spatial structure of populations. Mapping of the rocky areas of the continental shelf is critical for the identification of the rocky shelf and nonrocky shelf composite EFHs.

- Explore merits of harvest refugia as a potential management tool. Determine candidates, sites, and criteria for refugia; develop quantitative and qualitative methods to assess the effectiveness of the refugia; and develop methods to protect refugia from anthropogenic impacts.

Conduct experiments to assess the effects of various fishing gears on specific habitats on the West Coast and to develop methods to minimize those impacts, as appropriate. From existing and new sources, gather sufficient information on fishing activities for each gear type to prioritize gear research by gear, species, and habitat type.

- Explore and better define the relationships between habitat, especially EFH, and productivity of groundfish species. Improved understanding of the mechanisms that influence larval dispersal and recruitment is especially important.

- Evaluate the potential for incentives as a management tool to minimize adverse effects of fishing and nonfishing activities on EFH.

- Standardize methods, classification systems, and calibrate equipment and vessels to provide comparable results in research studies and enhance collaborative efforts.

- Develop methods, as necessary, and monitor effectiveness of recommended conservation measures for nonfishing effects. Develop and demonstrate methods to restore habitat function for degraded habitats.

Reference:

Oregon Ocean Resources Task Force. 1991. Oregon's Ocean Resources Management Plan. State of Oregon. Portland, Oregon. 202p.

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