3 Affected Environment

3.1 Introduction

This section describes current conditions of resources that may potentially be affected by implementation of the alternatives.

3.2 West Coast Marine Habitat

This chapter describes West Coast marine habitat in terms of its structure, role in the ecosystem, and information available for this EIS. Section 3.2.1 takes a broad scale view of marine habitat for the West Coast. Section 3.2.2 focuses on specific habitat types and their roles in groundfish sustainability and ecosystem function. Section 3.2.3 highlights specific habitat types (corals, anemones, sponges, sea pens, and sea whips) that the public has expressed concern for during scoping. Section 3.2.4 summarizes the vulnerability of habitat to impacts from fishing. And Section 3.2.5 summarizes the information compiled for the Risk Assessment on habitat types for this EIS.

3.2.1 Introduction–the Importance of West Coast Marine Habitats

Healthy marine habitat is basic to the well-being of marine species and their place in the food web. The marine habitats of the West Coast support living marine resources at the most fundamental level by providing the conditions necessary for populations to sustain themselves. From a broad perspective, habitat is the geographic area, and the characteristics of that area, where the species occurs at any time during its life. Habitat characteristics comprise a variety of attributes and scales, including physical (geological), biological, and chemical parameters, location, and time. It is the interactions between environmental variables that make up habitat that determine a species' biological niche. These variables include both physical variables such as depth, substrate, temperature range, salinity, dissolved oxygen, and biological variables such as the presence of competitors, predators, or facilitators.

Species distributions are affected by characteristics of habitats that include obvious structure or substrate (e.g., reefs, marshes, or kelp beds) and other structures that are less distinct (e.g., turbidity zones, thermoclines, or fronts separating water masses). Fish habitat utilized by a species can change with life history stage, abundance of the species, competition from other species, environmental variability in time and space, and human-induced changes. Occupation and use of habitats by fish may change on a wide range of temporal scales: seasonally, inter-annually, inter-decadal (e.g., regime changes), or longer. Habitat not currently used, but potentially used in the future, should be considered when establishing long-term goals for EFH and species productivity.

Fish and other species rely on habitat characteristics to support primary ecological functions comprising spawning, breeding, feeding, and growth to maturity. Important secondary functions that may form part of one or more of these primary functions include migration and shelter. Most habitats provide only a subset of these functions. The type of habitat available, its attributes, and its functions are important to species productivity and the maintenance of healthy ecosystems. While we know that marine organisms require habitat, the relationship of habitat to population dynamics or ecological function are poorly understood. Indeed, the lack of available science is a constant source of frustration to managers and scientists alike and is a recurring theme of this EIS as well as similar projects in other regions of the country (NOAA Fisheries Strategic Plan, In Press).

The information presented in this chapter, as well as the habitat analyses in Chapter 4, were largely facilitated through the Risk Assessment discussed in Chapter 1 (also see Appendix A). Every reasonable effort has been made to compile the best available data for this EIS so that readers are given access to the best and most current description of the status of habitat. This section provides an overview of information gathered for the Risk Assessment by outlining the types of habitat that have been characterized for the West Coast, the use of habitat by groundfish, current protection, and potential threats. Details, such as species-specific use patterns, are described where appropriate to give the reader the information necessary to focus the required conservation decisions. It should be noted however, that the Risk Assessment is incorporated by reference and contains many more details than are described in this or the following Chapters.

3.2.2 West Coast Habitat Types and their Role in Groundfish Sustainability and Ecosystem Function–Habitat Types

There are distinct large-scale patterns of biological distribution along the West Coast that provide for a first-order characterization of habitat into large zoogeographic provinces: the Oregonian and San Diego. The Oregonian Province extends from the Straight of Juan de Fuca in the North to Point Conception in the South. The San Diego Province begins at Point Conception in the north and runs south past the terminus of the EEZ (NMFS 2004 OLO).

3.2.2.1 Nearshore, Estuarine and Intertidal Habitats

3.2.2.1.1 Estuaries

Estuaries on the West Coast include major features such as San Francisco Bay and Puget Sound as well as smaller areas such as Gray’s Harbor, Washington and Yaquina Bay, Oregon. 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).

Estuarine habitats fulfill fish and wildlife needs for reproduction, feeding, refuge, and other physiological necessities (Good 1987; Phillips 1984; Simenstad et al. 1991). Coastal fish populations depend on 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 (Hoss and Thayer 1993; Lockwood 1990; Phillips 1984; Thayer *et al.* 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). This primary production, combined with other nutrients, provides high rates of secondary production in the form of fish (Emmett et al. 1991; Good 1987; Herke and Rogers 1993; Sogard and Able 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 play a significant role in salt marsh ecology (Maser and Sedell 1994). Reductions in woody debris input to estuaries may affect the ecological balance of the estuary. Large woody debris also play a significant role in benthic ocean ecology, where deep-sea wood borers convert the wood to fecal matter, providing carbon to the ocean food chain (Maser and Sedell 1994). Dams and commercial in-river harvest of large woody debris have reduced 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). 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 (NMFS 1993). Using NMFS data, Chambers (1992) determined that 75% 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.

Estuaries are probably the most susceptible to deleterious impacts from nonfishing activities. 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 (Fawcett and Marcus1991; Kagan 1991). Carefoot (1977), discussing Pacific seashores, states, “Estuaries are complex systems which can succumb to humankind’s massive and pervasive assaults.”

3.2.2.1.2 Nearshore Biogenic Habitats (Kelp, Seagrass, Sponges)

In some cases, the biological component of the habitat is the most important feature that makes the habitat suitable for a particular species/life stage. Certain habitat components known to be important to groundfish (e.g., rockfish) include canopy kelp, seagrass, and benthic invertebrates. Kelp beds (such as *Macrocystis* spp. and *Nereocystis* sp.) have been shown to be important to many groundfish species, including several rockfish species. Seagrasses, including eelgrass (*Zostera* spp., *Ruppia* sp.) and surfgrass (*Phyllospadix* spp.), are known to be important for many species. Structure-forming invertebrates, such as sponges and anemones, can also be an important and component of fish habitat and are discussed further in 3.2.3.

Of the habitats associated with the rocky-shelf-habitat-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 waterline to a depth of up to 10 meters, a mid-kelp, water-column region and the bottom, holdfast region. These stands provide nurseries, feeding grounds and/or shelter to a variety of groundfish species and their prey (Ebeling *et al.* 1980; Feder *et al.* 1974).

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 might 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).

Kelp forest ecosystems undergo distinct phase shifts between kelp dominated and sea urchin dominated states (Steneck et al. 2002). Kelp forests are vulnerable to cascading effects of top-down forcing and fishing down food webs (Steneck et al. 2002; Estes et al. 2004). Kelp forest phase shifts have complex explanations and consequences with linkages across multiple species, large areas and long periods of time (Estes et al. 2004).

Seagrass species found on the West Coast of the U.S. include eelgrass (*Zostera* spp., *Ruppia* sp.) and surfgrass (*Phyllospadix* spp.). These grasses are vascular plants, not seaweeds, forming dense beds of leafy shoots year-round in the lower intertidal and subtidal areas. Eelgrass is found on soft-bottom substrates in intertidal and shallow subtidal areas of estuaries. Surfgrass is found on hard-bottom substrates along higher energy coasts. 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). High primary production, results in high rates of secondary production (Emmett, et al. 1991; Good 1987; Herke and Rogers 1993; Sogard and Able 1991). Seagrasses also provide habitat for many invertebrates and epiphytes and provide many crustaceans, fish, and birds with protection and food. Several commercially important species use seagrass beds including Dungeness crab (Spencer 1932) and Pacific herring (Taylor 1964). Pacific coast seagrasses have been shown to be vulnerable to anthropogenically introduced species of seagrasses such as *Zostera japonica* (Harrison and Bigley 1982) and introduced marshgrass, *Spartina alterniflora* (Taylor et al. 2004).

Species utilizing vegetated bottom as biogenic habitat include black rockfish, black-and-yellow rockfish, blue rockfish, bocaccio, brown rockfish, cabezon, California scorpionfish, canary rockfish, chilipepper, China rockfish, copper rockfish, dusky rockfish, gopher rockfish, grass rockfish, kelp greenling, kelp rockfish, leopard shark, lingcod, olive rockfish, Pacific sanddab, shortbelly rockfish, speckled rockfish, splitnose rockfish, stripetail rockfish, vermilion rockfish, widow rockfish, and yellowtail rockfish.

Managed species known to use vegetated bottom habitats in the coastal zone during some portion of their life cycles include black rockfish, black-and-yellow rockfish, brown rockfish, cabezon, copper rockfish, english sole, gopher rockfish, grass rockfish, kelp greenling, leopard shark, lingcod, olive rockfish, quillback rockfish, silvergray rockfish, vermilion rockfish. In addition, juvenile quillback rockfish are know to use sponge habitat for feeding.

Non-fishing activities that may negatively impact nearshore biogenic habitats in the coastal zone are the same as those listed above for estuaries, described in Section 3.2.2.1.1.

3.2.2.1.3 Tide Pools

Tide pools are depressions along rocky coasts that are covered by the ocean during high tides and left filled with seawater when the tide recedes. They are often inhabited by a variety of attached algae, invertebrates, and small fishes.

Tide pool habitats are known to be utilized by juvenile and adult cabezon, and juvenile canary rockfish, grass rockfish, and black rockfish.

In general, tide pools are not affected by any fishing activities except direct hand harvest during low tides.

Non-fishing activities which may negatively impact intertidal pool habitats in the coastal zone are harvest of kelp and other food items, and trampling, as well as those listed above for estuaries, described in Section 3.2.2.1.1.

3.2.2.1.4 Nearshore Unconsolidated Bottom (Silt, Mud, Sand, Gravel or Mixed)

Unconsolidated bottom habitats are composed of small particles (i.e. gravel, sand, mud, silt, and various mixtures of these particles) and contain little to no vegetative growth due to the lack of stable surfaces for attachment. Benthic fauna often consist of infaunal organisms. Compared with unconsolidated bottom in deeper waters, the shallower habitats are subject to greater amounts of natural and anthropogenic disturbance.

Coastal unconsolidated bottom habitats are utilized by a number of managed fish species, which include big skate, butter sole, cabezon, calico rockfish, California scorpionfish, California skate, Dover sole, english sole, flathead sole, gopher rockfish, leopard shark, lingcod, Pacific cod, Pacific sanddab, petrale sole, quillback rockfish, rex sole, rock sole, sand sole, soupfin shark, spiny dogfish, spotted ratfish, and starry flounder.

Non-fishing activities which may negatively affect nearshore unconsolidated bottom in the coastal zone are the same as those listed above for estuaries, described in Section 3.2.2.1.1.

3.2.2.1.5 Nearshore Hard Bottom

Hard bottom habitats in the coastal zone may be composed of bedrock, boulders, cobble, or gravel/cobble. Hard substrates are one of the least abundant benthic habitats, yet they are among the most important habitats for fishes. Typical shallow-water hard bottom fishes include rockfish (e.g. *Sebastes* spp.), lingcod, and sculpins (MMS 2002).

Managed species known to use hard bottom habitat in the coastal zone include black rockfish, black-and-yellow rockfish, brown rockfish, cabezon, calico rockfish, California scorpionfish, chilipepper, copper rockfish, gopher rockfish, kelp greenling, leopard shark, lingcod, olive rockfish, quillback rockfish, redstripe rockfish, rosethorn rockfish, shortbelly rockfish, silvergray rockfish, and spotted ratfish.

Non-fishing activities which may negatively impact nearshore hard bottom habitats in the coastal zone are the same as those listed above for estuaries, described in Section 3.2.2.1.1.

3.2.2.1.6 Nearshore Artificial Structures

Artificial structures in the coastal zone consist of artificial reefs and piers as defined in the Habitat Use Database. Artificial reefs consist of items such as sunken vessels and other man-made objects that mimic reefs and hard substrates.

Managed species known to use coastal artificial structures include black rockfish, bocaccio, brown rockfish, copper rockfish vermilion rockfish, and leopard shark.

3.2.2.1.7 Nearshore Water Column

There are a number of species and life stages in the Groundfish FMP that occur in the water column, but do not have any association with benthic substrate. In the Habitat Use Database, species inhabiting the coastal epipelagic zone in open water or in association with macrophyte canopies or drift algae fall under this category.

Managed species known to use water column (epipelagic) habitat in the coastal zone include black rockfish, brown rockfish, cabezon, copper rockfish, Dover sole, english sole, flathead sole, gopher rockfish, grass rockfish, kelp greenling, lingcod, olive rockfish, Pacific cod, Pacific hake, Pacific sanddab, petrale sole, quillback rockfish, redstripe rockfish, rock sole, sand sole, silvergray rockfish, soupfin shark, spiny dogfish, and starry flounder. These are primarily the egg, larval, and juvenile stages of these species.

There is no separate analysis of the habitat sensitivity or habitat recovery times in relation to fishing gear effects on the water column. It is generally accepted that the physical impacts of fishing gears on water column habitat are minimal and temporary.

3.2.2.2 Offshore habitats (Shelf and Slope)

3.2.2.2.1 Offshore Biogenic Habitats (Corals, Sponges etc.)

Managed fish species associated with structure-forming invertebrates (such as corals, basketstars, brittlestars, demosponges, gooseneck barnacles, sea anemones, sea lilies, sea urchins. sea whips, tube worms, and vase sponges) as biogenic habitat include arrowtooth flounder, big skate, bocaccio, California skate, cowcod, Dover sole, flag rockfish, greenspotted rockfish, lingcod, longspine thornyhead, Pacific ocean perch, quillback rockfish, rosethorn rockfish, sablefish, sharpchin rockfish, shortspine thornyhead, spotted ratfish, starry rockfish, tiger rockfish, vermilion rockfish, yelloweye rockfish, and yellowtail rockfish.

Non-fishing activities which may negatively affect biogenic habitats in the offshore zone include vessel operations, installation of utility lines; cables, and pipelines; commercial use of habitat; disposal of fish processing waste (vessel operations); oil and gas exploration/development/production; and marine mining. See Appendix 14 to the Comprehensive Risk Assessment for detailed discussions of different non-fishing effects on fish habitats.

Corals, Anemones, sponges, sea pens, and sea whips are discussed further in section 3.2.3.

3.2.2.2.2 Offshore Unconsolidated Bottom (silt, mud, sand, gravel or mixed)

Offshore, unconsolidated bottom habitats are composed of small particles (i.e. gravel, sand, mud, silt, and various mixtures of these particles) and contain little to no vegetative growth due to the lack of stable surfaces for attachment. Benthic fauna often consist of infaunal organisms. Because unconsolidated bottom habitats in offshore waters are subject to lower levels of natural and anthropogenic disturbance than their inshore counterparts, they generally take longer to recover when they are disturbed.

Fish species commonly occurring over soft bottom benthos include skates and rays, smelts, surfperches, and flatfishes; however, other species may predominate in certain areas (e.g., white croaker, hagfish, and ratfish (MMS 2002)). In the Southern California Bight, about 40% of the fish species and 50% of the families occur in soft-bottom areas of the open coast (Cross and Allen 1993).

A large number of managed groundfish species utilize offshore unconsolidated bottom habitat during at least part of their life cycle including arrowtooth flounder, aurora rockfish, bank rockfish, big skate, blackgill rockfish, bocaccio, butter sole, calico rockfish, California scorpionfish, California skate, chilipepper, cowcod, curlfin sole, darkblotched rockfish, Dover sole, english sole, flathead sole, gopher rockfish, greenspotted rockfish, greenstriped rockfish, honeycomb rockfish, leopard shark, lingcod, longnose skate, longspine thornyhead, Pacific cod, Pacific ocean perch, Pacific rattail (grenadier), Pacific sanddab, petrale sole, pink rockfish, quillback rockfish, redbanded rockfish, rex sole, rock sole, rosethorn rockfish, rougheye rockfish, sablefish, sand sole, sharpchin rockfish, shortbelly rockfish, shortraker rockfish, shortspine thornyhead, soupfin shark, speckled rockfish, spiny dogfish, splitnose rockfish, spotted ratfish, starry flounder, stripetail rockfish, vermilion rockfish, widow rockfish, yelloweye rockfish, and yellowtail rockfish.

Non-fishing activities which may negatively affect unconsolidated bottom habitats in the offshore zone are the same as those listed above for offshore biogenic habitats.

3.2.2.2.3 Offshore Hard Bottom

Hard bottom habitats in the offshore zone may be composed of bedrock, boulders, cobble, or gravel/cobble. Many managed species are dependent on hard bottom habitat during some portion of their life cycle. Typically, deeper water hard bottom habitats are inhabited by large, mobile, nektobenthic fishes such as rockfish, sablefish, Pacific hake, spotted ratfish, and spiny dogfish (MMS 2002). Cross and Allen (1993) estimated that about 30% of the fish species and 40% of the families occur over hard substrates.

Many managed groundfish species use hard bottom habitats during one or more life stages including aurora rockfish, bank rockfish, black rockfish, black-and-yellow rockfish, blackgill rockfish, blue rockfish, bocaccio, bronzespotted rockfish, brown rockfish, cabezon, calico rockfish, California scorpionfish, canary rockfish, chilipepper, China rockfish, copper rockfish, cowcod, dusky rockfish, flag rockfish, gopher rockfish, grass rockfish, greenblotched rockfish, greenspotted rockfish, greenstriped rockfish, harlequin rockfish, honeycomb rockfish, kelp greenling, kelp rockfish, leopard shark, lingcod, Mexican rockfish, olive rockfish, Pacific cod, Pacific ocean perch, pink rockfish, quillback rockfish, redstripe rockfish, rosethorn rockfish, rosy rockfish, rougheye rockfish, sharpchin rockfish, shortbelly rockfish, shortraker rockfish, silvergray rockfish, speckled rockfish, spotted ratfish, squarespot rockfish, starry rockfish, stripetail rockfish, tiger rockfish, treefish, vermilion rockfish, widow rockfish, yelloweye rockfish, yellowmouth rockfish, and yellowtail rockfish.

Non-fishing activities which may negatively affect hard bottom habitats in the offshore zone are the same as those listed above for offshore biogenic habitats (Section 3.2.2.2.1).

3.2.2.2.4 Offshore Artificial Structures

Artificial structures in the offshore zone consist of artificial reefs and oil and gas platforms as described in the Risk Assessment, Appendix A to this EIS. Alternative B.8 includes 24 oil platforms (Table 2-1, Figure 2-13) for designation of HAPC under 50 CFR 600.815(a)(8)(1) and is also described in Sections 2.4 and 4.3.3.

Non-fishing activities which may negatively affect offshore artificial structures in the offshore zone are the same as those listed above for estuaries (Section 3.2.2.1.1). In addtition, oil platforms are subject to a process called decommissioning; oil and gas industry managers decide what to do with aging platform structures after they cease production. Federal regulations, under 30 CFR 250.1728, state that all platforms and other facilities must be completely removed to at least 15 feet below mudline. Complete removal of structures will eliminate any associated benefits they may provide to the ecosystem. However, areas under and around removed platforms would more closely resemble their natural state, as they existed prior to installation of the platforms. See Section 4.3.3 for more information on the extent and impacts of platform decommissioning.

Over 40 fish species have been observed in multiple studies of oil and gas platforms in Southern California (Love et al. 2003, Love et al. 2000a, Helvey 1999, Love et al. 1999a, Love et al. 1999b). Of the all observed fish species, 38 are managed under the Groundfish Fishery Management Plan, including over 27 species of groundfish (*Sebastes* sp.) (Love et al. 2003, Love 2000a, Helvey 1999).The following are some examples of managed species known to use offshore artificial structures; black rockfish, black-and-yellow rockfish, blue rockfish, bocaccio, brown rockfish, cabezon, calico rockfish, California scorpionfish, canary rockfish, copper rockfish, cowcod, darkblotched rockfish, flag rockfish, gopher rockfish, grass rockfish, greenblotched rockfish, greenspotted rockfish, greenstriped rockfish, kelp rockfish, leopard shark, Mexican rockfish, olive rockfish, quillback rockfish, rosy rockfish, sharpchin rockfish, starry rockfish, stripetail rockfish, treefish, vermilion rockfish, yelloweye rockfish, and yellowtail rockfish.

The habitat value of a number of oil and gas platforms was investigated by Dr. Milton Love and co-researchers from the Marine Science Institute (MSI) at the University of California at Santa Barbara (UCSB) (Love et al. 2000a, Love et al. 1999b). Researchers compared fish assemblages from eight platforms and eight natural outcrops at similar depth (Love et al. 1999b).

The MSI researchers found that species assemblages around platforms are somewhat different from those of natural reefs. However, these differences were due almost entirely to the greater numbers of more species of fishes around platforms, rather than differences in species composition between platforms and natural outcrops. At least 85 species of fish were observed at platforms and 94 species at the outcrops. Rockfishes dominated both habitats, comprising 89.7% of all fishes at platforms and 92.5% at outcrops (Love et al. 1999b).

Several species were more common at one or more platforms than at natural reefs including cowcod and bocaccio (young-of-the-year (YOY), juvenile, and adult), copper, halfbanded, greenspotted, greenstriped, YOY widow, vermilion, canary and flag rockfishes and YOY juvenile and adult lingcod (Love et al. 1999b, Love et al. 2001, Love 2004 unpublished data).

Those few species that appeared to be more characteristic of natural outcrops than platforms were bank, pygmy, speckled, squarespot, and swordspine rockfishes, primarily small or dwarf species. During the surveys, the researchers found that many heavily fished natural reefs are dominated by these diminutive forms (Love et al. 1999b).

A number of platforms harbored higher densities of YOY rockfishes than did natural outcrops. Thirteen of the 20 highest YOY rockfish densities over the period of research were observed at platforms (Grace, Harvest, Hermosa, Hidalgo, Holly, and Irene), primarily in the platform midwaters. It is interesting to note that most of the natural outcrops that the researchers surveyed that harbored high densities of YOY rockfishes (e.g. Hidden Reef and outcrops around islands) were also very high relief pinnacles that thrust their way well into the water column (Love et al. 1999b).

The preclusionary effects from fishing that platforms provide to species such as rockfish was also clearly shown by the researchers. The scientists compared densities of rockfish (of all sizes) observed at platforms and at natural outcrops. In most cases, fishes 30 cm or larger were less abundant, or sometimes absent, from many natural reefs compared to most platforms. Platform Gail, in particular, held some of the highest densities of the important but severely depleted cowcod and bocaccio that were seen anywhere during the observations.

The researchers believe that for some rockfish species such as bocaccio, cowcod, and lingcod, some platforms in the Santa Barbara Channel and Santa Maria Basin are major nursery grounds and harbor relatively high densities of both juveniles and adults (Love et al. 1999b, Love 2005 in press, Love 2005b in review). Given the very low populations of these important species, adults at platforms may be producing a significant amount of the rockfish larvae potentially entering the local fishery stocks. A recent study by Love (2005 in press) determined that 20% of juvenile bocaccio that suvive in a year over the species' entire range could be found around six platforms in the Santa Barbara Channel.

In a 1999 pilot study, followed up by a study in 2002, Dr. Love and his staff compared daily growth rates of young blue rockfish living at three platforms (Irene, Holly, and Gilda) and at three natural reefs in the same area. Fishes at the platforms grew faster than the fishes at paired natural reefs in all instances (Love et al. 1999b, Love 2005 unpublished data).

Some environmentalists are concerned that high recruitment at platforms may reduce recruitment at natural habitat. Data collected by Love (2005 in review) in 1999 and 2002 suggests that this is not the case. Using high frequency radar and simulating surface current movements, they estimated that less than 25% of young bocaccio would have survived to recruit to natural shallow water nursery habitat. Since platforms occupy more of the water column than do most natural outcrops and presettlement pelagic juvenile rockfishes are much more likely to encounter these tall structures than the relatively low-lying natural structures, thus aiding in recruitment (Love 1999b, Love et al. 2001, Love et al. 2003, Love 2005 in review).

Many of the major predators of young rockfishes are species that live and stay close to the bottom, such as lingcod, copper and vermilion rockfishes, cowcod and large bocaccio. Love et al. (1999b) found that in general, these species do not ascend the platform jacket up into the water column, and thus are absent from the platform midwaters where most juveniles were observed. In this respect, the researchers conclude that platforms resemble some of the pinnacles that dot southern California continental shelf.

Natural high relief 'pinnacles' are relatively rare off the California Coast. Love et al. (1999b, 2005b in review) found that the midwaters of many platforms bear a striking resemblance to some of the pinnacles that dot the outer continental shelf of southern California. At both the platforms and at relatively shallow and steep-sided pinnacles (such as those on Hidden Reef), the assemblages are dominated by young rockfishes and larger fish predators are relatively uncommon. Platforms provide high relief hard bottom habitat in otherwise primarily soft bottom areas (Love et al. 2001, Love et al. 2003, Love 2004 unpublished data).

3.2.2.2.5 Physical Oceanography

The marine and anadromous resources over which NOAA-Fisheries exercises stewardship on the West Coast of the U.S. occupy diverse habitats in the coastal ocean off Washington, Oregon, and California–a biogeographic region that is collectively termed the Coastal Upwelling Domain (Ware and McFarlane 1989). The dominant fisheries species within this domain include northern anchovy, Pacific sardine, Pacific hake, Pacific mackerel, jack mackerel, Pacific herring, sablefish, and coho and Chinook salmon. Within this domain, several smaller physical zones are recognized, including (a) a nearshore zone (where juvenile fall chinook salmon, sand lance, and smelts reside), (b) the upper 10-20 m of the water column across the continental shelf and slope (where the pelagic fishes including juvenile coho and chinook reside), and (c) the benthic and demersal habitats on the continental shelf (English sole), at the shelf break (whiting, rockfish), and beyond the shelf break to depths of 1,500 m (sablefish, Dover sole, and thornyheads). Each of these physical zones has unique circulation patterns that affect spawning and larval transport, and each is subject to different types of physical forcing, which leads to species-specific variations in growth, survival, and recruitment. Moreover, since many of the species have pelagic larvae/juvenile stages, broad-scale variations in ocean productivity (which affects the feeding environment of larval and juvenile fish) and variations in large-scale ocean circulation that affect transport of eggs and larvae are both general factors affecting recruitment.

The Coastal Upwelling Domain is part of the California Current (CC) system. The CC is a broad, slow, meandering, equatorward-moving flow that extends from the northern tip of Vancouver Island (50° N latitude) to the southern tip of Baja California (25° N latitude), from the shore to several hundred miles from land. In deep waters offshore of the continental shelf, flows are southward all year round; however, over the continental shelf, southward flows occur only in spring, summer, and fall. During winter months, flow over the shelf reverses, and water moves northward as the Davidson Current. The transitions between northward and southward flows on the shelf occur seasonally, in March/April and October/November thus are termed the "spring transition and fall transition." Another important feature of circulation within the Coastal Upwelling Domain is the deep, poleward-flowing undercurrent that is found at depths of 100 to 300 m over the outer shelf and slope year around. This current seems to be continuous at least from Southern California (33º N latitude) to the British Columbia coast (50º N latitude).

Coastal upwelling is the dominant physical force affecting advection and production in the Coastal Upwelling Domain. Upwelling off Washington and Oregon occurs primarily in continental shelf waters during the months of April to September, whereas upwelling can occur year-round off northern and central California. Upwelling also occurs in offshore waters through the action of Ekman pumping and through surface divergence in the centers of cyclonic eddies.

Coastal upwelling works as follows: winds that blow from the north (towards the equator) result in transport offshore of waters within the upper 15 m of the water column. The offshore transport of surface waters is balanced by onshore movement of cold nutrient rich waters that have their origin at approximately 100 to 125 m depth in the region of the shelf break. When winds are strong, the cold (8° C) nutrient rich water comes to the sea surface within the first five miles of the coast. The result is high production of phytoplankton from April through September fueled by the nearly continuous supply of nutrients, and concomitant high biomass of copepods, euphausiids and other zooplankton during summer.

Coastal upwelling is not a continuous process. Rather, it is a cyclic phenomenon, with favorable (equatorward) winds blowing for periods of 1 to 2 weeks, interspersed by periods of either calm or reversals in wind direction. These pulses in the winds produce what are called "upwelling events." Interannual variations in the length and number of upwelling events result in striking variations in the level of primary and secondary production, thus the overall level of production during any given year is highly variable, and is dependent on local winds. We do not yet now if there is an optimal frequency of upwelling event cycle, but one can easily imagine scenarios in which prolonged periods of continuous upwelling would favor production in offshore waters because nutrient waters would be transported far to sea. The other extreme is one in which winds are weak and produce upwelling only in the very nearshore zone, within a mile or two of the coast. In this case, animals living in waters off the shelf would be disadvantaged. Any process that leads to reduction in the frequency and duration of northerly winds will result in decreased productivity and vice versa. The most extreme of these processes is El Niño that disrupts coastal ecosystems every 5 to 10 years.

Despite the existence of high plankton biomass and productivity, coastal upwelling environments present unique problems to the fish and invertebrate populations that must complete their life cycles there. This is because the upwelling process transports surface waters and the associated pelagic larvae and juvenile life stages away from the coast and towards the south, away from productive habitats. Typical transport rates of surface waters are 1 kilometer per day in an offshore direction and 20 to 30 km per day southward. Zooplankton, and larval and juvenile fishes which live in the food-rich surface layers (i.e., the upper 15 m of the water column), can be transported rapidly offshore, out of the upwelling zone, and into relatively oligotrophic waters. Bakun (1996) argues that for any animal to be successful in such environments, the adults must locate habitats that are characterized by enrichment, with some mechanism for concentrating food (for larvae), and that offers a way for larvae to be retained within the system.

Perhaps because of problems related to transport (and loss) during the upwelling season, most fish species do not spawn. They either spawn during winter months before the onset of upwelling (such as Dover sole, sablefish and Dungeness crabs); perform an extended spawning migration and spawn in regions where there is no upwelling (such as hake spawning off southern California); spawn in restricted parts of an upwelling system where advective losses are minimized, such as in bays or estuaries (for example English sole); spawn in rivers (salmonids and eulachon); or bypass the egg and larval stage and give birth to live precocious "juvenile" individuals (e.g., most rockfish). Hake, for example, undertake an extended spawning migration during which the adults swim south to spawn in the South California Bight in autumn and winter, outside of the upwelling region and season. The migration is from as far north as Vancouver Island to southern California, a distance of several thousand kilometers. The return migration of adults and the northward drift of larvae and juveniles takes place at depths where fish take advantage of the poleward undercurrent.

<u>Variability in the physical environment at climatic scales</u>

Variability in productivity of the California Current occurs at climatic time scales, each of which must be taken into account when considering recruitment variability and fish growth. The North Pacific experiences dramatic shifts in climate on a 10 to 20 year frequency, caused by eastward-westward jumps in the location of the Aleutian Low in winter, which result in changes in strength and direction of winds. Shifts occurred in the 1926, 1947, 1977, and 1998. Changes in large-scale wind patterns lead to alternate states of either "a warm ocean climate regime" or "cold water regime." The ocean tends to be more productive during a warm period. Changes in biological productivity are best documented for the period since the 1950s, and this understanding is largely due to the CalCOFI program. For example, zooplankton biomass was high from the 1950s through 1977, but during the warm regime of 1977-1998, zooplankton biomass in the southern sector of the California Current declined by nearly an order of magnitude. The change in zooplankton biomass between regimes was not as dramatic in the northern California Current, but a doubling in biomass has been documented between the cool regime (pre-1977), warm regime (1977-1998) and then the cool regime since 1998.

Since the early 1980s, the California Current has been experiencing an increased frequency of El Niño events, with large El Niño events occurring every 5 to 6 years:1976-77, 1982-83, 1986-87, 1991-92, 1997-98 and again in 2002-2004. Prior to 1982, El Niño events seldom reached as far north as Oregon. However from 1992-1998, the Oregon and Washington coasts experienced almost continuous El Niño-like conditions during summer (i.e., reduced upwelling and warmer ocean conditions). Since 1998, ocean conditions have improved markedly and it appears that another regime shift was initiated in late 1998; thus the California Current now appears to have returned to a cool, productive phase.

3.2.2.2.6 Offshore Water Column

There are a number of species and life stages in the Groundfish FMP that occur in the water column, but do not have any association with benthic substrate. In the Habitat Use Database, species inhabiting the offshore epipelagic zone in open water or in association with fronts, current systems, macrophyte canopies, or drift algae fall under this category. Another set of species/life stages of managed groundfishes utilizes the mesopelagic zone.

Managed species known to use epipelagic offshore water column habitat include arrowtooth flounder, aurora rockfish, bank rockfish, black rockfish, back-and-yellow rockfish, blackgill rockfish, blue rockfish, bocaccio, brown rockfish, butter sole, cabezon, calico rockfish, California scorpionfish, canary rockfish, chilipepper, China rockfish, copper rockfish, cowcod, curlfin sole, darkblotched rockfish, Dover sole, dusky rockfish, english sole, flag rockfish, flathead sole, gopher rockfish, grass rockfish, greenblotched rockfish, greenspotted rockfish, greenstriped rockfish, harlequin rockfish, kelp greenling, kelp rockfish, leopard shark, lingcod, longspine thornyhead, Mexican rockfish, olive rockfish, Pacific cod, Pacific hake, Pacific ocean perch, Pacific rattail (grenadier), Pacific sanddab, petrale sole, quillback rockfish, redstripe rockfish, rex sole, rock sole, rosethorn rockfish, rosy rockfish, rougheye rockfish, sablefish, sand sole, sharpchin rockfish, shortbelly rockfish, shortraker rockfish, shortspine thornyhead, silvergray rockfish, soupfin shark, speckled rockfish, spiny dogfish, splitnose rockfish, squarespot rockfish, starry flounder, starry rockfish, stripetail rockfish, tiger rockfish, treefish, vermilion rockfish, widow rockfish, yelloweye rockfish, yellowmouth rockfish, and yellowtail rockfish. Many of these are the egg, larval and juvenile stages of these species.

Managed species known to use mesopelagic offshore water column habitat include arrowtooth flounder, aurora rockfish, bank rockfish, blackgill rockfish, blue rockfish, canary rockfish, chilipepper, cowcod, darkblotched rockfish, greenstriped rockfish, longspine thornyhead, Pacific cod, Pacific hake, Pacific ocean perch, Pacific rattail (grenadier), redstripe rockfish, rougheye rockfish, sablefish, sharpchin rockfish, shortbelly rockfish, shortspine thornyhead, silvergray rockfish, speckled rockfish, spiny dogfish, splitnose rockfish, stripetail rockfish, tiger rockfish, widow rockfish, and yellowtail rockfish.

There are no analyses of the habitat sensitivity or habitat recovery times in relation to fishing gear effects since it is generally accepted that the impacts of fishing gears on water column habitat are minimal and temporary. Non-fishing activities which may negatively affect unconsolidated bottom habitats in the offshore zone are the same as those listed above for offshore biogenic habitats (Section 3.2.2.2.1).

3.2.3 Corals, Anemones, Sponges, Sea Pens, and Sea Whips

The biogenic habitat types described in sections 3.2.2.1.2 and 3.2.2.2.1 includes corals, anemones, sea pens, and sea whips; however, because the Council and public showed particular interest in this habitat type, additional consideration is provided here. This subsection discusses the types and locations of these organisims known to occur on the West Coast; their function for groundfish and the ecosystem; and, vulnerability to impacts from fishing.

Cold water/deep-sea corals in particular received special attention prior to the policy development phase of this EIS process. Information for the EIS was provided to the Council in three major reports that are incorporated here by reference: (1) Occurrances of Habitat-forming Deep Sea Corals in the Northeast Pacific Ocean, December 2003; (2) Preliminary Report on Occurrances of Structure-Forming Megafaunal Invertebrates off the West Coast of Washington, Oregon and California, August 2004 (Appendix B to this EIS); and, (3) in sections 2.2, and 2.3 of the Risk Assessment (Appendix A). That information, as well as other information available from the literature, is summarized in this section.

3.2.3.1 Types and Locations of Corals, Anemones, Sponges, Sea Pens, and Sea Whips Observed on the West Coast

Observation data on corals, sea anemones, sea pens, and sea whips is available at the level of Order: sea anemones (Actiniaria); sea pens and sea whips (Pennatulacea); black corals (Antipatharia), lace corals (Filifera), gorgonian corals (Gorgonacea), stony corals (Scleractinia), and coral anenmones (Corralimorpharia). Sponges are grouped by phylum (Porifera).

Information on the location and abundance of these organisims comes primarily from trawl surveys, with additional data available from manned submersible and ROV work. The data, as summarized by NMFS, show where the organisims have been observed (Figure 3-1). The following observations were made in the *Preliminary Report on Occurrences of Structure-Forming Megafaunal Invertebrates off the West Coast of Washington, Oregon and California* (NMFS 2004) on the spatial patterns of the observations:

- Black coral observations appear concentrated north of Cape Mendocino with a few exceptions near Monterey Canyon, on Davidson Seamount (area of hard induration west-southwest of Monterey), and in the Southern California Bight. Gorgonians range from Cape Flattery, Washington southward into the Southern California Bight, but there distribution is fairly patchy south of Monterey, California. North of Monterey, (observations of) gorgonians appear concentrated on the continental slope. Six gorgonian observations also occur on or near a large patch of hard induration (close to Santa Lucia Escarpment) off Morro Bay, California. Filiferan, Scleractinian, and Corallimorpharian observations were fairly scarce throughout the EEZ; and discerning any spatial patterns proved problematic due to their low sample numbers.

- The distribution of (observations of) anemones appears fairly ubiquitous throughout the survey area.

- Sponge observations are conspicuously absent between Cape Mendocino and Santa Cruz, California with the exception of a cluster of observations off Pt. Arena.

- (Observations of) sea pens and whips also exhibit a wide distribution, although they tend to taper off between Eureka and Monterey, California. Sea pens and whips appear to exhibit a narrower depth distribution than anemones and sponges.

A recent pilot survey conducted by NOAA's National Ocean Service in the Olympic Coast National Marine Sanctuary (OCNMS) observed patches of stoney coral about 16 nautical miles west of Cape Alava, Washington, one of six sampling sites in the OCNMS (Hyland et al. 2005). Gorgonian coral was also observed during the survey.

In the same survey, anemones, sponges and sea pens were observed in ROV video footage of rock outcrop and adjacent seafloor throughout the study area (Hyland et al. 2005).

The utility of the data in describing the affected environment and considering protection measures has been the subject of considerable discussion leading up to the preparation of this EIS. In summary, it is not clear as of this writing if patterns in observation equate with patterns in location or abundance. The trawl surveys, which inform much of the work cited above, were not designed to sample invertebrates and conclusions regarding relative abundance drawn from such data are at present the subject of scientific debate. Submersible and ROV data are more appropriate for assessing the location and abundance of structure-forming invertebrates but are limited in geographic scope. The information presented here is meant to inform the reader of the types of organisims that have been observed and the broad geographical extent of the observations. Regardless of the potential inability to quantify abundance of these organisims, the observed data represent compelling evidence that cold water/deep-sea corals, anemones, sponges, sea pens and sea whips are distributed throughout the EEZ and likely in far larger numbers than the scientific and management communities were aware of.

Systematic study of the distribution of these organisims is relatively new. Only since December 2003 did the papers start to become available that are cited in this EIS. Work is ongoing to understand if the observations can be interpreted to infer or deduce location and abundance patterns from observed locations. A recent innovation by Oceana is their calculation of "biogenic areas" based on trawl survey data. This methodology had not been peer-reviewed as of publication of the DEIS, but was used for components of alternatives C-12 through C-14, as well as the final preferred alternative. During the public comment period, the Council's Scientific and Statistical Committee reviewed the methodology and approved use of the information within this EIS (See Appendix D). Figure 3-2 is a map of these biogenic areas. Another potential avenue of study that was discussed by the TRC would be to profile the habitat suitability of megafaunal structure-forming invertebrates in a similar fashion to the HSP model for groundfish as described in the Risk Assessment. This may hold promise in the long term; however, at this time it has proven beyond reach for the EIS.

3.2.3.2 The Groundfish Association and Ecosystem Function of Corals, Anemones, Sponges, Sea Pens, and Sea Whips

Corals, anemones, sponges, sea pens, and sea whips grow up from the ocean floor and increase the complexity of the benthic environment, a possibly unique ecological function. There is little data to support conclusions about the role of these organisims on the West Coast; however, studies from other areas of the world demonstrate that corals in particular support complex ecological communities and increased biodiversity in comparison with areas without corals (Roberts and Hirshfield 2004). The role or corals, anemones, sponges, sea pens, and sea whip in the lives of groundfish has not been clearly demonstrated. Several groundfish species have been observed in association with these benthic organisims; however, additional study is required to draw definitive conclusions.

3.2.3.3 Vulnerability of Corals, Anemones, Sponges, Sea Pens, and Sea Whips to Fishing Impacts

Corals, anemones, sponges, sea pens, and sea whips are a highly sensitive habitat that may be substantially modified with relatively little fishing effort (NRC 2002). Hyland et al. (2005) observed a site in the OCNMS containing patches of stony coral with large proportions consisting of dead and broken skeletal remains and broken gargonian coral. There was also evidence of bottom trawling and derelict fishing gear within the same sudy site. It may be that initial contact (i.e., the first time gear is deployed) is the most important due to the high sensitivity of the habitat to impact. Highly sensitive habitat may be most impacted by initial contact with fishing gear

There have not been many studies of how these organisims recover from initial impact; however, growth rates of corals in particular suggest that recovery is in excess of seven years and likely to be much longer (Roberts and Hirshfield 2004). The sensitivity and recovery indices prepared for the Risk Assessment should be interpreted with the caveat that very little science is available to understand the vulnerability of corals, anemones, sponges, sea pens, and sea whips to fishing impacts. It is plausible that the sensitivity and recovery times of corals, anemones, sponges, sea pens, and sea whips are underestimated and a precautionary approach may be warranted.

3.2.4 Summary of Habitat Sensitivity to Fishing Impacts

This sub-section summarizes the sensitivity of the habitat types discussed above to impacts from fishing as well as recovery time. Corals, anemones, sponges, sea pens and sea whips are discussed separately in section 3.2.3.3. The summary is presented in Table 3-1 and is derived from Appendix 10 of the Risk Assessment. There has been very little work done on the West Coast to understand the relationship of fishing gear to habitat. For this reason, it was necessary to develop a West Coast perspective based on global literature. Recovery times in Table 3-1 are presented in years. Sensitivity values are presented as an index where:

0 = No detectable adverse impacts on the seabed; i.e., no significant differences between impact and control areas in any metrics.

1 = Minor impacts, such as shallow furrows on bottom; small differences between impact and control sites, less than 25% in most measured metrics.

2 = Substantial changes, such as deep furrows on bottom; differences between impact and control sites 25-50% in most metrics measured.

3 = Major changes in bottom structure, such as re-arranged boulders; large losses of many organisms with differences between impact and control sites greater than 50% in most measured metrics.

Maps of habitat by sensitivity and recovery indices were created with GIS are shown in Figure 3-3 and Figure 3-4 with separate figures for different gear types.

Table 3-1: Summary of Habitat Type Sensitivity and Recovery Relative to Fishing Gear

Habitat Category	Habitat Type	Fishing Gear Type	Sensitivity to Impact (1)	Recovery from Impact (years)
Nearshore Biogenic	Estuarine Macrophyte	Dredge Gear	2.8 - 3.0	2.6 - 5.5
		Bottom Trawl	1.0 - 2.0	1.5 - 4.5
		Nets	0.5 - 1.0	0.5 - 2.0
		Pots and Traps	0 - 0.5	0 - 0.5
		Hook and Line	0 - 0.5	0 - 0.5
	Estuarine Shellfish	Dredge Gear	2.0 - 3.0	2.5 - 5.5
		Bottom Trawl	1.0 - 2.0	1.5 - 4.5
		Nets	0.5 - 1.0	0.5 - 2.0
		Pots and Traps	0 - 0.5	0 - 0.5
		Hook and Line	0 - 0.5	0 - 0.5
Nearshore Unconsolidated Bottom	Soft Bottom	Dredge Gear	1.0 - 1.6	0.2 - 0.6
		Bottom Trawl	0.5 - 1.0	0.1 - 0.3
		Nets	0.0 - 0.5	0.0 - 0.5
		Pots and Traps	0.0 - 0.5	0.0 - 0.5
		Hook and Line	0.0 - 0.5	0.0 - 0.5
Nearshore Hard Bottom	Hard Bottom	Dredge Gear	1.5 - 2.5	1.5 - 2.5
		Bottom Trawl	1.0 - 2.0	1.0 - 2.0
		Nets	0.5 - 1.0	0.5 - 1.0
		Pots and Traps	0 - 0.5	0 - 0.5
		Hook and Line	0 - 0.5	0 - 0.5
Offshore Biogenic	Macrophyte	Dredge Gear	1.4 - 3.0	2.0 - 6.0
		Bottom Trawl	1.0 - 3.0	1.5 - 4.5
		Nets	0.5 - 2.5	0.5 - 2.5
		Pots and Traps	0.3 - 1.3	0.3 - 1.3
		Hook and Line	0.3 - 1.3	0.3 - 1.3
	Shelf Shellfish	Dredge Gear	1.4 - 3.0	2.0 - 6.0
		Bottom Trawl	1.4 - 2.2	1.0 - 3.0
		Nets	0.9 - 1.8	0.5 - 1.5
		Pots and Traps	0.4 - 1.2	0.0 - 0.2
		Hook and Line	0.2 - 1.0	0.2 - 1.0
	Shelf Sponge	Dredge Gear	2.0 - 3.0	2.0 - 3.0
		Bottom Trawl	2.0 - 2.4	1.0 - 1.6
		Nets	0.9 - 1.8	0.5 - 1.5
		Pots and Traps	0.4 - 1.2	0.4 - 1.2
		Hook and Line	0.2 - 1.0	0.2 - 1.0
Offshore Biogenic	Slope Sponge	Dredge Gear	2.5 - 3.0	3.5 - 10.5
		Bottom Trawl	2.5 - 3.0	3.5 - 10.5
		Nets	1.0 - 2.0	2.0 - 8.0
		Pots and Traps	0.5 - 1.0	0.0 - 3.0
		Hook and Line	0.5 - 1.0	0.0 - 3.0

1 * See Appendix 10 to the Risk Assessment for a full description of the methodology for derivation of sensitivity and recovery values.

Habitat Category	Habitat Type	Fishing Gear Type	Sensitivity to Impact	Recovery from Impact (years)
Offshore Biogenic	Shelf Coral	Dredge Gear	2.0 - 3.0	2.0 - 3.0
		Bottom Trawl	2.0 - 3.0	1.0 - 1.6
		Nets	0.5 - 2.5	0.5 - 1.5
		Pots and Traps	0.3 - 1.3	0.4 - 1.2
		Hook and Line	0.3 - 1.3	0.2 - 1.0
	Slope Coral	Dredge Gear	2.5 - 3.0	3.5 - 10.5
		Bottom Trawl	2.0 - 3.0	3.5 - 10.5
		Nets	1.0 - 2.0	2.0 - 8.0
		Pots and Traps	0.5 - 1.0	0.0 - 3.0
		Hook and Line	0.5 - 1.0	0.0 - 3.0
	Ridge	Dredge Gear	2.0 - 3.0	2.0 - 3.0
		Bottom Trawl	2.0 - 3.0	2.0 - 3.0
		Nets	0.5 - 2.5	0.5 - 2.5
		Pots and Traps	0.3 - 1.3	0.3 - 1.3
		Hook and Line	0.3 - 1.3	0.3 - 1.3
	Basin	Dredge Gear	2.0 - 3.0	3.5 - 10.5
		Bottom Trawl	2.0 - 3.0	3.5 - 10.5
		Nets	0.5 - 2.5	2.0 - 8.0
		Pots and Traps	0.3 - 1.3	0.0 - 3.0
		Hook and Line	0.3 - 1.3	0.0 - 3.0
	Continental Rise	Dredge Gear	2.0 - 3.0	3.5 - 10.5
		Bottom Trawl	2.0 - 3.0	3.5 - 10.5
		Nets	0.5 - 2.5	2.0 - 8.0
		Pots and Traps	0.3 - 1.3	0.0 - 3.0
		Hook and Line	0.3 - 1.3	0.0 - 3.0
Offshore Unconsolidated Bottom	Shelf Soft Bottom	Dredge Gear	0.9 - 1.1	0.3 - 0.7
		Bottom Trawl	0.5 - 1.0	0.2 - 0.6
		Nets	0.5 - 1.0	0.1 - 0.5
		Pots and Traps	0.0 - 0.5	0.0 - 0.5
		Hook and Line	0.0 - 0.2	0.0 - 0.2
Offshore Unconsolidated Bottom	Shelf canyons, gullies, and ice-formed features	Dredge Gear	0.9 - 1.1	0.3 - 0.7
		Bottom Trawl	0.5 - 1.0	0.2 - 0.6
		Nets	0.2 - 0.8	0.1 - 0.5
		Pots and Traps	0.0 - 0.5	0.0 - 0.5
		Hook and Line	0.0 - 0.2	0.0 - 0.2
	Ridge	Dredge Gear	0.9 - 1.1	0.9 - 1.1
		Bottom Trawl	0.5 - 1.0	0.5 - 1.0
		Nets	0.8 - 1.6	0.8 - 1.6
		Pots and Traps	0.0 - 0.6	0.0 - 0.6
		Hook and Line	0.0 - 0.6	0.0 - 0.6

Habitat Category	Habitat Type	Fishing Gear Type	Sensitivity to Impact	Recovery from Impact (years)
Offshore Unconsolidated Bottom	Slope canyons, gullies, and ice-formed features	Dredge Gear	1.0 - 2.0	1.0 - 2.0
		Bottom Trawl	0.5 - 1.5	1.0 - 2.0
		Nets	0.3 - 1.0	0.5 - 1.0
		Pots and Traps	0.2 - 0.6	0.2 - 0.6
		Hook and Line	0.1 - 0.3	0.2 - 0.6
	Continental Rise canyons, gullies, and landslide	Dredge Gear	1.0 - 2.0	1.0 - 2.0
		Bottom Trawl	0.5 - 1.5	0.5 - 1.5
		Nets	0.3 - 1.0	0.3 - 1.0
		Pots and Traps	0.2 - 0.6	0.2 - 0.6
		Hook and Line	0.1 - 0.3	0.1 - 0.3
Offshore Hard Bottom	Canyon and ice-formed features	Dredge Gear	1.3 - 2.1	1.0 - 3.0
		Bottom Trawl	2.0 - 3.0	1.0 - 2.0
		Nets	0.8 - 1.6	0.5 - 1.5
		Pots and Traps	0.0 - 0.6	0.0 - 0.5
		Hook and Line	0.0 - 0.6	0.0 - 0.5
	Exposure	Dredge Gear	1.3 - 2.1	1.0 - 3.0
		Bottom Trawl	2.0 - 3.0	1.0 - 2.0
		Nets	0.8 - 1.6	0.5 - 1.5
		Pots and Traps	0.0 - 0.6	0.0 - 0.1
		Hook and Line	0.0 - 0.6	0.0 - 0.5
	Slope canyons, gullies, landslides, and exposures	Dredge Gear	2.5 - 3.0	2.5 - 3.0
		Bottom Trawl	2.5 - 3.0	2.5 - 3.0
		Nets	1.0 - 2.0	1.0 - 2.0
		Pots and Traps	0.5 - 1.0	0.5 - 1.0
		Hook and Line	0.5 - 1.0	0.5 - 1.0
	Basin	Dredge Gear	1.0 - 2.0	2.5 - 3.0
		Bottom Trawl	0.5 - 1.5	2.5 - 3.0
		Nets	0.3 - 1.0	1.0 - 2.0
		Pots and Traps	0.2 - 0.6	0.5 - 1.0
		Hook and Line	0.1 - 0.3	0.5 - 1.0

3.2.5 Mapping of Habitat Types

This sub-section describes the specific habitat-type data available for this EIS. To facilitate conservation decisions for groundfish EFH, a coastwide GIS database of habitat types was assembled. In the first instance, benthic habitat has been characterized for the purposes of the EIS on the basis of the physical substrate (Figure 3-5). Other important aspects of habitat, such as biogenic structures, are also considered to the extent possible (see Section 3.2.3). Marine geology experts have developed GIS data delineating bottom-types and physiographic features associated with groundfish habitats. Benthic habitat data for Washington and Oregon were developed by the Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences at Oregon State University (Appendix 2 to the Comprehensive Risk Assessment). Data for California were developed by the Center for Habitat Studies at Moss Landing Marine Laboratories (Appendix 3 to the Comprehensive Risk Assessment). TerraLogic GIS was responsible for merging and cleaning these two data sources to create a seamless West Coast coverage. All lithologic and physiographic features were classified according to a deep-water benthic habitat classification system developed by Greene, *et al*. (1999). Detailed documentation about the classification system and mapping methods are included in Appendix 3 to the Comprehensive Risk Assessment.

In general, the benthic habitats are classified according to physical features in a hierarchical system. The levels are: megahabitat, seafloor induration, meso/macrohabitat, and modifier(s). For the West Coast, the following types have been delineated:

<u>Level 1: Megahabitat</u>

- Continental Rise/Apron
- Basin Floor
- Continental Slope
- Ridge, Bank or Seamount
- Continental Shelf

<u>Level 2: Seafloor Induration</u>

- Hard substrate
- Soft substrate

<u>Level 3: Meso/macrohabitat</u>

- Canyon wall
- Canyon floor
- Exposure, bedrock
- Gully
- Gully floor
- Ice-formed feature
- Landslide

Level 4: Modifier

Bimodal pavement
Outwash
Unconsolidated sediment

Each unique combination of these four characteristics defines a unique benthic habitat type. For the West Coast EFH project, 35 unique benthic habitat types have been delineated. These are illustrated in Figure 3-6.

Information on the distribution of biogenic structures and other organisms, which may form an essential, and potentially sensitive, component of habitat is less readily available, but is included to the extent possible at this stage. Biological organisms may play a critical role in determining groundfish habitat use and preference. Structure-forming invertebrates, such as sponges, anemones and cold water corals, can be an important and component of fish habitat. An example within the U.S. EEZ is the Oculina Bank on the Atlantic coast of Florida. On the West Coast, however, assessment of the significance of associations between structure forming invertebrates and groundfish species is limited by available literature.

GIS data have been compiled for several essential biological habitat components, specifically, canopy kelp, seagrass, and benthic invertebrates. Limited information is available to spatially delineate these biological habitats coastwide. However, because these habitats are so important, the project team felt that incomplete coverage was preferable to leaving these data out of the GIS.

Estuaries are known to be important areas for some groundfish species, such as kelp greenling, starry flounder, and cabezon. However, the marine geologists did generally not map estuarine seafloor types during the initial data consolidation phase of the project. They are included as a separate mapped category for inclusion in modeling efforts.

3.3 Marine Resources

This section describes the general biology and management status of living marine resources that occur off the West Coast.

3.3.1 Groundfish Management Framework in Relation to Stock Status

The Council process for setting groundfish harvest levels and other specifications depends on periodic assessments of the status of groundfish stocks, rebuilding analyses of those stocks that are overfished and managed under rebuilding constraints, and a report from an established assessment review body or a Stock Assessment Review (STAR) Panel. As appropriate, the SSC recommends the best available science for groundfish management decision making in the Council process. The SSC reviews new assessments, rebuilding analyses, and STAR Panel reports. They then recommend the data and analyses that should be used to set groundfish harvest levels and other specifications for the following biennial management period.

NMFS is planning the next round of stock assessments for completion and review in 2005 for developing management measures and harvest specifications for the 2007-2008 biennial management cycle. Rebuilding plans for overfished species are subject to review every two years. Updated assessments are planned for over 20 species. NMFS held a series of workshops in 2004 that focused on data needs and available data sources for the ambitious list of stock assessments being considered for 2005. Additionally, the SSC is finalizing standards for the required review of rebuilding analyses. These reviews are required every two years for species under rebuilding plans.

3.3.1.1 Non-overfished Groundfish Species

The following Groundfish FMP species are not presently considered overfished by the Council, although most of these species have not been fully assessed because they are not target species or are not caught in large amounts.

Leopard Shark (*Triakis semifasciata*)
Soupfin Shark (*Galeorhinus zyopterus*)
Spiny Dogfish (*Squalus acanthias*)
Big Skate (*Raja binoculata*)
California Skate (*Raja inornata*)
Longnose Skate (*Raja rhina*)
Ratfish (*Hydrolagus colliei*)
Finescale Codling (*Antimora microlepis*)
Pacific Rattail (*Coryphaenoides acrolepis*)
Cabezon (*Scorpaenichthys marmoratus*)
Kelp Greenling (*Hexagrammos decagrammus*)
Pacific Cod (*Gadus macrocephalus*)
Pacific Whiting (Pacific Hake) (*Merluccius productus*)
Aurora Rockfish (*Sebastes aurora*)
Bank Rockfish (*Sebastes rufus*)
Black Rockfish (*Sebastes melanops*)
Black-and-Yellow Rockfish (*Sebastes chrysomelas*)
Blackgill Rockfish (*Sebastes melanostomus*)
Blue Rockfish (*Sebastes mystinus*)
Bronzespotted Rockfish (*Sebastes gilli*)
Brown Rockfish (*Sebastes auriculatus*)
Calico Rockfish (*Sebastes dalli*)
California Scorpionfish (*Scorpaena guttata*)
Chilipepper (*Sebastes goodei*)
China Rockfish (*Sebastes nebulosus*)
Copper Rockfish (*Sebastes caurinus*)
Dusky Rockfish (*Sebastes ciliatus*)
Flag Rockfish (*Sebastes rubrivinctus*)
Gopher Rockfish (*Sebastes carnatus*)
Grass Rockfish (*Sebastes rastrelliger*)
Greenblotched Rockfish (*Sebastes rosenblatti*)
Greenspotted Rockfish (*Sebastes chlorostictus*)
Greenstriped Rockfish (*Sebastes elongatus*)
Harlequin Rockfish (*Sebastes variegatus*)
Honeycomb Rockfish (*Sebastes umbrosus*)
Kelp Rockfish (*Sebastes atrovirens*)
Longspine Thornyhead (*Sebastolobus altivelis*)
Mexican Rockfish (*Sebastes macdonaldi*)
Olive Rockfish (*Sebastes serranoides*)
Pink Rockfish (*Sebastes eos*)
Quillback Rockfish (*Sebastes maliger*)
Redbanded Rockfish (*Sebastes babcocki*)

Redstripe Rockfish (*Sebastes proriger*)
Rosethorn Rockfish (*Sebastes helvomaculatus*)
Rosy Rockfish (*Sebastes rosaceus*)
Rougheye Rockfish (*Sebastes aleutianus*)
Sharpchin Rockfish (*Sebastes zacentrus*)
Shortbelly Rockfish (*Sebastes jordani*)
Shortraker Rockfish (*Sebastes borealis*)
Shortspine Thornyhead (*Sebastolobus alascanus*)
Silvergray Rockfish (*Sebastes brevispinis*)
Speckled Rockfish (*Sebastes ovalis*)
Splitnose Rockfish (*Sebastes diploproa*)
Squarespot Rockfish (*Sebastes hopkinsi*)
Starry Rockfish (*Sebastes constellatus*)
Stripetail Rockfish (*Sebastes saxicola*)
Tiger Rockfish (*Sebastes nigrocinctus*)
Treefish (*Sebastes serriceps*)
Vermilion Rockfish (*Sebastes miniatus*)
Yellowmouth Rockfish (*Sebastes reedi*)
Yellowtail Rockfish (*Sebastes flavidus*)
Arrowtooth Flounder (*Atheresthes stomias*)
Butter Sole (*Pleuronectes isolepis*)
Curlfin Sole (*Pleuronichthys decurrens*)
English Sole (*Pleuronectes vetulus*)
Flathead Sole (*Hippoglossoides elassodon*)
Pacific Sanddab (*Citharichthys sordidus*)
Petrale Sole (*Eopsetta jordani*)
Rex Sole (*Errex zachirus*)
Rock Sole (*Lepidopsetta bilineata*)
Sand Sole (*Psettichthys melanostictus*)
Starry Flounder (*Platichthys stellatus*)

For each of these species, detailed information can be found in the Life History Appendix to the FMP regarding habitat utilization patterns, fisheries that harvest the species, geographic range, migrations and movements, reproduction, growth and development, and trophic interactions. The Habitat Use Database also contains information on the utilization of West Coast habitats and other life history characteristics of the various life stages of the managed groundfish species listed above.

Several species managed under the Groundfish FMP were observed at Davidson Seamount during 6 ROV dives between May 17 and May 24, 2002 (Monterey Bay National Marine Sanctuary, 2002 unpublished data). Pacific rattail (*Coryphaenoides acrolepis*) were most abundant, followed by finescale codling (*Antimora microlepis*). Pacific cod (*Gadus macrocephalus*) and shortspine thornyhead (*Sebastolobus alascanus*) were also observed. Due to the small sample size results are inconclusive as to the importance of the habitat association, but it does show a presence of groundfish in habitat areas around Davidson Seamount. We are not aware of other biological studies that have been made around Davidson Seamount (Burden, August 2005, personal communication).

3.3.1.2 Overfished Groundfish Species

Eight species of West Coast groundfish are currently declared overfished by NMFS. They are:

Cowcod (*Sebastes levis*)
Canary Rockfish (*Sebastes pinniger*)
Darkblotched Rockfish (*Sebastes crameri*)
Pacific Ocean Perch (*Sebastes alutus*)
Lingcod (*Ophiodon elongatus*)
Bocaccio (*Sebastes paucispinis*)
Widow Rockfish (*Sebastes entomelas*)
Yelloweye Rockfish (*Sebastes ruberrimus*)
Rockfish are long-lived, late maturing, and slow-growing species. These traits make them particularly vulnerable to overfishing.

Pacific whiting was declared overfished in 2002. However, following Council review and approval of the latest Pacific whiting stock assessment in March 2004, NMFS announced that whiting is estimated to be above the target rebuilding biomass and is no longer considered overfished.

"Overfishing" and "overfished" are defined in the West Coast Groundfish FMP for each species or species complex. According to the FMP's definition, a stock (or fish population) is overfished when its spawning stock abundance declines to 25% of its estimated "unfished biomass" (the spawning population size if the stock had never been fished; biomass is the weight of a population of fish). Once a stock is declared overfished, measures must be taken to rebuild stock abundance to a level that supports maximum sustained yield (MSY). For most West Coast groundfish stocks, that level is defined as 40% of the stock's virgin, unfished abundance. "Overfishing" is defined as a harvest rate that is predicted to cause a stock to decline to an overfished level. The FMP further defines overfishing as fishing at a rate that exceeds Fmsy. The Magnuson-Stevens Fishery Management and Conservation Act and FMP require management measures that end overfishing.

The Magnuson-Stevens Act also requires that the Council rebuild an overfished stock within ten years, if the stock's biology allows it to be rebuilt within this relatively short timeframe. Rebuilding the currently overfished rockfish species will probably take significantly longer. If a stock cannot be rebuilt within ten years, then the maximum allowable time to rebuild the stock is the time to rebuild the stock in the absence of fishing, plus one mean generation time. (Mean generation time is the time it takes for a sexually mature female to replace herself in the population).

Historically, these species were taken by trawl, hook and line, and sport gear. Trawl catches of rockfish have been reduced by the small footrope restrictions put in place on the shelf since 2000, which may keep trawlers out of most rockfish habitat. Overfished shelf rockfish species are still incidentally caught with commercial and sport line gear, but are now much less common in bottom trawl catches. Depth-based restrictions have been adopted to reduce harvest of overfished groundfish, to end overfishing, and to rebuild these stocks.

Some assessed species, including some of the most important target species such as sablefish (*Anoplopoma fimbria*), Dover sole (*Microstomus pacificus*), and shortspine thornyhead (*Sebastolobus alascanus*) are below the target biomass, BMSY, although not overfished. These species are classified as precautionary zone species and OYs for these stocks are set according to a precautionary formula that progressively reduces the OY below the ABC as the estimated stock size is lower. This precautionary reduction allows sufficient surplus production to allow the stock to increase to the target biomass over time.

For each of the above overfished or precautionary zone fish species, detailed information can be found in the Life History Appendix to the FMP regarding habitat utilization patterns, fisheries which harvest the species, geographic range, migrations and movements, reproduction, growth and development, and trophic interactions. The Habitat Use Database also contains information on the utilization of West Coast habitats and other life history characteristics of the various life stages of these species.

3.3.2 Non-groundfish Stocks

The following non-groundfish species may be caught incidentally in fisheries targeting groundfish. Thus, changes in fishing regulations in groundfish fisheries could increase or decrease fishing mortality on incidentally caught species. Alternatively, those fisheries targeting nongroundfish species may be affected by management measures intended to reduce or eliminate incidental catches of overfished groundfish species in these fisheries.

3.3.2.1 California Halibut

California halibut (*Paralichthys californicus*) are a left-eyed flatfish of the family Bothidae. They range from Northern Washington at approximately the Quileute River to southern Baja, California (Eschmeyer et al. 1983), but are most common south of Oregon.

California halibut feed on fishes and squids and can take their prey well off the bottom. They are an important sport and commercial species, especially in California where they are targeted using hook-and-line and trawl gear.

3.3.2.2 California Sheephead

California sheephead (*Semicossyphus pulcher*) are a large member of the wrasse family Labridae. They range from Monterey Bay south to Guadalupe Island in central Baja, California and in the Gulf of California, but are uncommon north of Point Conception..

They can live to 50 years of age and a maximum length of 91 cm (16 kg). Like some other wrasse species, California sheephead change sex starting first as a female, but changing to a male at about 30 cm in length.

3.3.2.3 Coastal Pelagic Species (CPS)

CPS are schooling fish, not associated with the ocean bottom, that migrate in coastal waters. These species include: northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), Pacific (chub) mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and market squid (*Decapoda spp*.). Until 1999, northern anchovy was managed under the Council's Northern Anchovy FMP. Amendment 8 to the Northern Anchovy FMP brought the remaining CPS species under federal management and renamed the FMP the Coastal Pelagic Species FMP. This FMP was implemented in December 1999.

Sardines inhabit coastal subtropical and temperate waters, and at times, have been the most abundant fish species in the California current. During times of high abundance, Pacific sardine range from the tip of Baja, California to southeastern Alaska. When abundance is low, Pacific sardine do not occur in large quantities north of Point Conception, California. Pacific mackerel in the northeastern Pacific range from Banderas Bay, Mexico to southeastern Alaska. They are common from Monterey Bay, California to Cabo San Lucas, Baja, California, and most abundant south of Point Conception, California. The central subpopulation of northern anchovy ranges from San Francisco, California to Punta Baja, Mexico. Jack mackerel are a pelagic schooling fish that range widely throughout the northeastern Pacific; however, much of their range lies outside the U.S. EEZ. Adult and juvenile market squid are distributed throughout the Alaska and California current systems, but are most abundant between Punta Eugenio, Baja, California and Monterey Bay, Central California.

Stock assessments indicate Pacific sardine and Pacific mackerel are increasing in relative abundance. Pacific sardine biomass in U.S. waters was estimated to be 1,581,346 mt in 1999; Pacific mackerel biomass (in U.S. waters) was estimated to be 239,286 mt. Pacific sardine landings for the directed fisheries off California and Baja, California reached the highest level in recent history during 1999, with a combined total of 115,051 mt harvested. In 1998 70,799 mt of Pacific mackerel were landed, representing near-record levels for the combined directed fisheries off California and Baja, California. Population dynamics for market squid are poorly understood, and annual fluctuations in commercial catch vary from <10,000 mt to 90,000 mt. Amendment 10 to the CPS FMP describes and analyzes several approaches for estimating an MSY-proxy for market squid. Amendment 10 was adopted by the Council in June 2002 and is currently under review by NMFS. Market squid are thought to have an annual mortality rate approaching 100%, which means the adult population is almost entirely new recruits and successful spawning is crucial to future years abundance.

3.3.2.4 Dungeness crab

The Dungeness crab (*Cancer magister*) is distributed from the Aleutian Islands, Alaska, to Monterey Bay, California. They live in bays, inlets, around estuaries, and on the continental shelf. Dungeness crabs are found to a depth of about 180 m. Although it is found at times on mud and gravel, this crab is most abundant on sand bottoms; frequently it occurs among eelgrass. The Dungeness crab, which are typically harvested using traps (crab pots), ring nets, by hand (scuba divers), or dip nets are incidentally taken or harmed unintentionally by groundfish gears. Dungeness crabs are managed by the states of Oregon and California, and by the State of Washington in cooperation with Washington Coast treaty tribes.

3.3.2.5 Highly Migratory Species

Highly migratory species (HMS) include tunas, billfish, dorado, and sharks—species that range great distances during their lifetime, extending beyond national boundaries into international waters and among the EEZs of many nations in the Pacific. The Council is adopting a Highly Migratory Species FMP to federally regulate the take of HMS within and outside the EEZ. The HMS FMP describes species proposed for active management in detail. These are five tuna species, five shark species, striped marlin, swordfish, and dorado or dolphinfish. A much longer list of species, constituting all those that have been caught in HMS fisheries and not already under state or federal management, will be monitored, but are not part of the management unit.

3.3.2.6 Ocean whitefish

Ocean whitefish (*Caulolatilus princeps*) occur as far north as Vancouver Island in British Columbia, but are rare north of Central California. A solitary species, it inhabits rocky bottoms and is also found on soft sand and mud bottoms. Whitefish dig into the substrate for food.

3.3.2.7 Pacific pink shrimp

Pacific pink shrimp (*Pandalus jordani*) are found from Unalaska in the Aleutian Islands to San Diego, California, at depths of 25 fm to 200 fm (46 m to 366 m). Off the U.S. West Coast these shrimp are harvested with trawl gear from Northern Washington to Central California between 60 fm and 100 fm (110 m to 180 m). The majority of the catch is taken off the coast of Oregon. Concentrations of pink shrimp are associated with well-defined areas of green mud and muddy-sand bottoms. Shrimp trawl nets are usually constructed with net mesh sizes smaller than the net mesh sizes for legal groundfish trawl gear. Thus, shrimp trawlers commonly take groundfish in association with shrimp (rather than the reverse). Pacific shrimp fisheries are managed by the states of Washington, Oregon, and California.

3.3.2.8 Pacific halibut

Pacific halibut (*Hippoglossus stenolepis*) belong to a family of flounders called Pleuronectidae. Pacific halibut can be found along the continental shelf in the North Pacific and Bering Sea. They have flat, diamond-shaped bodies and are able to migrate long distances. Most adult fish tend to remain on the same grounds year after year, making only a seasonal migration from the more shallow feeding grounds in summer to deeper spawning grounds in winter. Halibut are usually found in deep water (40 m to 200 m).

The bilateral (U.S./Canada) International Pacific Halibut Commission (IPHC) manages pacific halibut. The Pacific Halibut Catch Sharing Plan for waters off Washington, Oregon, and California (Area 2A) specifies catch allocation for Pacific halibut on the West Coast. Implementation of IPHC catch levels and regulations is the responsibility of NMFS, the states of Washington, Oregon, and California, and the Pacific halibut treaty tribes.

3.3.2.9 Ridgeback prawn

Ridgeback prawns (*Sicyonia ingentis*) are found south of Monterey, California to Baja, California in depths of 145 metric feet to 525 metric feet (Sunada *et al.* 2001). They are more abundant south of Point Conception and are the most common invertebrate appearing in trawls. Their preferred habitat is sand, shell and green mud substrate, and they are relatively sessile. Although information about their feeding habits is limited, these prawns probably are detritus feeders. In turn, they are prey for sea robins, rockfish, and lingcod. Unlike other shrimp species, which carry their eggs during maturation, ridgeback prawns release their eggs into the water column. They spawn seasonally from June to October. Surveys recorded increasing abundance of ridgeback prawns from 1982, when surveys began, to 1985. The population then declined. More recent CPUE data suggest increased abundance in the 1990s. These changes may be due to climate phenomena, particularly El Niño events.

3.3.2.10 Sea cucumber

Two sea cucumber species are targeted commercially: the California sea cucumber (*Parastichopus californicus*) and the warty sea cucumber (*P. parvimensis*) (Rogers-Bennett and

Ono 2001). These species are tube-shaped Echinoderms, a phylum that also includes sea stars and sea urchins. The California sea cucumber occurs as far north as Alaska, while the warty sea cucumber is uncommon north of Point Conception and does not occur north of Monterey. Both species are found in the intertidal zone to as deep as 300 feet. These bottom-dwelling organisms feed on detritus and small organisms found in the sand and mud. Because sea cucumbers consume bottom sediment and remove food from it, they can alter the substrate in areas where they are concentrated. They can also increase turbidity as they excrete ingested sand or mud particles. Sea stars, crabs, various fishes, and sea otters prey upon them. They spawn by releasing gametes into the water column, and spawning occurs simultaneously for different segments of a population. During development, they go through several planktonic larval stages, settling to the bottom two months to three months after fertilization of the egg. Little is known about the population status of these two species; and assessment is difficult, because of their patchy distribution. However, density surveys suggest abundance has declined since the late 1980s. This is not unexpected since a commercial fishery for these species began in the late 1970s and expanded substantially after 1990.

3.3.2.11 Spot prawn

Spot prawn (*Pandalus platyceros*) are the largest of the pandalid shrimp and range from Baja, California north to the Aleutian Islands and west to the Korean Strait (Larson 2001). They inhabit rocky or hard bottoms including coral reefs, glass sponge reefs, and the edges of marine canyons. They have a patchy distribution, which may result from active habitat selection and larval transport. Spot prawns are hermaphroditic, first maturing as males at about three years of age. They enter a transition phase after mating at about four years of age when they metamorphose into females.

Spot prawns are taken by both traps and trawls on the West Coast with the fishery taking predominantly older females. These fisheries are open access and managed by the West Coast states.

3.3.2.12 White seabass

White seabass (*Atractoscion nobilis*), a large member of the croaker family, range from southeast Alaska to Baja but are rare north of California (Eschmeyer et al. 1983). White seabass are primarily targeted with driftnet gear since the setnet fishery for white seabass was prohibited in 1994. White seabass may also be caught with commercial hook-and-line gear in the early spring, when large seabass are available. Regulations covering white seabass have been in effect since 1931 and have included a minimum size limit, closed seasons, bag limits, and fishing gear restrictions. Such regulations are in effect today, with slight variations. An FMP for white seabass is presently being adopted and the need for additional regulations will be considered (Vojkovich and Crooke 2001).

3.3.2.13 Miscellaneous species

Little information is available on nongroundfish species that are incidentally captured in the groundfish fishery. Other than those species mentioned above, documentation from the whiting fishery indicates that species such as U.S. shad (*Alosa sapidissima*) and walleye pollock (*Theragra chalcogramma*) are taken incidentally. According to preliminary data, about 112 mt of shad and 280 mt of pollock were taken as incidental catch in the at-sea sector of the Pacific whiting fishery in 2001, through October. U.S. shad was also taken in the shore-based whiting fishery. Introduced in 1885, they have flourished throughout the lower Columbia River, producing a record run of 4.0 million fish in 1990 (ODFW and WDFW 2002). Walleye pollock are found in the waters of the Northeastern Pacific Ocean from the Sea of Japan, north to the Sea of Okhotsk, east in the Bering Sea and Gulf of Alaska, and south in the Northwestern Pacific Ocean along the Canadian and U.S. West Coast to Carmel, California. In 2002 trawlers began targeting this species off Washington after the primary whiting fishery closed, based on reports of larger concentrations of the fish in these waters. Since this species is not managed under any of the Council's FMPs, there are no harvest levels, management measures, or observer requirements specified for this fishery. In 2003, WDFW sponsored an EFP to explore selective harvesting of pollock while minimizing impacts to incidental species. WDFW has submitted an application for this EFP to continue in 2004.

3.3.3 Prey Species

Major prey items of managed groundfish species include copepod eggs, copepod nauplii, amphipods, diatoms, dinoflagellates, tintinnids, cladocerans, fish and invertebrate eggs and larvae, mysids, ophiuroids, tunicates, worms (e.g. annelids and polychaetes), shrimp, decapod crustaceans, bivalve mollusks, squids and octopi, euphausiids, pelagic fishes (e.g. anchovies, smelt, lanternfishes, and herring), sculpins, juvenile flatfishes, juvenile rockfishes, and other small fishes. These prey occupy the same habitats as the groundfish species/life stage that prey upon them. There is usually a dietary progression in groundfish coinciding with ontogeny, which generally begins with the consumption of zooplankton during early life stages and culminates with the consumption of crustaceans, bivalves, cephalopods and/or fishes in the adult life stage. The various species/life stages of groundfish take prey by a wide range of strategies including planktivory, sit and wait predation, and active predation on sedentary or mobile prey items. Some groundfish species feed throughout the diel cycle, some feed diurnally, while others are nocturnal hunters. Groundfish diets may shift in response to seasonal variations in prey abundance.

Pink shrimp are associated with green mud and muddy-sand bottoms and are important prey for many species. Arrowtooth flounder, petrale sole, sablefish, and Pacific whiting are some of the groundfish that prey heavily on pink shrimp. Small coastal pelagic fishes provide an important prey source for Pacific whiting and other marine species. Dungeness crab, through all its life history stages, is an important prey species for many groundfish. Krill (i.e. euphausiids) are a critical prey item for many managed groundfish species, either as primary prey or through secondary or later food web dependencies (see 3.3.3.1 for more details). No krill fishery currently exists for on the West Coast, but concerns have been raised regarding the potential development of such a fishery and the possible detrimental effects it might have on the groundfish prey field. Removal of large amounts of krill or other zooplankton could result in reduced productivity and mortality of higher trophic animals.

Cannibalism on various life stages is known to occur in some groundfish such as the macrourids, cabezon, kelp greenling, gopher rockfish, Pacific whiting, rock and petrale sole.

See the Life History Appendix to the FMP and the Habitat Use Database for detailed information on the trophic interactions of each species in the groundfish FMU.

3.3.3.1 Krill

Two species of euphausiid, *Euphausia pacifica* and *Thysanoessa spinifera*, dominate the euphausiid assemblage along the West Coast of North America from southern California to the Gulf of Alaska (Brinton, 1962). These species play key roles in pelagic ecosystems of the California Current as grazers, and secondary producers in shelf and slope zooplankton communities, and as prey for fishes, birds and mammals. Euphausiids can comprise up 80% of zooplankton biomass in outer continental shelf waters and at the shelf break, and can potentially consume 100% of local primary production at the shelf break. Euphausiids are commonly taken as prey by all pelagic fishes off Oregon (mackerel, herring, hake, sardines, coho and chinook salmon, and juvenile sablefish), as well as by some of the more benthic oriented rockfish.

Thysanoessa spinifera is the dominant euphausiid species in shelf waters and is the only euphausiid common inshore of the 150 m isobath. In contrast, *E. pacifica* is dominant along and seaward of the shelf break. On a basin-scale basis, *T. spinifera* occupies coastal waters from Baja California north into the Gulf of Alaska whereas *E. pacifica* is found in shelf and shelf break waters all around the Pacific Rim as well in oceanic waters across the entire Pacific. Thus although the two species can occupy similar niches in continental shelf waters, *E. pacifica* can also be considered to be an oceanic species. The larvae of both species are found chiefly in the food-rich continental shelf waters, within the coastal upwelling zone. Curiously, in inland coastal regions, (e.g., Puget Sound, Dabob Bay, and the Straits of Georgia), *E. pacifica* is most abundant whereas *T. spinifera* is either uncommon or absent. Thus, the two species may have very different life history strategies.

3.3.3.1.1 Aggregations and Diel Vertical Migration

One of the most fundamental pieces of information needed to describe the population dynamics of any species is data on the distribution and abundance of animals and of any tendencies to form aggregations. Aggregations have been well described for the Antarctic krill, *Euphausia superba*. Aggregations of our local euphausiids are known only from sketchy descriptions by various authors for both *Euphausia pacifica* and *Thysanoesssa spinifera*. Studies of euphausiid distributions in the California Current using high-frequency acoustics have confirmed the importance and prevalence of aggregations; however, acoustics cannot determine species composition of swarms. Similarly, marine bird and mammal observers frequently note the presence of "euphausiid swarms" during their surveys, but again, few-to-no attempts have been made to actually sample the swarms to determine their species composition and the sex/age/size of the members of the swarm. Results of plankton net tows show variations in numbers of animals per cubic meter of several orders of magnitude. These variations are undoubtedly due to the presence of swarms. Lacking detailed studies, we must admit to not knowing enough about swarming behavior to produce any generalizations. This represents a huge gap in our knowledge, and is one that must be filled if we embark on any krill stock assessment activities.

Juveniles and adults of both species perform strong diel vertical migrations; they reside in deep waters during the daytime presumably to avoid being seen and eaten by predators, but swim to the sea surface at night to feed. The extent of these vertical excursions is on the order of 200 m vertically and is accomplished in approximately 1 hour, at dusk and dawn. The larvae of both species also perform diel vertical migrations but the extent of the migration is far less, ranging over 10-30 m in extent. Animals that reside at the shelf break spend the daylight hours within the poleward undercurrent.

3.3.3.1.2 Seasonal Cycle of Abundance

The seasonal cycles of abundance for *E. pacifica* and *T. spinifera* appear to be similar with both species having their highest abundances at the end of the upwelling season, generally in September or October.

3.3.3.1.3 Spawning Seasons

Although spawning can occur as early as February, significant numbers of eggs first appear in our plankton samples in mid-May. Very high numbers of eggs are encountered throughout the summer months. *T. spinifera* spawns during both spring and summer months whereas *E. pacifica* appears to be chiefly a summer spawner. The summer peak in egg numbers is due chiefly to spawning by *E. pacifica.* Spawning by both species ceases after mid-September.

3.3.3.1.4 Recruitment Variations

Interannual variations in egg production are pronounced: euphausiid eggs were relatively rare during 1996-1998 (particularly during the 1998 El Niño) and were found in NMFS plankton samples only during the summer. Abundances of euphausiid eggs increased by 4-10 fold in the year 2000, but have tended to decline since. In fact, abundances of eggs during the summer of 2001 and 2003 were similar to abundances observed in 1996-1998.

3.3.3.1.5 Brood Size

During many cruises we incubated females to determine the number of eggs (i.e., brood size) produced by females as a function of body length. Brood sizes were highly variable, ranging from a few eggs to more than 800 eggs per female. Maximum brood sizes were seen for females of 21 mm total length, with smaller brood sizes seen in both smaller as well as larger females.

3.3.3.1.6 Egg production rates

Our laboratory studies of spawning by adult females in incubations have shown that on average females of both species produce about 120 eggs per brood. We have maintained ~ 30 adult female *E. pacifica* in the laboratory for periods of 6-9 months, checking them daily for eggs, in order to determine the period of time between production of a brood, and to determine the "life time" fecundity. We found on average that a brood is produced every six days, and that females may produce on the order of 800 eggs per month. Unfortunately we do not know females' life spans in the ocean so cannot estimate in situ fecundity; however, the laboratory studies confirm that females can live for at least nine months, and that they can produce 5,000-8,000 eggs within that time period. With regards to *T. spinifera*, although we attempted similar experiments, adult females never produced more than one brood under laboratory conditions. Thus we do not know if they produce multiple broods (as seen in *E. pacifica*) or if they produce only one brood per female.

3.3.3.1.7 Development Times

We have raised batches of eggs produced in the laboratory, checked them daily and noting developmental stage, and followed development through to adult. We have found that eggs hatch within 38 hours, that larval development is approximately one month, that the juvenile stage is reached within two months, and that animals reach adulthood after 9 months.

We have determined for *E. pacifica* from our field sampling program that there are two cohorts produced each year, one in spring and one in summer. This matches well with our observations of eggs abundances in the field in that both the spring and summer spawning events produce cohorts of animals that can be traced for many months.

3.3.3.1.8 Life Span

Cohort analysis suggests that krill live for one year. However we have maintained adult males and females in the laboratory for nearly three years so we know that they can live far longer than one year. This suggests that predation mortality is very high in the field.

3.3.3.1.9 Growth

We have determined growth by several methods. One is to incubate 40-50 individuals each in its own jar, check them every 12 hours for a total of 48 hours, to determine the frequency of molting. We determined that they molt every 6 days during summer but every 10 days in winter. To estimate growth, we measure the difference in length between the molted animal and the molted skin. This gives us a growth increment. A second method is to use cohort analysis of animals collected in our plankton nets during biweekly cruises to estimate changes in length-frequency distributions with time. In both cases, we have found that growth rates of juveniles and adults average 2 mm per month.

3.3.3.1.10 Overwintering

During the winter months, there is no primary production thus very little food for planktonic animals. Many copepod species go in to diapause, a process similar to hibernation of mammals. When in diapause, their metabolism decreases greatly and individuals survive by metabolizing lipids that are stored from a previous summer of feeding. Euphausiids appear to remain somewhat active all winter long in that they continue to molt but we have determined that they do not grow, rather they shrink. Thus an animal that entered the winter months at a length of 20 mm could end up 12-14 mm in length the following spring.

3.3.3.1.11 Mortality

We have not done any rigorous analysis of stage-specific mortality rates. We do know that high numbers of eggs do not result in high numbers of larvae, suggesting high mortality in the embryo stage. In fact, the ratio of number of nauplii (the first larval stage) to numbers of eggs is on the order of 0.02 to 0.05. In our plankton samples, apparently only 2-5% of the eggs survive to the nauplius stage.

3.3.3.2 Other Groundfish Prey

Other common prey for groundfish include: Amphipods; Clupeids; copepod adults, eggs and nauplii; crabs; fish adults, juveniles, larvae and eggs; Molluscs; Mysids; octopi; Polychaetes, shrimp; squid; and tunicates (HUD August 2005). For a more detailed list and literature review of known prey for each groundfish species, see HUD output table (Table 3-2).

During 90 hours of ROV diving around Davidson Seamount in May 2002, many groundfish prey were observed, including: Cephalopods, bony fishes, Amphipods, shrimp, crabs, Isopods, brittle stars, sea stars, bivalve molluscs, Gastropods, Polychaetes, fish eggs, and Mysids (Monterey Bay National Marine Sanctuary, 2002 unpublished data). Due to the small sample size results are inconclusive as to the importance of habitat around Davidson Seamount to groundfish prey. It is also inconclusive regarding the relative abundance of groundfish prey, but it does indicate the presence of known groundfish prey species. No other biological studies have been made around Davidson Seamount (Burden, August 2005 personal communication).

Table 3-2 Groundfish species and their associated prey at different life stages.

Species - Scientific	Species - Common Name	Lifestage	Prey Name
Atheresthes stomias	Arrowtooth flounder	Adults	Clupeids Gadids krill Shrimp Theragra chalcogramma
		Juveniles	Clupeids Gadids krill Shrimp Theragra chalcogramma
		Larvae	Copepod eggs Copepod nauplii Copepods
Sebastes rufus	Bank rockfish	Adults	gelatinous plankton krill Small fishes tunicates
		Juveniles	gelatinous plankton krill Small fishes tunicates
Raja binoculata	Big skate	Adults	Crustaceans Fish
Sebastes melanops	Black rockfish	Adults	Amphipods Cephalopods Clupeids Euphausiids Mysids polychaetes salps
		Juveniles	Amphipods barnacle cypriots Copepods crustacean zoea fish larvae Mysids polychaetes
		Larvae	Copepods invertebrate eggs Invertebrate nauplii
Sebastes chrysomelas	Black-and-yellow rockfish	Adults	Crabs fish Juvenile rockfish Octopi Shrimp
		Juveniles	Copepods crustacean zoea
		Larvae	Copepod nauplii Copepods fish larvae invertebrate eggs Molluscs

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Sebastes melanostomus	Blackgill rockfish	Adults	Euphausiids Small fishes Squids tunicates
		Juveniles	Euphausiids Small fishes Squids tunicates
Sebastes mystinus	Blue rockfish	Adults	algae crab fish juveniles fish larvae hydroids jellyfish krill salps tunicates
		Juveniles	algae Copepods crab Euphausiids fish juveniles hydroids krill salps tunicates
Sebastes paucispinis	Bocaccio	Adults	fish juveniles Juvenile rockfish Molluscs Small fishes
		Juveniles	Copepods Euphausiids
		Larvae	Cladocerans Diatoms Dinoflagellates tintinnids
Sebastes auriculatus	Brown rockfish	Adults	Crabs Fish isopods polychaetes Shrimp
		Juveniles	Amphipods Copepods Crabs Fish
Isopsetta isolepis	Butter sole	Adults	Amphipods Decapod crustaceans Fish Molluscs polychaetes Sea stars Shrimp

*

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Scorpaenichthys marmoratus	Cabezon	Adults	Crabs Fish eggs Lobsters Molluscs Small fishes
		Juveniles	Amphipods Crabs Shrimp Small Crustacea Zooplankton
		Larvae	Barnacles Copepods Fish eggs fish larvae Scorpaenichthys marmoratus
Sebastes dalli	Calico rockfish	Adults	Amphipods Cephalopods Copepods Crabs Euphausiids Fish Molluscs
		Juveniles	barnacle cypriots Copepods fish larvae
Scorpaena guttata	California scorpionfish	Adults	Clupeids Fish isopods juvenile crab Octopi Shrimp
Raja inornata	California skate	Adults	Invertebrates Shrimp
Sebastes pinniger	Canary rockfish	Adults	Euphausiids Fish krill
Sebastes goodei	Chilipepper	Adults	Clupeids Euphausiids Merluccius productus Squids
		Juveniles	Copepods Euphausiids
		Larvae	Copepods Euphausiids
Sebastes nebulosus	China rockfish	Adults	Brittle Stars Chitons Crab larvae Crabs Fish Octopi Shrimp
		Juveniles	barnacle cypriots Crustaceans
		Larvae	Copepods invertebrate eggs Invertebrate nauplii

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Sebastes caurinus	Copper rockfish	Adults	Crustaceans Fish Molluscs Shrimp
		Juveniles	Amphipods Crabs Euphausiids Fish Octopi Shrimp Squids
Sebastes levis	Cowcod	Adults	Fish Octopi Squids
		Juveniles	Crabs Shrimp
Pleuronichthys decurrens	Curlfin sole	Adults	Crustacean eggs Echiurid proboscises Nudibranchs polychaetes
Sebastes crameri	Darkblotched rockfish	Adults	Amphipods Euphausiids Octopi salps Shrimp Small fishes Squids
Microstomus pacificus	Dover sole	Adults	Amphipods Brittle Stars Molluscs polychaetes
		Juveniles	Amphipods Brittle Stars Molluscs polychaetes
		Larvae	Copepod eggs Copepod nauplii Copepods
Parophrys vetulus	English sole	Adults	Amphipods Crustaceans Cumaceans Molluscs Ophiuroids polychaetes
		Juveniles	Amphipods Copepods Cumaceans Molluscs Mysids polychaetes
		Larvae	Copepod eggs Copepod nauplii Copepods

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Sebastes rubrivinctus	Flag rockfish	Adults	Crabs Fish Octopi Shrimp
Hippoglossoides elassodon	Flathead sole	Adults	Clupeids Fish Molluscs Mysids polychaetes Shrimp
		Juveniles	Amphipods Molluscs Mysids Shrimp
Sebastes carnatus	Gopher rockfish	Adults	Crabs Molluscs Rockfish Shrimp Small fishes
		Juveniles	barnacle cypriots Copepods Crabs Shrimp
		Larvae	Copepods invertebrate eggs Invertebrate nauplii
Sebastes rastrelliger	Grass rockfish	Adults	Cephalopods Crabs Crustaceans Fish gastropod Ophiodon elongatus Rockfish Salmon Scorpaenichthys marmoratus Shrimp
		Juveniles	Crustaceans
		Larvae	Copepods invertebrate eggs Invertebrate nauplii
Sebastes rosenblatti	Greenblotched rockfish	Adults	Fish Squids
		Juveniles	Amphipods Copepods Euphausiids Shrimp tunicates
Sebastes chlorostictus	Greenspotted rockfish	Adults	Euphausiids Fish tunicates

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Sebastes elongatus	Greenstriped rockfish	Adults	Copepods Euphausiids Shrimp Small fishes Squids tunicates
		Juveniles	Copepods Euphausiids Shrimp Small fishes Squids tunicates
Hexagrammos decagrammus	Kelp greenling	Adults	Brittle Stars Crabs Octopi Shrimp Small fishes Snails Worms
		Juveniles	Amphipods Brachyuran Copepod nauplii Copepods Euphausiids fish larvae
		Larvae	Amphipods Brachyuran Copepod nauplii Copepods Euphausiids fish larvae
Sebastes atrovirens	Kelp rockfish	Adults	Cephalopods gastropod Juvenile rockfish Shrimp tunicates
		Juveniles	Amphipods barnacle cypriots fish juveniles
		Larvae	Copepods invertebrate eggs Invertebrate nauplii
Triakis semifasciata	Leopard shark	Adults	Clams Crabs Fish Fish eggs Octopi polychaetes Shrimp Urechis caupo
		Juveniles	Crabs Shrimp

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Ophiodon elongatus	Lingcod	Adults	Demersal fish
			juvenile crab
			Octopi
			Squids
		Juveniles	Clupeids
			Copepods
			Shrimp
			Small Crustacea
			Small fishes
		Larvae	Amphipods
			Copepod eggs
			Copepod nauplii
			Copepods
			decapod larvae
			Euphausiids
		Eggs	gastropod
Sebastolobus altivelis	Longspine thornyhead	Adults	Crustaceans
			Fish
			Molluscs
			polychaetes
		Juveniles	Euphausiids
Sebastes serranoides	Olive rockfish	Adults	Copepods
			Crab larvae
			Fish
			Octopi
			polychaetes
			Squids
		Juveniles	barnacle cypriots
			Copepods
			Crab larvae
			fish juveniles
			Octopi
			polychaetes
			Squids
		Larvae	Copepods
			invertebrate eggs
			Invertebrate nauplii
Gadus macrocephalus	Pacific cod	Adults	Amphipods
			Crabs
			Mysids
			Sandlance
			Shrimp
			Theragra chalcogramma
		Juveniles	Amphipods
			Copepods
			Crabs
			Shrimp
		Larvae	Copepods
Antimora microlepis	Pacific flatnose	Adults	Clupeids
			Euphausiids
			Octopi
			Rockfish
			Shrimp

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Merluccius productus	Pacific hake	Adults	Amphipods Clupeids Crabs Merluccius productus Rockfish Squids
		Juveniles	Euphausiids
		Larvae	Copepod eggs Copepod nauplii Copepods
Sebastes alutus	Pacific ocean perch	Adults	Copepods Euphausiids Mysids Shrimp Small fishes Squids
		Juveniles	Copepods Euphausiids
		Larvae	Zooplankton
Coryphaenoides acrolepis	Pacific rattail (grenadie)r	Adults	Cephalopods Demersal fish
Citharichthys sordidus	Pacific sanddab	Adults	Clupeids Crab larvae Octopi Squids
		Juveniles	Amphipods Copepods Euphausiids fish juveniles Mysids Shrimp
Eopsetta jordani	Petrale sole	Adults	Eopsetta jordani Euphausiids Ophiuroids Pelagic fishes Shrimp
		Juveniles	Euphausiids Juvenile flatfish Mysids Ophiuroids Pelagic fishes Sculpins Shrimp
		Larvae	Copepod eggs Copepod nauplii Copepods

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Sebastes maliger	Quillback rockfish	Adults	Amphipods Clupeids Crabs Euphausiids fish juveniles Molluscs polychaetes Shrimp
		Juveniles	barnacle cypriots Copepods Shrimp
		Larvae	Copepods invertebrate eggs Invertebrate nauplii
Sebastes proriger	Redstripe rockfish	Adults	Clupeids fish juveniles Squids
		Juveniles	Copepod eggs Copepod nauplii Copepods Euphausiids
		Larvae	Copepod eggs Copepod nauplii Copepods Euphausiids
Glyptocephalus zachirus	Rex sole	Adults	Cumaceans Euphausiids Larvacea polychaetes
		Juveniles	Amphipods Copepods Crab larvae Euphausiids Larvacea Ostracods polychaetes
Lepidopsetta bilineata	Rock sole	Adults	echinoderms Echiurans Fish Molluscs polychaetes tunicates
		Juveniles	Amphipods Cumaceans Shrimp
		Larvae	Copepod eggs Copepod nauplii Copepods
Sebastes helvomaculatus	Rosethorn rockfish	Adults	Amphipods Copepods Euphausiids
Sebastes rosaceus	Rosy rockfish	Adults	Crabs Shrimp

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Anoplopoma fimbria	Sablefish	Adults	Clupeids Euphausiids Octopi Rockfish Shrimp
		Juveniles	Amphipods Cephalopods Copepods Demersal fish Euphausiids krill Pelagic fishes Small fishes Squids tunicates
		Larvae	Copepod eggs Copepod nauplii Copepods
Psettichthys melanostictus	Sand sole	Adults	Clupeids Crabs Fish Molluscs Mysids polychaetes Shrimp
		Juveniles	Euphausiids Molluscs Mysids polychaetes Shrimp
		Larvae	Copepod eggs Copepod nauplii Copepods
Sebastes zacentrus	Sharpchin rockfish	Adults	Amphipods Copepods Euphausiids Shrimp Small fishes
		Juveniles	Amphipods Copepods Euphausiids Shrimp Small fishes
Sebastes jordani	Shortbelly rockfish	Adults	Copepods Euphausiids
Sebastes borealis	Shortraker rockfish	Adults	Bathylagids Cephalopods Decapod crustaceans Fish Molluscs Myctophids Mysids Shrimp

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Sebastolobus alascanus	Shortspine thornyhead	Adults	Amphipods Copepods Crabs Fish polychaetes Sebastolobus alascanus Sebastolobus altivelis Shrimp
Galeorhinus galeus	Soupfin shark	Adults Juveniles	Fish Invertebrates Fish Invertebrates
Sebastes ovalis	Speckled rockfish	Adults	Amphipods Copepods Euphausiids fish juveniles
Squalus acanthias	Spiny dogfish	Adults	Invertebrates Pelagic fishes
Sebastes diploproa	Splitnose rockfish	Adults Juveniles	Euphausiids Amphipods Cladocerans Copepods
Hydrolagus colliei	Spotted ratfish	Adults Juveniles	algae Amphipods Annelids Brittle Stars Fish Hydrolagus colliei Molluscs Nudibranchs Opisthobranchs Ostracods Small Crustacea Squids algae Amphipods Annelids Brittle Stars Fish Hydrolagus colliei Molluscs Nudibranchs Opisthobranchs Ostracods Small Crustacea Squids
Sebastes hopkinsi	Squarespot rockfish	Adults	Copepods Crab larvae krill

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Platichthys stellatus	Starry flounder	Adults	Crabs fish juveniles Molluscs polychaetes
		Juveniles	Amphipods Copepods polychaetes
		Larvae	barnacle cypriots Copepod eggs Copepod nauplii Copepods Diatoms
Sebastes constellatus	Starry rockfish	Adults	Crabs fish juveniles Shrimp
Sebastes saxicola	Stripetail rockfish	Adults	Copepods Euphausiids
		Juveniles	Copepods
Sebastes nigrocinctus	Tiger rockfish	Adults	Amphipods Clupeids Crabs fish juveniles Juvenile rockfish Shrimp
		Juveniles	Amphipods
		Larvae	Amphipods Copepods
Sebastes serriceps	Treefish	Adults	Crabs fish juveniles Molluscs Shrimp
Sebastes miniatus	Vermilion rockfish	Adults	Clupeids Juvenile rockfish krill Octopi Squids
		Juveniles	Amphipods Copepods Euphausiids
Sebastes entomelas	Widow rockfish	Adults	Amphipods Copepods Euphausiids Merluccius productus salps Shrimp Squids
		Juveniles	Copepod eggs Copepods Euphausiid eggs

Table 3-2 Groundfish species and their associated prey at different life stages (continued).

Sebastes ruberrimus	Yelloweye rockfish	Adults	Clupeids Cottids Crabs Gadids Juvenile rockfish Sea Urchin Shrimp Snails
Sebastes flavidus	Yellowtail rockfish	Adults	Clupeids Euphausiids krill Merluccius productus Mysids salps Squids tunicates
		Juveniles	Clupeids Euphausiids Juvenile rockfish krill Mysids salps Squids tunicates

Source: Habitat Use Database (HUD) August 2005.

3.3.4 Predator Species

Groundfish species may be preyed upon by a number of different organisms depending on the life stage in question. The eggs of groundfish species may be consumed by various planktivores and benthic predators (e.g. gastropods, crabs, fishes, echinoderms). Larvae and juveniles are taken by sea birds, porpoises, larger life stages of groundfish, chaetognaths, and invertebrates (e.g. siphonophores, jellyfishes). Adults of managed groundfish species are preyed upon by man, sharks, marine mammals (e.g. sea lions, seals, whales, dolphins, porpoises, otters), halibut, albacore, salmon, and other larger predatory groundfishes such as cabezon, lingcod, and sablefish. These groundfish predators either occupy the same habitats as their groundfish prey or encounter those habitats in the course of hunting over larger areas of ocean territory.

There is some concern that the biological environment has been directly affected by fishing and other marine harvesting activities that remove top-level predators. For example, several recent studies have suggested that removal of whales and other marine mammals has created cascading effects throughout marine food webs. From an ecosystem perspective, human fishing activities might be viewed as large-scale predation that consumes species at a variety of trophic levels and may also affect other tropic levels directly or indirectly. Effects of fishing on species abundance, species diversity, community structure and physical environment have been described in numerous studies.

For example, top predators may be removed, resulting in increases of species lower in the food web. Fishing practices can also affect habitats, community structure and biodiversity. The cumulative effects of 100 years of West Coast groundfish fishing (and fishing for other species) have helped shape present day ecosystem structure. Forage species (including groundfish and nongroundfish) captured in the course of groundfish fishing may be removed from the environment. Top-level predator species may also be removed, resulting in increases of their prey species. Or, their competitors may increase, making it difficult to regain their previous position in the hierarchy. In either case, fishing increases the mortality rate of "unfished" populations. These and other changes could alter trophic dynamics, abundance and biodiversity of the ecosystem. It is difficult, however, to separate many of these fisheries-related changes from environmental ones.

See the Life History Appendix to the FMP and the Habitat Use Database for detailed information on the known predators of each species in the groundfish FMU.

3.4 Protected Species

Protected species fall under three overlapping categories, reflecting four mandates: the Endangered Species Act of 1973 (ESA), the Marine Mammal Protection Act of 1972 (MMPA), the Migratory Bird Treaty Act (MBTA), and Executive Order 13186. These mandates, and the species thus protected, are described below.

3.4.1 ESA-listed Species

The ESA protects species in danger of extinction throughout all or a significant part of their range and mandates the conservation of the ecosystems on which they depend. "Species" is defined by the Act to mean a species, a subspecies, or—for vertebrates only—a distinct population. Under the ESA, a species is listed as endangered if it is in danger of extinction throughout a significant portion of its range and threatened if it is likely to become an endangered species within the foreseeable future throughout all, or a significant part, of its range.

3.4.1.1 Salmon

Salmon caught in West Coast fisheries have life cycle ranges that include coastal streams and river systems from Central California to Alaska and marine waters along the U.S. and Canada seaward into the north central Pacific Ocean, including Canadian territorial waters and the high seas. Some of the more critical portions of these ranges are the freshwater spawning grounds and migration routes.

Chinook, or king salmon (*Oncorhynchus tshawytscha*), and coho, or silver salmon (*O. kisutch*), are the main species caught in Council-managed ocean salmon fisheries. In odd-numbered years, catches of pink salmon (*O. gorbuscha*) can also be significant, primarily off Washington and Oregon. NMFS issues a Biological Opinion for fisheries with a potential interaction with protected salmon species listed under the ESA that specifies the allowable take given ESA conservation constraints. Additional information on Council-managed salmon fisheries and affected stocks may be found in the most recent environmental assessment for the ocean salmon fishery, prepared each April by the Council (available upon request from Council offices).

Salmon are caught incidentally in both the at-sea and shore-based segments of the whiting fishery. This bycatch is closely monitored through an at-sea observer program and dockside sorting of shore deliveries. A salmon bycatch reduction plan has also been implemented in this fishery. Because several chinook salmon runs are listed under the ESA, bycatch of chinook salmon is a concern in the at-sea whiting fishery. In 2002, the catcher-processor fleet caught 970 chinook for a bycatch rate of 0.0235 chinook per metric ton of whiting, the non-tribal mothership fleet caught 709 chinook for a bycatch rate of 0.0269 , and the tribal whiting fishery caught 1,018 chinook for a bycatch rate of 0.467 (NMFS 2003a). Vessels supplying fish to shore-based processors caught 1,062 Chinook for a bycatch rate of 0.023 (NMFS 2003d). Table 3-3 provides the equivalent data for the years 1999-2001. It can be seen that bycatch rates both fluctuate year-to-year and differ among sectors.

The estimated coastwide bycatch of chinook in the whiting fishery, including the shore-based component, has averaged 7,067 annually since 1991. Limits on chinook bycatch in the whiting fishery were established as result of the September 27, 1993, Biological Opinion (BO) issued pursuant to the ESA. This opinion established the bycatch rate of 0.05 chinook salmon/mt of whiting with an 11,000 fish threshold for the entire whiting fishery (at-sea and shore-base sectors combined). Re-initiation of the BO is required if both the bycatch rate and bycatch limit are exceeded (NMFS 2003c). Table 3-4 shows the incidental annual catch of Chinook salmon for all sectors of the whiting fleet combined (at-sea and shore-based), from 1991 to 2001. Values in bold indicate years in which the threshold established in the biological opinion was exceeded.

3.4.1.2 Sea Turtles

Sea turtles are highly migratory, and four of the six species found in U.S. waters have been sighted off the West Coast. These are loggerhead *(Caretta caretta*), green (*Chelonia mydas)*, leatherback (*Dermochelys coriacea*), and olive ridley (*Lepidochelys olivacea*) sea turtles. Little is known about the interactions between sea turtles and West Coast fisheries. Directed fishing for sea turtles in West Coast groundfish fisheries is prohibited because of their ESA listings; however, incidental take of sea turtles by longline or trawl gear may occur. (Green, leatherback, and olive ridely sea turtles are listed as endangered; loggerheads are listed as threatened.) The management and conservation of sea turtles is shared between NMFS and the U.S. Fish and Wildlife Service (USFWS).

The following species descriptions are taken from Appendix A to the groundfish bycatch mitigation draft programmatic EIS (DPEIS) (NMFS 2004b).

<u>Loggerhead Sea Turtles</u>

Loggerhead sea turtles (*Caretta caretta)* are widespread, inhabiting shallower continental areas in the subtropical and temperate waters (Eckert 1993; MMS 1992). Their population is estimated at about 300,000 (NMFS and USFWS 1998c; Pitman 1990) and with peak abundance summer and fall off southern California (NMFS and USFWS 1998c). The loggerhead turtle is listed as a threatened species throughout its range under the ESA.

Juvenile and subadult loggerheads are omnivorous, foraging on pelagic crabs, molluscs, jellyfish, and vegetation captured at or near the surface. The maximum recorded diving depth for a loggerhead is 233 meters (Eckert 1993).

The primary fishery threats to the loggerheads in the Pacific are longline and gillnet fisheries (NMFS and USFWS 1998c).

<u>Green Sea Turtle</u>

Green sea turtles *(Chelonia mydas)* are a cosmopolitan, highly migratory species, nesting mainly in tropical and subtropical regions. Green turtles have been declining throughout the Pacific Ocean, probably due to overexploitation and habitat loss (Eckert 1993) and are listed as threatened, except for breeding populations found in Florida and the West Coast of Mexico, which are listed as endangered.

The maximum-recorded dive depth for an adult green turtle was 110 meters, while subadults routinely dive 20 m for 9 to 23 ‘, with a maximum-recorded dive of 66 ‘ (Eckert 1993). It is presumed that drift lines or surface current convergences are preferential zones due to increased densities of likely food items.

The primary green turtle nesting grounds in the eastern Pacific are located in Michoacán, Mexico, and the Galapagos Islands, Ecuador. More than 165,000 turtles were harvested from 1965 to 1977 in the Mexican Pacific. The nesting population at the two main nesting beaches in Michoacán decreased from 5,585 females in 1982 to 940 in 1984 (NMFS and USFWS 1998b).

Leatherback Sea Turtle

Leatherback sea turtles *(Dermochelys coriacea)* are distributed in most open ocean waters and range into higher latitudes than other sea turtles, as far north as Alaska (NMFS and USFWS 1998a), possibly associated with El Niño events. Leatherbacks are commonly sighted near Monterey Bay, mainly in August (Starbird et al. 1993). The leatherback turtle is listed as an endangered species under the ESA throughout its range.

Leatherbacks are the largest of the sea turtles, possibly to maintain warmer body temperature over longer time periods. Prey includes jellyfish, siphonophores, and tunicates (Eckert 1993). Leatherbacks are reported diving to depths exceeding 1000 m (Lutz and Musick 1997).

Primary threats to leatherbacks in the Pacific are the killing of nesting females and eggs at the nesting beaches and the incidental take in coastal and high seas fisheries (NMFS and USFWS 1998a).

Olive Ridley Sea turtle

Olive Ridley sea turtles *(Lepidochelys olivacea)* are the most abundant sea turtle in the Pacific basin. However, although these turtles remain relatively widespread and abundant, most nest sites support only small or moderate-scale nesting, and most populations are thought to be depleted. The olive ridley populations on the West Coast of Mexico are listed as endangered; all other populations are listed as threatened.

This sea turtle species appears to forage throughout the eastern tropical Pacific Ocean, often in large groups, or flotillas. Occasionally they are found entangled in scraps of net or other floating debris. Despite its abundance, there are surprisingly few data relating to the feeding habits of the olive ridley. However, those reports that do exist suggest that the diet in the western Atlantic and eastern Pacific includes crabs, shrimp, rock lobsters, jellyfish, and tunicates. In some parts of the world, it has been reported that the principal food is algae. Although they are generally thought to be surface feeders, olive ridleys have been caught in trawls at depths of 80 to 110 m (NMFS and USFWS 1998d).

3.4.2 Marine Mammals

The waters off Washington, Oregon, and California support a wide variety of marine mammals. Approximately 30 species, including seals and sea lions, sea otters, whales, dolphins, and porpoise, occur within the EEZ. Many marine mammal species seasonally migrate through West

Coast waters, while others are year-round residents. Table 3-6 lists marine mammal species occurring off the West Coast.

In addition to the ESA, the federal MMPA guides marine mammal species protection and conservation policy. Under the MMPA, on the West Coast NMFS is responsible for the management of cetaceans and pinnipeds, while the USFWS manages sea otters. Stock assessment reports review new information every year for strategic stocks and every three years for non-strategic stocks. (Strategic stocks are those whose human-caused mortality and injury exceeds the potential biological removal [PBR].) Marine mammals, whose abundance falls below the optimum sustainable population (OSP), are listed as "depleted" according to the MMPA.

Fisheries that interact with species listed as depleted, threatened, or endangered (Tables 3-3, 3-6 and 3-7) may be subject to management restrictions under the MMPA and ESA. NMFS publishes an annual list of fisheries in the *Federal Register* separating commercial fisheries into one of three categories based on the level of serious injury and mortality of marine mammals occurring incidentally in that fishery. The categorization of a fishery in the list of fisheries determines whether participants are subject to certain provisions of the MMPA, such as registration, observer coverage, and take reduction plan requirements. West Coast groundfish fisheries are in Category III, denoting a remote likelihood of, or no known, serious injuries or mortalities to marine mammals.

California Sea Lion

California sea lions *(Zalophus californianus)* range from British Columbia south to Tres Marias Islands off Mexico. Breeding grounds are mainly on offshore islands from the Channel Islands south into Mexico. Breeding takes place in June and early July within a few days after the females give birth. NMFS conducts annual pup censuses at established rookeries (Lowry 1999) and uses a correction factor to obtain a total estimated population of 214,000 sea lions (Carretta et al. 2001). The stock appears to be increasing at about 6.2% per year while fishery mortality also is increasing (Lowry et al. 1992). California sea lions are not endangered or threatened under the Endangered Species Act (ESA) nor depleted under the MMPA. This stock is also not listed as strategic under the MMPA and total human-caused mortality (1,352 sea lions) is less than the 6,591 sea lions allowed under the Potential Biological Removal formula (Carretta et al. 2001).

During the summer breeding season, most adults are present near rookeries principally located on the southern California Channel Islands and Nuevo Island near Monterey Bay. Males migrate northward in the fall, going as far north as Alaska and returning to their rookeries in the spring. Adult females generally do not migrate far away from rookery areas. Juveniles remain near rookery areas or move into waters off central California. Diet studies indicate that California sea lions feed on squid, octopus, and a variety of fishes: anchovies, sardine, mackerel, herring, rockfish, hake, and salmon (Antonelis et al. 1984; Lowry et al. 1990; NMFS 1997).

Incidental mortalities of California sea lions have been documented in set and drift gillnet fisheries (Carretta et al. 2001; Hanan et al. 1993). Skippers' logs and at-sea observations have shown that California sea lions have been incidentally killed in Washington, Oregon, and California groundfish trawls and during Washington, Oregon, and California commercial passenger fishing vessel fishing activities (Carretta et al. 2001).

Harbor Seal

Harbor seals *(Phoca vitulina richardsi*) inhabit nearshore and estuarine areas ranging from Baja California, Mexico, to the Pribilof Islands, Alaska. MMPA stock assessment reports recognize six stocks along the U.S. West Coast: California, Oregon/ Washington outer coastal waters, Washington inland waters, and three stocks in Alaska coastal and inland waters (Carretta et al. 2001). Using the latest complete aerial survey (Hanan 1996) and appropriate corrections for counting bias, Carretta, et al. (2001) estimates the California stock at 30,293 seals, the Oregon/ Washington Coast stock at 26,180 seals, and the Washington inland-water stock at 16,056 seals. These estimates combine for a West Coast total of 72,529 seals. The population appears to be growing and fishery mortality is declining. Harbor seals are not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as strategic under the MMPA and total human-caused mortality (666 seals) is less than the 1,678 harbor seals allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Harbor seals do not migrate extensively, but have been documented to move along the coast between feeding and breeding locations (Brown 1988; Herder 1986; Jeffries 1985). The harbor seal diet includes herring, flounder, sculpin, cephalopods, whelks, shrimp, and amphipods (Bigg 1981; NMFS 1997).

Combining mortality estimates from California set net, northern Washington marine set gillnet, and groundfish trawl results in an estimated mean mortality rate in observed groundfish fisheries of 667 harbor seals per year along Washington, Oregon, and California (Carretta et al. 2001).

Northern Elephant Seal

Northern elephant seals *(Mirounga angustirostris*) range from Mexico to the Gulf of Alaska. Breeding and whelping occurs in California and Baja California, during winter and early spring (Stewart and Huber 1993) on islands and recently at some mainland sites. Stewart et al. (1994) estimated the population at 127,000 elephant seals in the U.S. and Mexico during 1991. The population is growing and fishery mortality may be declining, and the number of pups born may be leveling off in California during the last five years (Carretta et al. 2001). Northern elephant seals are not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as strategic under the MMPA and total human-caused mortality (33 seals) is less than the 2,142 elephant seals allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Northern elephant seals are polygynous breeders with males forming harems and defending them against other mature males in spectacular battles on the beach. Female give birth in December and January, mate about three weeks later, after which the pups are weaned (Reeves et al. 2002). They were hunted for their oil to near extinction and the current population is composed of the descendants of a few hundred seals that survived off Mexico (Stewart et al. 1994). They feed mainly at night in very deep water, consuming whiting, hake, skates, rays, sharks, cephalopods, shrimp, euphasiids, and pelagic red crab (Antonelis et al. 1987). Males feed in waters off Alaska, and females off Oregon and California (Le Boeuf et al. 1993; Stewart and Huber 1993).

There are no recent estimated incidental kills of Northern elephant seals in groundfish fisheries along Washington, Oregon, and California; however, they have been caught in setnet fisheries (Carretta et al. 2001).

Guadalupe Fur Seal

The historical distribution and abundance of the Guadalupe fur seal *(Arctocephalus townsendi)* are uncertain because commercial sealers and other observers failed to distinguish between this species and northern fur seals. However, the species likely ranged from Islas Revillagigedo, Mexico (18º N) to Point Conception, California (34º N latitude) and possibly as far north as the Farallon Islands, California (37º N). At the present time, this species ranges from Cedros Island, Mexico, to the northern Channel Islands. Remains have been found in Indian trash middens throughout the southern California bight and individual seals frequent Channel Island sea lion colonies (Stewart et al. 1987). This species was once thought to be extinct; however, Gallo (1994) estimated a total of about 7,408 animals in 1993, and a growth rate of about 13.7% per year (Carretta et al. 2001). Guadalupe fur seals are protected under Mexican law (Guadalupe Island is a marine sanctuary), the U.S. MMPA (depleted and strategic), the U.S. ESA (threatened), the California Fish and Game Code (fully protected), and the California Fish and Game Commission (threatened).

In 1892, only seven of these seals could be found; they were presumed extinct until 1926, when a group of 60 animals was discovered on Isla de Guadalupe, Mexico (Hubbs and Wick 1951). Although the primary breeding colony is on Guadalupe Island, Mexico, a pup was born at San Miguel Island, California (Melin and DeLong 1999). Males defend territories during May through July and mate with the females approximately one week after the birth of single pups. Guadalupe fur seals are reported to feed on fish including hake, rockfish, and cephalopods (Fleischer 1987) and probably require about 10% of their own body weight in fish per day.

There have been no U.S. reports of mortalities or injuries for Guadalupe fur seals (Cameron and Forney 1999; Julian 1997; Julian and Beeson 1998), although there have been reports of stranded animals with net abrasions and imbedded fish hooks (Hanni et al. 1997).

Northern Fur Seal

Northern fur seals *(Callorhinus ursinus)* range in the eastern north Pacific Ocean, from southern California to the Bering Sea. Two separate stocks of northern fur seals are recognized within U.S. waters: an Eastern Pacific stock and a San Miguel Island stock. Nearly hunted to extinction for its fur, the San Miguel Island stock is estimated at 4,336 seals (Carretta et al. 2001) and the Eastern Pacific stock at 941,756 seals (Angliss and Lodge 2002). The San Miguel Island stock is not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as strategic under the MMPA and total human-caused mortality (zero seals) is less than the 100 fur seals allowed under the Potential Biological Removal formula (Carretta et al. 2001). "The Eastern Pacific stock is classified as strategic because it is designated as depleted under the MMPA" (Angliss and Lodge 2002).

Prior to harvesting, northern fur seal populations were mainly located on the Pribilof Islands of Alaska, and were estimated at two million animals. Northern fur seals were harvested commercially from the 1700s to 1984. San Miguel Island is the only place in California where northern fur seals breed and pup. Offshore, they dive to depths of 20 to 130 m, usually at night, to feed opportunistically on pollock, herring, lantern fish, cod, rockfish, squid, loons, and petrels (Fiscus 1978; Gentry 1981; Kajimura 1984; Kooyman et al. 1976).

Fur seals are a pelagic species spending many months at sea migrating throughout the eastern North Pacific Ocean including off Oregon and California (Roppel 1984). There were no reported mortalities of northern fur seals in any observed fishery along the West Coast of the continental

U.S. during the period 1994-1998 (Carretta et al. 2001), although there were incidental mortalities in trawl and gillnet fisheries off Alaska (Angliss and Lodge 2002).

Northern or Steller Sea Lion

The northern or Steller sea lion *(Eumetopias jubatus*) ranges along the North Pacific Ocean from Japan to California (Loughlin et al. 1984). Two stocks are designated in U.S. waters with the eastern stock extending from Cape Suckling, Alaska to southern California (Loughlin 1997). The eastern stock of Steller sea lion has a threatened listing under the ESA, depleted under the MMPA, and therefore is classified as a strategic stock (Angliss and Lodge 2002).

They do not make large migrations, but disperse after the breeding season (late May-early July), feeding on rockfish, sculpin, capelin, flatfish, squid, octopus, shrimp, crabs, and northern fur seals (Fiscus and Baines 1966).

Eastern stock Steller sea lions were observed taken incidentally in West Coast groundfish trawls and marine set gillnet fisheries (Angliss and Lodge 2002). Total estimated mortalities of this stock (44) is less than the 1,396 Steller sea lions allowed under the Potential Biological Removal formula (Angliss and Lodge 2002).

Southern Sea Otter

Southern sea otters *(Enhydra lutris nereis*) range along the mainland coast from Half Moon Bay, San Mateo County south to Gaviota, Santa Barbara County; an experimental population currently exists at San Nicolas Island, Ventura County (VanBlaricom and Ames 2001). Prior to the harvest that drove the population to near extinction, sea otters ranged from Oregon to Punta Abreojos, Baja California, Mexico (Wilson et al. 1991). The 2002 spring survey of 2,139 California sea otters reflects an overall decrease of 1.0% from the 2001 spring survey of 2,161 individuals, according to scientists at the U.S. Geological Survey. Observers recorded 1,846 independents in 2002 (adults and subadults), down 0.9% from the 2001 count of 1,863 independents; 293 pups were counted in 2002, down by 1.7% from the 2001 count of 298 pups (USGS 2002). The U.S. Fish and Wildlife Service declared the southern sea otter a threatened species in 1977 under the ESA and therefore the stock is also designated as depleted under the MMPA (VanBlaricom and Ames 2001).

Harvest for their fur reduced the sea otter population to very few animals and presumed extinction until California Department of Fish and Game biologists and wardens discovered a remnant group near Point Sur. In 1914, the total California population was estimated to be about 50 animals (CDFG 1976). Sea otters eat large-bodied bottom dwelling invertebrates such as sea urchins, crabs, clams, mussels, abalone, other shellfish, as well as market squid. Otters can dive up to 320 feet to forage (VanBlaricom and Ames 2001).

During the 1970s and 1980s considerable numbers of sea otters were observed caught in gill and trammel entangling nets in central California. This was projected as a significant source of mortality for the stock until gillnets were prohibited within their feeding range. During 1982 to 1984 an average of 80 sea otters were estimated to drown in gill and trammel nets (Wendell et al. 1986). More recent mortality data (Pattison et al. 1997) suggest similar patterns during a period of increasing trap and pot fishing for groundfish and crabs (Estes et al. In Press). This elevated mortality appears to be the main reason for both sluggish population growth and periods of decline in the California sea otter population (Estes et al. In Press).

Sea Otter

Sea otters *(Enhydra lutris kenyoni,* Washington stock) range from Pillar Point south to Destruction Island. In an effort to return the extirpated sea otters to Washington State waters, otters were transplanted from Amchitka Island, Alaska in 1969 and 1970; 59 otters were introduced (Jameson et al. 1982). The experiment worked, sea otter numbers increased, and they are re-occupying former range (Richardson and Allen 2000). The highest count for the 2001 survey was 555 sea otters, an increase of 10% from 2000 (USGS 2002). The rate of increase for this population since 1989 is about 8.8%. The Washington sea otter has no formal Federal listing under ESA or MMPA but is designated as endangered by the State of Washington.

Sea otters eat bottom dwelling invertebrates such as sea urchins, crabs, sea cucumbers, clams, mussels, abalone, and other shellfish, as well as market squid. Otters can dive up to 320 feet to forage (VanBlaricom and Ames 2001).

Gillnet and trammel net entanglements were a significant source of mortality for southern sea otters (Wendell et al. 1986) and some sea otters were taken incidentally in setnets off Washington (Kajimura 1990). Evidence from California and Alaska suggests that incidental take of sea otter in crab pots and tribal set-net fisheries may also occur. Sea otters are also quite vulnerable to oil spills due to oiled fur interfering with thermoregulation, ingested oil disintegrating the intestinal track, and inhaled fumes eroding the lungs (Richardson and Allen 2000).

Harbor Porpoise

Harbor porpoises *(Phocoena phocoena*) are small and inconspicuous. They range in nearshore waters from Point Conception, California, into Alaska and do not make large scale migrations (Gaskin 1984). Harbor porpoise in California are split into two separate stocks based on fisheries interactions: the central California stock, Point Conception to the Russian River, and the northern California stock in the remainder of northern California (Barlow and Hanan 1995). Oregon and Washington harbor porpoise are combined into a coastal stock and an inland Washington stock is also designated for inland waterways. The most recent abundance estimates, based on aerial surveys are 7,579 in central California, 15,198 in northern California, 44, 644 in Oregon/Washington coastal, and 3,509 in inland Washington. There are no clear trends in abundance for these stocks (Carretta et al. 2001). Harbor porpoise are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. "The average annual mortality for 1996-99 (80 harbor porpoise) is greater than the calculated PBR (56) for central California harbor porpoise; therefore, the central California harbor porpoise population is strategic under the MMPA" (Carretta et al. 2001).

Although usually found in nearshore waters, "distinct seasonal changes in abundance along the West Coast have been noted, and attributed to possible shifts in distribution to deeper offshore waters during late winter" (Barlow 1988; Carretta et al. 2001; Dohl et al. 1983). The harbor porpoise diet is mainly composed of cephalopods and fishes, and they prefer schooling non-spiny fishes, such as herrings, mackerels, and sardines (Reeves et al. 2002).

Harbor porpoise are very susceptible to incidental capture and mortalities in setnet fisheries (Julian and Beeson 1998). Off Oregon and Washington, fishery mortalities of harbor porpoise have been recorded in the northern Washington marine set and drift gillnet fisheries (Carretta et al. 2001).

Dall's Porpoise

Dall's porpoises *(Phocoenoides dalli*) are common in shelf, slope and offshore waters in the northeastern Pacific Ocean down to southern California (Morejohn 1979). As a deep-water oceanic porpoise, they are often sighted nearshore over deep-water canyons. These porpoise are abundant and widely distributed, with at least 50,000 off California, Oregon, and Washington; however, because of their habit of approaching vessels at sea, it may be difficult to obtain an unbiased estimate of abundance (Reeves et al. 2002). They are not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as strategic under the MMPA and total human-caused mortality (12) is less than the 737 porpoise allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Dall's porpoise calf between spring and fall after a 10 to 11 month gestation period (Reeves et al. 2002). Carretta, et al. (2001) observe that "north-south movement between California, Oregon and Washington occurs as oceanographic conditions change, both on seasonal and inter-annual time scales." Dall's porpoise feed on squid, crustaceans, and many kinds of fish including jack mackerel (Leatherwood et al. 1982; Scheffer 1953).

There is a harpoon fishery for Dall's porpoise in Japan where large numbers are killed (Reeves et al. 2002). Observers document that Dall's porpoise have been caught in the California, Oregon, and Washington domestic groundfish trawl fisheries (Perez and Loughlin 1991) but the estimated annual take is less than two porpoise per year.

Pacific White-Sided Dolphin

Pacific white-sided dolphins *(Lagenorhynchus obliquidens*) are abundant, gregarious and found in the cold temperate waters of the North Pacific Ocean. Along the West Coast of north America they are rarely observed south of Baja California, Mexico. Aerial surveys have exceeded 100,000 white-sided dolphins over the California continental shelf and slope waters (Reeves et al. 2002). These dolphins are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (seven) is less than the 157 dolphins allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Little is known of their reproductive biology, although a 29-year-old pregnant female is reported, indicating a relatively long reproductive span (Reeves et al. 2002). White-sided dolphins inhabit California waters during winter months moving northward into Oregon and Washington during spring and summer (Green et al. 1992). Shifts in abundance likely represent changes in prey abundance or migration of prey species. They are opportunistic feeders and often work collectively to concentrate and feed small schooling fish, including anchovies, hakes, herrings, sardines, and octopus.

Observers have documented mortalities in the California, Oregon, and Washington groundfish trawl fisheries for whiting (Perez and Loughlin 1991). The total estimated kill of white-sided dolphins in these fisheries averages less than one dolphin per year (Carretta et al. 2001).

Risso's Dolphin

Risso's dolphins (*Grampus griseus*) have worldwide distribution in warm-temperate waters of the upper continental slope in waters depths averaging 1,000 feet. They commonly move into shallow areas in pursuit of squid (Reeves et al. 2002). Reeves et al. (2002) also report up to

30,000 Risso's dolphins off the U.S. West Coast. They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (six) is less than the 105 dolphins allowed under the Potential Biological Removal formula (Carretta et al. 2001).

The reproductive biology of this species is not well known. Risso's dolphins feed at night on fish, octopus and squid, but they concentrate on squid. They are usually observed in groups of 10-40 animals and may form loose aggregations of 100 to 200 animals (Reeves et al. 2002). It has been speculated that changes in ecological conditions and an El Niño event off southern California may have resulted in this species filling a niche previously occupied by pilot whales (Reeves et al. 2002).

There have been no recent Risso's dolphin moralities in West Coast groundfish fisheries (Carretta et al. 2001), although Reeves et al. (2002) report that Risso's are a bycatch in some longline and trawl fisheries.

Short-Beaked Common Dolphin

Short-beaked common dolphins *(Delphinus delphis)* commonly inhabit tropical and warm temperate oceans. Their distribution along the U.S. West Coast extends from southern California to Chile and westward to 135º W longitude (Reeves et al. 2002). "The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 373,573 short-beaked common dolphins" (Barlow 1997; Carretta et al. 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (79) is less than the 3,188 dolphins allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Reproductive activity is non-seasonal in tropical waters calving peaks in spring and summer in more temperate waters (Reeves et al. 2002). Short-beaked common dolphins feed nearshore on squid, octopus, and schooling fish like anchovies, hake, lantern fish, deep-sea smelt or herring. These dolphins are often seen in very large schools of hundreds or thousands and are active bow riders.

Common dolphin mortality has been estimated for set gillnets in California (Julian and Beeson 1998); however, the two species (short-beaked and long-beaked) were not reported separately. Reeves et al. (2002) relate that short-beaked common dolphins are also a bycatch in some trawl fisheries.

Long-Beaked Common Dolphin

Long-beaked common dolphins *(Delphinus capensis)* were recognized as a distinct species in 1994 (Heyning and Perrin 1994; Rosel et al. 1995). Their distribution overlaps with the short-beaked common dolphin, although they are more typically observed in nearshore waters. "The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 32,239 long-beaked common dolphins" (Barlow 1997; Carretta et al. 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (14) is less than the 250 dolphins allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Reproductive activity is similar to short-beaked: non-seasonal in tropical waters spring and summer peaks in more temperate waters (Reeves et al. 2002). Long-beaked common dolphins feed nearshore on squid, octopus, and schooling fish like anchovies or herring. They are also active bow riders and break the water surface frequently when swimming in groups averaging 200 animals.

Common dolphin mortality has been estimated for set gillnets in California (Julian and Beeson 1998); however, short-beaked and long-beaked dolphin mortalities were not reported separately. Reeves et al. (2002) relate that long-beaked common dolphins are also a bycatch in some trawl fisheries.

Short-Finned Pilot Whale

Short-finned pilot whales *(Globicephala macrorhynchus*) favor a tropical and warm temperate distribution and are considered abundant (Reeves et al. 2002). They were common to Southern California, especially the isthmus of Santa Catalina Island during the winter (Dohl et al. 1983). However, following the 1982-83 El Niño they have been rarely observed (Barlow 1997). "The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on three ship surveys is 970 short-finned pilot whales" (Barlow 1997; Carretta et al. 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (three) is less than the six short-finned pilot whales allowed under the Potential Biological Removal formula (Carretta et al. 2001).
They form social groups of 15- 50 individuals often traveling in long lines two to three animals wide. A typical sex ratio is one mature male to eight mature females; mating occurs in August through January with a 15-month gestation period (Reeves et al. 2002).

Short-finned pilot whales feed somewhat exclusively on market squid, Loligo opalescens, and were believed by fishermen to significantly compete with squid purse seine operations off Southern California. There were many records and observations of short-finned pilot whale shootings by fishermen (Heyning and Perrin 1994; Miller et al. 1983). Although the squid fishery has become the largest fishery in California since 1992 (Vojkovich 1998), coinciding with reduced short-finned pilot whales numbers, there have been no recent reports of mortalities in this fishery (Carretta et al. 2001).

Gray Whale

The gray whale *(Eschrichtius robustus*) is represented as the Eastern Pacific stock along the West Coast of North America. Currently, the population is estimated at about 26,000 whales (Reeves et al. 2002) with rates of increase just above 2% (Angliss and Lodge 2002). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (48) is less than the 432 gray whales allowed under the Potential Biological Removal formula (Angliss and Lodge 2002).

Gray whales breed as they migrate through warmer waters; gestation lasts 12 to 13 months with females calving every 2 to 3 years (Reeves et al. 2002). At 5,000 miles, their migration from summer feeding grounds in the waters of Alaska to calving areas in bays and estuaries of Baja California, Mexico, is one of the longest for any mammal. The Eastern North Pacific stock feeds by filtering from the bottom sediments small, bottom-dwelling amphipods, crustaceans, and polychaete worms off Alaska during summer months (Rice and Wolman 1971).

The Eastern Pacific gray whale stock was removed from the ESA List of Endangered and Threatened Wildlife in 1994. They have been an incidental catch in set net fisheries, but there have been no recent takes in groundfish fisheries (Angliss and Lodge 2002).

Minke Whale

Minke whales *(Balaenoptera acutorostrata*) are one of the most widely distributed of baleen whales, ranging from South America to Alaska. For management, NMFS recognizes a California, Oregon, and Washington stock within the EEZ. "The number of minke whales is estimated as 631 (CV = 0.45) based on ship surveys in 1991, 1993, and 1996 off California and in 1996 off Oregon and Washington" (Barlow 1997; Carretta et al. 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (zero) is less than the four minke whales allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Little is known of their reproductive biology; presumably they calve in winter in tropical waters after about a ten-month gestation (Reeves et al. 2002). They are the smallest of the rorqual whales and only the pygmy right whale is smaller. Some migrate as far north as the ice edge in summer. The diet of Minke whales consists of plankton, krill, and small fish, including schools of sardines, anchovies and herring.

They have occasionally been caught in coastal gillnets off California (Hanan et al. 1993), in salmon drift gillnet in Puget Sound, Washington, and in drift gillnets off California and Oregon (Carretta et al. 2001). There have been no recent takes in groundfish fisheries off California, Oregon, or Washington (Carretta et al. 2001).

Sperm Whale

Sperm whales occur throughout the oceans and seas of the world near canyons and the continental slope. They are observed along the coasts of Oregon, and Washington (Carretta et al. 2001; Dohl et al. 1983). "Recently, a combined visual and acoustic line-transect survey conducted in the eastern temperate North Pacific in spring 1997 resulted in estimates of 24,000 (CV=0.46) sperm whales based on visual sightings, and 39,200 (CV=0.60) based acoustic detections and visual group size estimates" (Carretta et al. 2001). Sperm whales are ESA listed as endangered; therefore, this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (1.7 whales) is less than the 2.1 sperm whales allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Mating occurs in the spring, and the calving interval is a minimum of four to six years. Combined with a gestation period of 18 months, this results in extremely low population growth rates (Reeves et al. 2002). All age classes and both sexes move throughout tropical waters, while males range farther and farther from the equator. Sperm whales feed near the ocean bottom, diving as deep as one mile to eat large squid (including giant squid), octopuses, rays, sharks, and fish (Reeves et al. 2002).

There are no recent observations of sperm whale incidental catches in West Coast groundfish fisheries.

Humpback Whale

Humpback whales *(Megaptera novaeangliae)* have a worldwide distribution and along Washington, Oregon, and California. NMFS recognizes the eastern North Pacific stock which is observed frequently in coastal areas. "The North Pacific total now almost certainly exceeds 6,000 humpback whales" (Calambokidis et al. 1997; Carretta et al. 2001). Humpback whales are ESA listed as endangered; therefore, this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (>0.2 whales) is less than the 1.9 whales allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Male humpback whale songs are one of the most famous breeding behaviors of all the marine mammals. They breed during winter with a two to three year gestation and calving in the tropics (Reeves et al. 2002). Their migrations can be as long as 5,000 miles (one way) from the higher latitude feeding grounds to the tropics for breeding and calving. They feed on krill and pelagic schooling fish.

There are no recent observations of humpback whale incidental catches in West Coast groundfish fisheries.

Blue Whale

The blue whale *(Balaenoptera musculus*) is the largest animal ever to exist on this planet. They inhabit most oceans and seas of the world. The eastern north Pacific stock summers off California to feed and migrates as far south as the Costa Rica Dome. "The best estimate of blue whale abundance is the average of the line transect and mark-recapture estimates, weighted by their variances, or 1,940" (Carretta et al. 2001) whales in this stock. Blue whales are ESA listed as endangered; therefore, this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (zero whales) is less than the 1.7 whales allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Blue whale mating is unknown but calving takes place in winter after an eleven-month gestation. Calving interval is about two to three years. They feed on krill and possibly pelagic crabs (Reeves et al. 2002).

There are no recent observations of blue whale incidental catches in West Coast groundfish fisheries.

Fin Whale

Fin whales *(Balaenoptera physalus)* occur in the major oceans of the world and tend to be more prominent in temperate and polar waters. The California, Oregon, and Washington Stock was estimated at 1,851 fin whales, based on ship surveys in summer/autumn of 1993 and 1996 (Barlow and Taylor 2001). Fin whales are ESA listed as endangered; therefore, this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (1.5 whales) is less than the 3.2 whales allowed under the Potential Biological Removal formula (Carretta et al. 2001).

Little is known of their reproductive behavior, breeding, or calving areas. The female calving cycle is two to three years with an eleven or twelve-month gestation period following winter breeding. They probably do not make large-scale migrations and feed on krill and small pelagic fish such as herring (Reeves et al. 2002).

There are no recent observations of fin whale incidental catches in West Coast groundfish fisheries.

Killer Whale

Killer whales *(Orcinus orca*) inhabit most oceans and seas without respect to water temperature or depth, but are more prevalent in the higher colder latitudes (Reeves et al. 2002). Off Washington, Oregon, and California three stocks are recognized, based on behavior, photographic identification, and genetics differences. Those stocks are: Eastern North Pacific Offshore Stock, Eastern North Pacific Transient Stock, and Eastern North Pacific Southern Transient Stock (Carretta et al. 2001). "Based on summer/fall shipboard line-transect surveys in 1991, 1993 and 1996 (Barlow 1997), the total number of killer whales within 300 nm of the coasts of California, Oregon and Washington was recently estimated to be 819 animals. There is currently no way to reliably distinguish the different stocks of killer whales from sightings at sea..." (Carretta et al. 2001). Killer whales are not listed as endangered or threatened under the ESA nor depleted under the MMPA. None of the three stocks is listed as strategic under the MMPA and total human-caused mortality is less than that allowed under the Potential Biological Removal formula (Carretta et al. 2001).

A coalition of environmental groups recently filed a petition to protect the southern population of resident killer whales under the ESA. (This population lives in both U.S. and Canadian waters.) In June 2002, NMFS ruled this population of killer whales does not merit protection under the ESA. NMFS said the stock met two criteria: that it was a separate group and that it was in danger of extinction. But the third criteria—that of being a "significant" group—was not met because the southern population is considered part of the general killer whale population in the North Pacific, which is considered healthy. NMFS favors depleted status, with some protections under the MMPA. In December 2002, environmental groups filed a lawsuit on agency's ruling.

Killer whales give birth in all months with the peak in calving during winter. Movement seems to track prey items; along the West Coast, movements from Southeast Alaska to central California are documented (Goley and Straley 1994). Resident killer whales feed on fish, including salmon, and other large bodied fish. Transient killer whales feed on other marine mammals including sea otters, seals, porpoise, and baleen whales (Baird 2000). Offshore killer whales probably feed on squid and fish.

The only incidental take recorded by groundfish fishery observers was in the Bering Sea/Aleutian Islands (BSAI) groundfish trawl fishery (Carretta et al. 2001). There are also reports of interactions between killer whales and longline vessels (Perez and Loughlin 1991). (Longline fishers in the Aleutian Islands reported several cases where orcas removed sablefish from longlines as the gear was retrieved.) There are no other reports of killer whale takes in West Coast groundfish fisheries (Carretta et al. 2001).

Sei Whale

Sei whales *(Balaenoptera borealis)* occur in subtropical and tropical waters and into the higher latitudes, occupying both oceanic and coastal waters. "Seis are known worldwide for their unpredictable occurrences, with a sudden influx into an area followed by disappearance and subsequent absence for years or even decades" (Reeves et al. 2002). They are rare off Washington, Oregon, and California and there are no estimates of abundance or population trends for this stock. Sei whales in the eastern North Pacific (east of 180° W longitude) are considered a separate stock and listed as endangered under the ESA. Consequently, the eastern North Pacific stock is automatically considered as a depleted and strategic stock under the MMPA (Carretta et al. 2001).

Sei whales usually travel alone or in small groups and little is known of their behavior. They breed and calve in winter after an 11 to 12 month gestation. They forage on small fish, squid, krill, and copepods.

There are no observations of sei whale incidental catches in West Coast fisheries, therefore no estimated groundfish fishery related losses.

Common Bottlenose Dolphin

Common bottlenose dolphins *(Tursiops truncatus)* are distributed worldwide in tropical and warm-temperate waters. For the MMPA stock assessment reports, bottlenose dolphins within the Pacific U.S. EEZ are divided into three stocks: California coastal stock; California, Oregon, and Washington offshore stock; and Hawaiian stock.

California coastal bottlenose dolphins are found within about one kilometer of shore, primarily from Point Conception south into Mexican waters. El Niño events appear to influence the distribution of animals along the California coast; since the 1982-83 El Niño they have been consistently sighted in central California as far north as San Francisco. Studies have documented north-south movements of coastal bottlenose dolphins (Defran et al. 1999; Hansen 1990). Coastal bottlenose dolphins spend an unknown amount of time in Mexican waters, where they are subject to mortality in Mexican fisheries. The best estimate of the average number of coastal bottlenose dolphins in U.S. waters is 169, based on two surveys conducted in 1994 and 1999 that covered virtually the entire U.S. range of this species. The minimum population size estimate for U.S. waters is 154 coastal bottlenose dolphins. The PBR level for this stock is 1.5 coastal bottlenose dolphins per year. This is calculated by multiplying the minimum population size by one half the default maximum net growth rate for cetaceans (half of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality (Wade and Angliss 1997).

Due to its exclusive use of coastal habitats, this bottlenose dolphin population is susceptible to fishery-related mortality in coastal set net fisheries. However, from 1991 to 1994 observers saw no bottlenose dolphins taken in this fishery, and in 1994 the Sate of California banned coastal set gillnet fishing within 3 nm of the Southern California coast. In central California, set gillnets have been restricted to waters deeper than 30 fathoms (56 m) since 1991 in all areas except between Point Sal and Point Arguello. These closures greatly reduced the potential for mortality of coastal bottlenose dolphins in the California set gillnet fishery. Coastal gillnet fisheries are still conducted in Mexico and probably take animals from this population, but no details are available.

Coastal bottlenose dolphins are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. Because no recent fishery takes have been documented, coastal bottlenose dolphins are not classified as a strategic stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

California/Oregon/Washington Offshore Stock: On surveys conducted off California, offshore bottlenose dolphins have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight. They have also been documented in offshore waters as far north as about 41º N latitude, and they may range into Oregon and Washington waters during warm water periods. Sighting records off California and Baja California, Mexico (Lee 1993; Mangels and Gerrodette 1994) suggest that offshore bottlenose dolphins have a continuous distribution in these two regions. The most comprehensive multi-year average abundance for California, Oregon, and Washington waters, based on the 1991-96 ship surveys, is 956 offshore bottlenose dolphins (Barlow 1997). The minimum population size estimate of offshore bottlenose dolphins is 850. The PBR level for this stock is 8.5 offshore bottlenose dolphins per year.

In 1997, a Take Reduction Plan for the California drift gillnet (non-groundfish) fishery was implemented, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders. Overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). Based on 1997-98 data, the estimate of offshore bottlenose dolphins taken annually in the U.S. fishery is zero. Drift gillnet fisheries for swordfish and sharks are also conducted along the entire West Coast of Baja California and may take animals from the same population.

Offshore bottlenose dolphins are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. Because no recent fishery takes have been documented, offshore bottlenose dolphins are not classified as a strategic stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

<u>Striped Dolphin</u>

Striped dolphins *(Stenella coeruleoalba)* are distributed worldwide in tropical and warm-temperate pelagic waters. For the MMPA stock assessment reports, striped dolphins within the Pacific U.S. EEZ are divided into two discrete, noncontiguous areas: 1) waters off California, Oregon, and Washington and 2) waters around Hawaii.

<u>California/Oregon/Washington Stock:</u> On recent shipboard surveys extending about 300 nm offshore of California, striped dolphins were sighted within about 100 nm to 300 nm from the coast. No sightings have been reported for Oregon and Washington waters, but striped dolphins have stranded in both states (Oregon Department of Fish and Wildlife, unpublished data; Washington Department of Fish and Wildlife, unpublished data). Striped dolphins are also commonly found in the central North Pacific, but sampling between this region and California has been insufficient to determine whether the distribution is continuous. Based on sighting records off California and Mexico, striped dolphins appear to have a continuous distribution in offshore waters of these two regions (Mangels and Gerrodette 1994; Perrin et al. 1985).

The abundance estimate for California, Oregon and Washington waters is 20,235 striped dolphins (Barlow 1997). The minimum population size estimate is 17,995. The PBR level for this stock is 180 striped dolphins per year, calculated as the minimum population size (17,995) times one half the default maximum net growth rate for cetaceans (half of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997).

Drift gillnet fisheries for swordfish and sharks conducted along the West Coast of Baja California, Mexico, may take animals from this population.

Striped dolphins are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. Including U.S. driftnet information only for years after implementation of the Take

Reduction Plan (1997-98), the average annual human-caused mortality in the years 1994 to 1998 is zero. Because recent mortality is zero, striped dolphins are not classified as a strategic stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

3.4.3 Seabirds

The highly productive California Current System, an eastern boundary current that stretches from Baja California, Mexico, to southern British Columbia, supports more than two million breeding seabirds and at least twice that number of migrant visitors. Tyler, et al. (1993) reviewed seabird distribution and abundance in relation to oceanographic processes in the California Current System and found that over 100 species have been recorded within the EEZ, including albatross, shearwaters, petrels, storm-petrels, cormorants, pelicans, gulls, terns, and alcids (murres, murrelets, guillemots, auklets, and puffins). In addition to these "classic" seabirds, millions of other birds are seasonally abundant in this oceanic habitat including: waterfowl, waterbirds (loons and grebes), and shorebirds (phalaropes). Not surprisingly, there is considerable overlap of fishing areas and areas of high bird density in this highly productive upwelling system. The species composition and abundance of birds varies spatially and temporally. The highest seabird biomass is found over the continental shelf, and bird density is highest during the spring and fall when local breeding species and migrants predominate.

The USFWS is the primary federal agency responsible for seabird conservation and management. Four species found off the West Coast are listed under the ESA, as noted in Table 3-7. In 2002, the USFWS classified several seabird species that occur off the West Coast as "Species of Conservation Concern." These species include the black-footed albatross (*Phoebastria nigripes*), ashy storm-petrel (*Oceanodroma homochroa*), gull-billed tern (*Sterna nilotica*), elegant tern (*Sterna elegans*), arctic tern (*Sterna paradisaea*), black skimmer (*Rynchops niger*), and Xantus's murrelet (*Synthliboramphus hypoleucus*).

The Migratory Bird Treaty Act (MBTA) implements various treaties and conventions between the U.S. and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful. In addition to the MBTA, an Executive Order, Responsibilities of Federal Agencies to Protect Migratory Birds (EO 13186), directs federal agencies to negotiate Memoranda of Understanding with the USFWS that would obligate agencies to evaluate the impact on migratory birds as part of any NEPA process. The USFWS and NMFS are working on a Memorandum of Understanding concerning seabirds.

Under the Magnuson-Stevens Act, NMFS must ensure fishery management actions comply with other laws designed to protect seabirds. NMFS is also required to consult with USFWS if fishery management plan actions may affect seabird species listed as endangered or threatened. Taken together, these laws and directives underscore the need to consider impacts to seabirds in decision-making and consider ways to reduce potential impacts of the proposed action. In February 2001, NMFS adopted a National Plan of Action (NPOA) to Reduce the Incidental Take of Seabirds in Longline Fisheries. This NPOA contains guidelines that are applicable to relevant groundfish fisheries and would require seabird incidental catch mitigation if a significant problem is found to exist. During the first two years of NPOA implementation, NMFS regions were tasked with assessing the incidental take of seabirds in longline fisheries. In the limited entry groundfish longline fleet off the coast of Washington, Oregon, and California during September 2001–October 2002, there were no incidental seabird takes documented by West Coast Groundfish Observers. (During the assessment period, approximately 30% of landings by the limited entry fixed gear fleet had observer coverage.)

Albatross

Albatross range extensively throughout waters off the West Coast. In particular, three albatross species, the short-tailed albatross (*Phoebastria albatrus*), the black-footed albatross (*Phoebastria nigripes*), and the Laysan albatross (*Phoebastria immutabilis*) occur in the waters off Washington, Oregon, and California.

Once considered the most common albatross ranging over the continental shelf, the short-tailed albatross was hunted to near extinction in the early 1900s and is now thought to be one of the rarest birds in the world.

Short-tailed albatross range widely in the North Pacific: breeding occurs off Japan and sightings extend from the Aleutian Islands to southern California (West Coast Groundfish Observer Program, NMFS, unpublished data, 2002). There are two known short-tailed albatross breeding colonies, one on Torishima Island and one on Minami-kojima Island, in the waters off Japan. Historical records indicate that there were over 100,000 individuals at the Torishima Island colony at the turn of the century and during 1998 and 1999 just over 400 breeding adults were found at the colony. The population on Torishima Island is now growing at an annual rate of 7.8%. The current estimate of the short-tailed albatross world population is about 1700 individuals (Hasegawa 2002 personal communication; START 2002).

The short-tailed albatross feeds at the water's surface on squid, crustaceans, and various fish species. They sometimes follow fishing vessels and feed on offal. Chicks are fed a mixture of stomach oil and partially digested food that is regurgitated; nestlings are often fed squid, flying fishes, and crustaceans. Threats to short-tailed albatross include volcanic eruptions on the primary nesting island, Torishima, incidental take in commercial fisheries, ingestion of plastic, and the potential threat of oil spills.

Much like the short-tailed albatross, the black-footed albatross ranges throughout the North Pacific. Breeding occurs in the Northwestern Hawaiian Islands and Torishima Island, and the species disperses from the Bering Sea south along the West Coast to California.

The black-footed albatross is the most numerous albatross species along the West Coast and is present throughout the year (Briggs et al. 1987). The global black-footed albatross population is estimated at about 56,500 breeding pairs and thought to be decreasing (Naughton 2003). This species is classified as vulnerable by the IUCN (International Union for the Conservation of Nature and Natural Resources) based on a 19% population decrease during 1995 to 2000 and a projected future decline of more than 20% over the next 60 years owing to interactions with longline fisheries for tuna, billfish, and groundfish in the North Pacific (2001).

Black-footed albatross fed on fish, sea urchins, amphipods, and squid; foraging is done at night and prey is caught at the ocean's surface. This species will also follow fishing vessels and feed on discard. Besides interactions with longline fisheries, other threats to black-footed albatross include nest loss due to waves, pollution, introduced predators, oiling, ingestion of plastic, and volcanic eruptions on Torishima (2001).

The most abundant North Pacific albatross species is the Laysan albatross. The vast majority of the Laysan albatross population breeds in the Northwestern Hawaiian Islands, fewer numbers breed on the Japanese Ogasawara Islands, and still fewer pairs breed on islands off Baja California, Mexico (Guadalupe Island, Alijos Rocks, and in the Revillagigedo Islands). When at sea, the Laysan albatross ranges from the Bering Sea, to California, to Japan.

The USFWS counts this species at Midway Atoll once every four years and counts or samples density at French Frigate Shoals and Laysan Island every year. These monitoring sites account for 93% of the world population of about 393,000 breeding pairs. At these three sites breeding populations have declined at an average rate of 3.2% per year since 1992. This represents a 32% decline in annual breeding attempts over a 10-year period (Naughton 2003).

Similar to the other North Pacific albatross species, Laysan albatross feed on schooling fish and squid at the ocean's surface. The primary threat to their population is interactions with fisheries.

<u>California brown pelican</u>

Brown pelicans *(Pelecanus occidentalis californicus)* range along the West Coast from British Columbia south to Central America. Historically, breeding colonies were found at Point Lobos, California, and from the Channel Islands south to Baja California, Mexico. They are found in coastal areas, on rocky shores and cliffs, in sloughs, and may also be found on breakwaters, jetties, pilings, and sandbars in harbors. While the California brown pelican still occurs throughout its original range, the breeding colonies in California, located in the Channel Islands National Park, West Anacapa Island, and the Santa Barbara Islands, are in decline (CDFG 2000).

In the 1970s, California brown pelicans were threatened with extinction by the widespread use of the pesticide DDT (dichlorodiphenyltrichloroethane). This chemical is transmitted via the food chain and becomes concentrated in top predators. DDT affects the pelican's ability to metabolize calcium, resulting in thin-shelled eggs that break during incubation. The use of DDT was banned in 1972 and the California brown pelican population subsequently began its recovery (CDFG 2000).

In the early 2000s, it was estimated that the brown pelican breeding population in California was about 9,000 adults (CDFG 2001). While the brown pelican population is thought stable, food availability is a cause for concern. Pacific mackerel, Pacific sardine, and the northern anchovy are important prey for brown pelicans, especially during the breeding season. However, commercial over-harvesting of these coastal pelagic species has reduced the quantity of prey that is available to pelicans (CDFG 2000).

The primary threats to California brown pelicans are human development in coastal regions, entanglement in abandon recreational fishing gear, and oil spills (CDFG 2000).

<u>Terns</u>

Nine species of terns occur along the West Coast, they are the arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*), black tern (*Chlidonias niger*), California least tern (*Sterna antillarum browni*), Caspian tern (*Sterna caspia*), Forster's tern (*Sterna forsteri*), gull-billed tern (*Sterna nilotica*), royal tern (*Sterna maxima*), and elegant tern (*Sterna elegans*).

The populations of most tern species found along the West Coast are stable; however, some tern species are listed under the ESA or are considered Species of Conservation Concern by the USFWS.

The range of the California least tern is limited to California and Baja California. During 1988 and 1989 in California, the population was estimated to be about 1,250 pairs. As with most species of terns, California least tern are found along seacoasts, beaches, bays, estuaries, lagoons, lakes, and rivers. Terns usually nest on open, flat beaches along lagoons or estuary margins.

California least terns usually nest in the same area during successive years and tend to return to the natal site to nest.

Terns obtain their prey by diving from the air into shallow water and their diet is predominately small fishes (e.g., anchovy, surf-perch).

Primary threats to the California least tern population, and possible threats to other tern populations, include human development of nesting habitat and predation of adults, eggs, and young by other birds and introduced mammals.

Murrelets

Four species of murrelets occur along the West Coast, they are the marbled murrelet (*Brachyramphus marmoratus*), Craveri's murrelet (*Synthliboramphus craveri*), Xantus's murrelet (*Synthliboramphus hypoleucus*), and the ancient murrelet (*Synthliboramphus antiquus*).

The marbled murrelet has an extensive range along the West Coast, extending from Alaska to California and breeding occurs throughout their range. These birds are found in coastal areas, mainly in salt water, often in bays and sounds. They are also found up to 5 km offshore and are occasionally sighted on lakes and rivers within 20 km of the coast. Most populations are dependent upon large coniferous trees in old-growth forests as suitable nesting habitat.

The marbled murrelet population has probably declined substantially throughout the region and it is estimated that 10,000 to 20,000 individuals remain (Carter et al. 1995).

The diet of marbled murrelets includes fishes (e.g., sandlance, capelin, herring), crustaceans, and mollusks. Birds may also feed exclusively on freshwater prey for several weeks. Marbled murrelets typically forage in waters up to 80 m in depth and two kilometers from shore. Birds dive to capture prey; dives may extend down 30 m below the water's surface.

The continued harvest of old growth and mature coastal coniferous forest threatens critical nesting habitat throughout the marbled murrelet range. Additional threats to this population are interactions with gillnet fisheries and oil spills.

The ancient murrelet ranges along the West Coast from Alaska to California. The estimated global population is on the order of half a million breeding pairs, with just over half found on the Queen Charlotte Islands of British Columbia. This species nests in rocky offshore islands in crevices, under rocks, at the base of trees, and in burrows. Declines in the ancient murrelet population are often attributed to the introduction of predators onto offshore islands used for breeding. Rats, raccoons, and foxes have reduced what was once the world's the largest colony (Langara Island, British Columbia) from about 200,000 pairs in 1969 to 15,000 pairs in 1994. Ancient murrelets are also threatened by food availability, which is subject to pesticide pollution, and changes in marine currents controlling local productivity.

Xantus's and Craveri's murrelets have relatively restricted ranges, when compared to other West Coast murrelets, and are primarily found in California. Both species breed on islands; the Craveri's breeds in the Gulf of California and along the western coast of Baja California, Mexico, while the Xantus's breeds on islands off central California and western Baja California.

The population of the Craveri's murrelets is estimated to be between 6,000 and 10,000 individuals. Xantus's murrelets persist in very low numbers and the breeding population is estimated to be between 2,000 and 5,000 individuals. Both species are threatened by predators introduced onto breeding islands—specifically, rats and feral cats—and oil spills, especially from offshore platforms in Santa Barbara Channel and oil tanker traffic in Los Angeles harbor Carter et al. 1995).

Northern Fulmars

Northern fulmars (*Fulmarus glacialis*) range along the West Coast from Alaska to Oregon and they are primarily pelagic.

The estimated total population of northern fulmars in the North Pacific is between 3 and 3.5 million individuals (Hatch 1993). This species primarily breeds in Alaska at colonies on sea cliffs and, less frequently, on low, flat rocky islands. Northern fulmars show strong mate and nest site fidelity (Shallenberger 1984). Nests are often raided by weasels and gulls.

Northern fulmars are surface feeders, they swim or float upon the ocean's surface while feeding on organisms found just below the surface. The diet of this species includes fishes, mollusks, crustaceans, and cephalopods. Northern fulmars have also been observed following fishing vessels, presumably to feed on offal.

Primary threats to northern fulmars are oil pollution, plastic debris, entanglement in fishing gear, and introduced predators and human disturbance on breeding islands (Hatch 1993).

Storm-Petrels

Seven species of storm-petrels occur along the West Coast, they include the black storm-petrel (*Oceanodroma melania*), fork-tailed storm-petrel (*Oceanodroma furcata*), ashy storm-petrel (*Oceanodroma homochroa*), least storm-petrel (*Oceanodroma microsoma*), Galapagos storm-petrel (*Oceanodroma tethys*), Wilson's storm-petrel (*Oceanites oceanicus*), and Leach's storm-petrel (*Oceanodroma leucorhoa*).

Populations of storm-petrel species found along the West Coast, along with the amount of information known about different populations, varies considerably. In the North Pacific, Leach's storm-petrel is the most abundant species (a conservative total population estimate is between 10 and 15 million individuals) followed by the fork-tailed storm-petrel (total population estimate is between 5 and 10 million individuals). Conversely, the populations of ashy storm-petrels (total population estimated at fewer than 10,000 individuals), black storm-petrels (population estimate ranges between 10, 000 and 100,000 individuals), and least storm-petrels (population estimate ranges between 10,000 and 50,000 individuals) may be at risk (Boersma and Groom 1993).

Storm-petrels are pelagic, spending the majority of their lives at sea and returning to land only to breed. When at the breeding colonies, storm-petrels are nocturnal, an adaptation that reduces their susceptibility to diurnal predators (e.g., gulls) (Speich and Wahl 1989). Nests are often located in burrows, rocky crevices, or grassy slopes on small coastal islands. Some species of storm-petrels nest in the same burrow in successive years (Spendelow and Patton 1988).

Storm-petrels feed at the water's surface, rarely diving beneath the surface in pursuit of food. They catch prey by "dipping and pattering," that is they hover on outstreched wings, paddle the water with their webbed feet, and dip their bills into the water (Ainley 1984b). The diet of storm-petrels includes such things as plankton, small fishes, crustaceans, and small squid.

Primary threats to storm-petrels include introduced predators on breeding islands, pesticides and contaminants, pollution, and oil spills.

Shearwaters

Eight species of shearwaters range along the West Coast, they include Townsend's shearwater (*Puffinus auricularis*), black-vented shearwater (*Puffinus opisthomelas*), wedge-tailed shearwaters (*Puffinus pacificus*), sooty shearwater (*Puffinus griseus*), short-tailed shearwater (*Puffinus tenuirostris*), pink-footed shearwater (*Puffinus creatopus*), flesh-footed shearwater (*Puffinus carneipes*), and Buller's shearwater (*Puffinus bulleri*).

The populations of most shearwater species found along the West Coast are stable; however, some shearwater populations are considered at risk by the IUCN. Many species of shearwaters move between hemispheres to take advantage of the best feeding conditions (Shallenberger 1984).

The black-vented shearwater breeds on a handful of small islands off the coast of Baja California; the wedge-tailed and Townsend's shearwater breed on islands off the coasts of Mexico and Hawaii. The five remaining species of shearwater breed in the southern hemisphere on islands off the coast of Chile, Australia, and New Zealand. Much like storm-petrels, shearwaters nest in burrows and rocky crevices and their activities at breeding colonies are largely nocturnal.

When foraging, shearwaters may feed at the water's surface, plunge from just above the water's surface, or dive to depths of 50 m. Their diet includes small fishes (e.g., northern anchovies, Pacific sardines), squid, plankton, and crustaceans.

Shearwater populations are primarily threatened by predation by feral mammals (e.g., cats, pigs, mongoose, rats) and loss of habitat on breeding islands. Other threats associated with urbanization include collisions with power lines and attraction to lights.

Cormorants

Three species of cormorants occur along the West Coast: Brandt's cormorant (*Phalacrocorax penicillatus*), double-crested cormorant (*Phalacrocorax auritus*), and pelagic cormorant (*Phalacrocorax pelagius*).

Brandt's cormorants are by far the most abundant cormorant species nesting along the coast of Oregon and California. In Washington, however, they have never been numerous or widespread (Spendelow and Patton 1988). Brant's cormorants are typically found in inshore, coastal areas, especially in areas having kelp beds, brackish bays, sheltered inlets, and quiet bays. Large numbers of birds breed in California and Oregon with fewer numbers breeding in Washington. Brandt's cormorant usually nests on offshore islands or, less frequently, on inaccessible mainland bluffs and wide cliff ledges near the water (Speich and Wahl 1989). Resident throughout the year near nesting areas, birds range more widely during non-breeding periods.

Double-crested cormorants are widespread and breeding populations along the West Coast seem to be increasing in number (Carter et al. 1995; Spendelow and Patton 1988). They can be found along seacoasts, marine islands, coastal bays, swamps, lagoons, rivers, and lakes. Double-crested cormorants nest in variety of habitats. Along the coast, they nest on offshore rocks and islands, exposed dunes, abandoned wharf timbers, and power poles. Birds nesting inland often use trees

or snags (Sowls et al. 1980; Speich and Wahl 1989). Birds are usually found within a few hours of their roosting or breeding sites (Ainley 1984a).
Breeding populations of pelagic cormorants are relatively evenly distributed from Washington to California (Spendelow and Patton 1988), and in recent years populations have been increasing in number. Pelagic cormorants occur in outer coastal habitats, bays, and inlets, especially in rock-bottom habitats and often in water less than 100 m and within 1 - 2 km of shore. These birds will often nest with other pelagic cormorants or near other species of seabirds. Nesting occurs on island cliff ledges, crevices, and in sea caves by building nests out of seaweed (Sowls et al. 1980).

Cormorants are classified as diving birds; their strong swimming ability enables them to pursue and capture their prey underwater. Their diet includes small fishes, squid, crabs, marine worms, and amphipods.

Cormorant populations are threatened by pesticides, human disturbance at nesting sites, oiling, and interactions with fisheries.

Jaegers

Three species of jaegers occur along the West Coast: the pomarine jaeger (*Stercorarius pomarinus*), parasitic jaeger (*Stercorarius parasiticus*), and long-tailed jaeger (*Stercorarius longicaudus*).

All three species of jaegers are primarily pelagic, but may be found in bays and harbors. Jaegers breed in the arctic and sub-arctic. Non-breeding birds and breeders during the non-breeding season can be found off Washington, Oregon, and California.

The diet of jaegers includes small mammals, birds, bird eggs, fishes, invertebrates, and offal from fishing vessels. Jaegers are well known for their habit of pursing other seabirds on the wing (Maher 1984), forcing the other birds to disgorge their food, and then stealing the food before it hits the ground.

Gulls

Eleven species of gulls occur along the West Coast, these include the glaucous gull (*Larus hyperboreus*), glaucous-winged gull (*Larus glaucescens*), western gull (*Larus accidentalis*), herring gull (*Larus argentatus*), California gull (*Larus californicus*), Thayer's gull (*Larus thayeri*), ring-billed gull (*Larus delawarensis*), mew gull (*Larus canus*), Heermann's gull (*Larus heermanni*), Bonaparte's gull (*Larus philadelphia*), and Sabine's gull (*Larus sabini*).

For most marine-nesting species in the North Pacific, only rough estimates of nesting populations exist and reproductive success has only been investigated for one to two years (Vermeer et al. 1993). However, it is thought that most gull populations along the West Coast are stable and not considered to be at risk.

Most gulls along the West Coast occur during the non-breeding season or are non-breeding individuals. Birds can be found at sea, along the coast, on rocky shores or cliffs, bays, estuaries, beaches, and garbage dumps. Only two species of gulls breed along the West Coast. The glaucous-winged gull has breeding colonies in British Columbia and Washington and the western gull has breeding colonies in California (most are located on the Farallon Islands), Oregon, and Washington (Drury 1984). Breeding habitat for these gulls includes coastal cliffs, rocks, grassy slopes, or offshore rock or sandbar islands.

West Coast gulls feed at the ocean's surface and their diet typically includes fishes, mollusks, crustaceans, carrion, and garbage.

Primary threats to gulls include human disturbance at nesting locations.

<u>Black-Legged Kittiwakes</u>

Black-legged kittiwakes *(Rissa tridactyla)* range along the West Coast from Alaska to Mexico (Drury 1984). While they are primarily pelagic, black-legged kittiwakes can also be found along sea coasts, bays, and estuaries.

It is estimated that there are approximately 2.6 million black-legged kittiwakes at colonies in the North Pacific. This species breeds on mainland and island sites in the Arctic and along the Aleutian islands.

Black-legged kittiwakes feed at the ocean's surface and their diet typically includes small fishes, mollusks, crustaceans, and plankton (Hatch 1993).

Primary threats to black-legged kittiwakes are unknown.

<u>Common Murres</u>

Common murres *(Uria aalge)* range along the West Coast from Alaska to central California. While they are primarily pelagic, common murres can also be found along rocky seacoasts.

Common murres are the dominant member of the breeding seabird community along the West Coast, but numbers have declined substantially in central California and Washington. In the mid-1800s, over 14 million murre eggs were harvested from Southeast Farallon Island to feed residents of the San Francisco Bay area (Manuwal 1984). The Washington population has been almost extirpated over the last decade due to a combination of oceanographic conditions, gillnets, low-flying aircrafts, and oil spills, and has not recovered. In contrast, the population of common murres in Oregon and California has been stable or increasing despite human disturbance (Carter et al. 1995). In the late 1980s, the West Coast population was estimated to be greater than 600,000 individuals. Nesting typically occurs in large, dense colonies on mainland and island cliff ledges or on rocky, low-lying islands. Common murres do not build nests but lay their eggs directly on the bare soil or rock (Spendelow and Patton 1988).

Common murres are diving birds, capturing their prey underwater, and can descend to depths of 180 m. Their diet includes fishes, squid, mysids, and shrimp.

Primary threats to common murres include predators on breeding islands, increasing sea surface temperature, oil spills, gill-net mortality, and military practice bombing activity.

<u>Pigeon Guillemots</u>

Pigeon guillemots *(Cepphus columba)* range along the West Coast from Alaska to southern California. While these birds are primarily pelagic, they can be found along rocky coasts and in bays and inlets.

In the late 1980s, the pigeon guillemot breeding population along the West Coast was estimated to be greater than 20,000 individuals. Breeding occurs along coasts, on islands, on cliffs, in rock crevices, in abandoned burrows, or they may dig their own burrows. Pigeon guillemots have a spectacular courtship behavior (Manuwal 1984) and may use the same nest in successive years (Spendelow and Patton 1988).

Pigeon guillemots forage underwater; their diet includes small fishes, and inshore benthic species, mollusks, such as crustaceans, and marine worms.

Primary threats to pigeon guillemots include introduced predators on breeding islands, inshore gillnet fisheries, and oil spills (Erwins et al. 1993).

<u>Auklets</u>

Three species of auklets occur along the West Coast: the parakeet auklet (*Aethia psittacula*), the rhinoceros auklet (*Cerorhinca monocerata*), and the Cassin's auklet (*Ptychoramphus aleuticus*).

In the eastern North Pacific, the estimated population of Cassin's auklets is over three million and the estimated population of parakeet auklets is approximately 200,000 (Springer et al. 1993). The estimated breeding population of rhinoceros auklets along the West Coast is just over 60,000 (Spendelow and Patton 1988).

Auklets are primarily pelagic; however, they are also found along rocky coasts. The parakeet auklet only breeds in Alaska, while the rhinoceros and Cassin's auklets breed on offshore islands between Alaska and Baja California. Nesting generally occurs in areas with low vegetation, in burrows, or under rocks. Some nesting sites are used in successive years. Auklets may be diurnal as well as nocturnal.

Auklets dive from the water's surface when foraging. Their diet generally includes small fishes, crustaceans, and squid.

Primary threats to auklets include introduced predators on nesting islands; long-term oceanographic changes in the California Current System, which caused a decline in zooplankton populations; and oil spills.

<u>Puffins</u>

Two species of puffins occur along the West Coast: the horned puffin (*Fratercula corniculata*) and the tufted puffin (*Fratercula cirrhata*). These colorful puffins are primarily pelagic but they can also be found along the coast (Manuwal 1984).

In the North Pacific, the estimated breeding population of tufted puffins and horned puffins is 3.5 million and 1.5 million, respectively (Byrd et al. 1993). Puffins breed on offshore islands or along the coast; nesting occurs in ground burrows, under and among rocks, and occasionally under dense vegetation. Horned puffins only nest in Alaska, while tufted puffins nest all along the West Coast from Alaska to California.

Puffins are diving birds and capture their prey underwater. Their diet includes fish, cephalopods, crustaceans, and polychaetes.

Primary threats to puffins include introduced predators on breeding islands, oil spills, and gillnet fisheries. The low numbers of tufted puffins in California may be due to oil pollution and/or declines in the sardine population.

South Polar Skuas

South polar skuas (*Stercorarius maccormicki*) range along the West Coast from Alaska to Mexico. While these birds are primarily pelagic and solitary, they can sometimes be found in small, loose groupings in and around harbors.

South polar skuas breed in and around Antarctica. Non-breeders can be found spring through fall along the West Coast.

The diet of south polar skuas is diverse (Maher 1984). At sea, they pursue foraging seabirds until the other birds relinquish their prey, as well as following fishing vessels to forage on offal. On the breeding grounds, their diet includes fish, seabirds, small mammals, krill, penguin eggs and young, and carrion.

Because south polar skuas breed in such remote locations, there are relatively few threats to the breeding population. Additionally, they are relatively immune to threats during the non-breeding season because they spend the majority of their time at sea.

Black Skimmers

Black skimmers (*Rynchops niger*) can be found in California. This species is primarily found nearshore in coastal waters including bays, estuaries, lagoons, and mudflats.

In the late 1970s to early 1980s, the estimated breeding population of black skimmers throughout the United States was about 65,000 individuals and increasing. In California, however, less than 100 breeding individuals were found (Spendelow and Patton 1988).

Nesting generally occurs near coasts on sandy beaches, shell banks, coastal and estuary islands, salt pond levees, and on dredged material sites. Black skimmers are often nesting in association with or near terns.

As their name suggests, black skimmers forage by flying low over the water and skimming food off the surface with their lower mandible. The diet primarily includes small fish and crustaceans.

Primary threats to black skimmers include predation and human disturbance on nesting islands.

Table 3-3 Protected salmon species on the West Coast with their protected species designations.

Species and Stock	Scientific Name
Salmon species listed as endangered under the ESA	
Chinook salmon- Sacramento River Winter; Upper Columbia Spring	*Oncorhynchus tshawytscha*
Sockeye salmon- Snake River	*Oncorhynchus nerka*
Steelhead- Southern California; Upper Columbia	*Oncorhynchus mykiss*
Salmon species listed as threatened under the ESA	

Coho salmon- Central California, Southern Oregon, and Northern California Coasts	*Oncorhynchus kisutch*
Chinook salmon- Snake River Fall, Spring, and Summer; Puget Sound; Lower Columbia; Upper Willamette; Central Valley Spring; California Coastal	*Oncorhynchus tshawytscha*
Chum salmon- Hood Canal Summer; Columbia River	*Oncorhynchus keta*
Sockeye salmon- Ozette Lake	*Oncorhynchus nerka*
Steelhead- South-Central California, Central California Coast, Snake River Basin, Lower Columbia, California Central Valley, Upper Willamette, Middle Columbia, Northern California	*Oncorhynchus mykiss*

Table 3-4 Total catch of salmon (number) and chinook salmon bycatch rates (number of salmon/mt of whiting) taken by the at-sea and shore-based processing fleets, 1999-2001.

	Catcher-processors		Non-tribal Motherships		Tribal Mothership		Shore-based	
Species	Catch (no.)	Bycatch	Catch (no.)	Bycatch	Catch (no.)	Bycatch	Catch (no.)	Bycatch
2001								
Chinook	847	0.014	1,721	0.048	959	0.158	2,634	0.036
Other	146		624		16		371	
2000								
Chinook	1,839	0.027	4,420	0.094	1,947	0.312	3,321	0.039
Other	88	0.001	27	0.001	16	0.003	24	
1999								
Chinook	2,704	0.040	1,687	0.036	4,497	0.174	1696	0.020
Other	296		506		278		16	

Sources: NMFS. 2003. Implementation of an observer program for at-sea processing vessels in the West Coast groundfish fishery. National Marine Fisheries Service, Northwest Region, Seattle, June 2003. NMFS. 2003. Implementing a monitoring program to provide a full retention opportunity in the shore-based whiting fishery; Preliminary draft environmental assessment. National Marine Fisheries Service, Northwest Region, Seattle, September 2003.

Table 3-5 Incidental catch of chinook salmon in the whiting fishery 1991-2001, all sectors .

Year	Whiting (mt)	Chinook Salmon (no.)[a/]	Bycatch Rate (no/mt whiting)[a/]
1991	222,114	6,194	0.0279
1992	201,168	4,753	0.0236
1993	135,516	5,387	0.0398
1994	248,768	4,605	0.0185
1995	175,255	**15,062**	**0.0859**
1996	212,739	2,327	0.0109
1997	232,958	5,896	0.0253
1998	232,587	5262	0.0226
1999	224,459	10,579	0.0471
2000	202,527	**11,516**	**0.0569**
2001	173,857	6,161	0.0354
2002	130,004	3,759	0.0289

a/ Values in bold indicate years in which the threshold established in the biological opinion was exceeded. Source: NMFS. 2003. Implementation of an observer program for at-sea processing vessels in the West Coast groundfish fishery. National Marine Fisheries Service, Northwest Region, Seattle, June 2003.

Table 3-6 Marine mammals occurring off the West Coast .

Common Name	Scientific Name	ESA Status	MMPA Status
<u>Pinnipeds</u>			
California sea lion	*Zalophus californianus*		
Pacific harbor seal	*Phoca vitulina richardsi*		
Northern elephant seal	*Mirounga angustirostris*		
Guadalupe fur seal	*Arctocephalus townsendi*	T	D
Northern fur seal	*Callorhinus ursinus*		
Northern or Steller sea lion	*Eumetopias jubatus*	T	D
<u>Sea otters</u>			
Southern	*Enhydra lutris nereis*	T	
Washington	*Enhydra lutris kenyoni*		
<u>Cetaceans</u>			
Minke whale	*Balaenoptera acutorostrata*		
Short-finned pilot whale	*Globicephala macrorhyncus*		
Gray Whale	*Eschrichtius robustus*		
Harbor porpoise	*Phocoena phocoena*		
Dall's porpoise	*Phocoenoides dalli*		
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*		
Short-beaked common dolphin	Delphinus delphis		
Long-beaked common dolphin	*Delphinus capensis*		
The following cetaceans are present within the area managed by this FMP but not likely to interact with groundfish fisheries or have not been documented having had interactions in observed groundfish fisheries:			
Bottlenose dolphin	*Tursiops truncatus*		
Striped Dolphin	*Stenella coeruleoalba*		
Sei whale	*Balaenoptera borealis*	E	
Blue whale	*Balaenoptera musculus*	E	D
Fin whale	*Balaenoptera physalus*	E	D
Sperm whale	*Physeter macrocephalus*	E	D
Humpback whale	*Megaptera novaeangliae*	E	D
Bryde's whale	*Balaenoptera edeni*		
Sei whale	*Balaenoptera*	E	
Killer whale	*Orcinus orca*		D
Baird's beaked whale	*Berardius bairdii*		
Cuvier's beaked whale	*Ziphius cavirostris*		
Pygmy sperm whale	*Kogia breviceps*		
Risso's dolphin	*Grampus griseus*		
Striped dolphin	*Stenella coeruleoalba*		
Northern right-whale dolphin	*Lissodelphis borealis*		

(Source: Groundfish bycatch draft programmatic EIS, 2004.)

Table 3-7 Protected seabirds on the West Coast with their protected species designations.

Species	Scientific Name
Seabirds listed as endangered under the ESA	

Short-tail albatross	*Phoebastria (=Diomedea) albatrus*
California brown pelican	*Pelecanus occidentalis*
California least tern	*Sterna antillarum browni*
Seabirds listed as threatened under the ESA	
Marbled murrelet	*Brachyramphs marmoratus*

3.5 Description of Fishing Gear

This section describes basic characteristics of commercial gear used in state and federal marine and estuarine waters off Washington, Oregon, and California. The fishing gear descriptions below are organized under the broad categories of net gear, dredge gear, pot gear, gear that uses hooks and lines, and other gear. This section is primarily excerpted from Appendix 8 of the Risk Assessment.

3.5.1 Trawl Gear

Trawling involves the towing of a funnel shaped net or nets behind a fishing vessel[2]. This section of the document describes gear that use "doors" to spread the mouth of the net. Gear that doesn't use doors to open the net, for example beam trawls and Scottish seine gear, may also be considered trawl gear, but is sufficiently different to be described separately in this document. Trawl gears are depicted in Figure 3-7 through Figure 3-10.

The trawl gear varies depending on the species sought and the size and horsepower of the boats used. Trawl gear may be fished on the bottom, near the bottom, or up in the water column to catch a large variety of species. These include deep water slope fish (the deep water complex of sablefish, dover sole, shortspine thornyheads and longspine thornyheads); shelf and slope rockfish, midwater rockfish (widow, yellowtail, chilipepper), shelf and slope flatfish, lingcod, skates, Pacific cod, Pacific whiting, spiny dogfish, pink shrimp, spot and ridgeback prawns, California halibut, sea cucumbers, sculpins and sea urchins.

The rigging, adjusting, and fishing of trawl gear is complex. Fishermen work to configure their gear to require the minimum horsepower while maintaining configuration of the net. Drag, lift, thrust and gravity are all considerations. Inefficiently rigged gear increases drag and fuel burn. A properly tuned set of door, sweeps and net should have very light contact with the bottom, should have low drag and therefore require less horsepower and fuel burn to fish (Larkin 2003).

The mouth of a trawl net is spread horizontally in the water column by the use of two doors located one on each side of the net, forward and outward of the net. The doors, generally made of metal, are pushed apart and down by hydrodynamic forces and by their own weight, and some increase their spread by bottom friction. Fishermen choose trawl doors based on the horsepower of their vessel, the type of fishery they are pursuing, bottom type and other factors. Doors are made by many different companies and may be rectangular, oval and flat or slightly V shaped. They can also be cambered (curved) and/or vented.

Fishermen, through trial and error, will tune the doors depending on conditions, bottom, and species sought, to get the proper angle of the gear. Fishermen will adjust the doors to control the angle of the forward end of the door, the amount of spread, and other factors. Doors can be adjusted on both the inside where the main towing wire attaches and the backside where the net system attaches.

2 Pair trawling, which involves towing a net held open between two boats, was common in the 1930s and 1940s, but is not currently practiced. Pair trawling could occur on the bottom or in the water column. Historically, this trawl gear was known as otter trawl gear, named after the otter doors (also called otter boards). These terms is no longer commonly used, but appears in the literature.

Trawl nets can vary in size from small to very large, controlled by the horsepower of the vessel. The trawl net is wide at the mouth tapering to an intermediate piece attached to the cod end, the bag that collects the fish. The mesh sizes for the net and cod-end are regulated to allow undersized species to escape during fishing.

Trawl nets are generally made of polyethylene (P.E.) or high-tensile polyethylene (H.T.P.E). Some older nets are made of nylon fibers. Most nets are constructed of 4 mm or 5 mm twine and web. Some of the heavier nets may be made of 6 mm twine and some small nets may be constructed of 3 mm twine. Tougher netting is used around bottom contact areas (where wear occurs) and also around the headrope to protect the web from damage from the floats. Lighter netting is used on the top and the main body (belly) of the net. (Heavy web has traditionally been a double twine version of the body netting. For example, double 6 mm orange P.E. netting has been used for the guard mesh and single 5 mm orange P.E. netting for the body of the trawl.) Some newer P.E. fibers (using new manufacturing processes) allow a smaller diameter twine to be used, resulting in nets that are easier to pull (increasing fuel efficiency).

Different net configurations and designs are used. To catch bottom-dwelling species, such as flat fish, the width of the mouth of the net is generally more important than the height, while for fish that swim higher in the water column, the height of the net opening is more important (Sainsbury 1996).

The top of the mouth of the net is called the headrope (headline or floatline). The headrope usually overhangs the footrope to ensure that fish disturbed by the ground rope do not escape upwards, but are shepherded down into the cod-end at the back of the net. (Midwater square net, no overhang, shrimp trawl roughly same). NMFS, state agencies, and the fishing community are now testing new headrope and trawl designs in order to minimize bycatch of rockfish in flatfish trawls.

The footrope or ground rope is directly attached to the lower leading edge of the mouth of the net. The purpose of the headrope and footropes are to provide a framework for the net, which the web is hung on (McMullen 2003, personal communication). It also has two conflicting functions of separating the target species from the seabed while raising the netting far enough above the seabed to prevent damage (Rose et al. 2002). The footrope may be weighted with chain or may be rope-wrapped cable when used on a soft bottom. If the net is to be towed over rough bottoms (as for rockfish or spot prawns) or over soft sea beds that may contain boulders, rubber disks or rubber rollers (also called bobbins) are attached to the footrope under the center and wing sections of the net, to allow the net to ride over obstacles. This protects the netting more effectively, but may inhibit fish from passing back into the net and allows more opportunities for escape under the net (Rose et al. 2002).

Two or more riblines are used on bottom trawl nets and midwater trawl nets. The riblines go fore and aft in the net to provide strength to the net, help provide security in event of a tear in the net, and prevent tears from going all the way around the net (McMullen 2003, personal communication). Shrimp nets don't commonly use riblines.

Midwater and bottom fish trawl nets are attached by sets of bridles (upper and lower bridles) to the doors, or may be attached to mud gear which in turn is attached to the doors. (NOTE: shrimp bridles are often just a synthetic rope extension of the headrope and footrope). Bridles are made of wire rope (also called cable). They function to hold the net open as it is towed and help herd fish into the path of the trawl net. The fishermen select the length of these bridles and their angle of attack is based on the herding characteristics of the target species. Flatfish trawls for example are fished with long bridles, while shrimp trawls usually have short bridles (Rose et al. 2002). Bridle length is also dependent on seabed type (Rose et al. 2002). On rough ground where there is a high risk of snagging on obstructions only short bridle lengths are possible.

Most trawl vessels targeting fish on the West Coast are stern trawlers, using one net that is set and retrieved off the stern of the vessel, though a few retrieve their nets over the side. Many stern trawl vessels on the West Coast also have a sloping stern ramp to allow for ease of handling large catches of fish. Shrimp trawlers often use two nets towed from each side of the boat, these are called double riggers, with net retrieval being accomplished either over the side of the vessel or from the stern.

3.5.1.1 Bottom Trawl Gear

A bottom trawl is a trawl in which the doors, the footrope of the net, or both are in contact with the seabed. Additionally, any trawl that doesn't meet the requirements for a mid-water trawl (including an unprotected footrope, no bobbins or rollers on the net) is also considered a bottom trawl. Bottom trawl nets may be used to target groundfish, flatfish or shrimp. The type and construction of net varies by which species is targeted.

Fish are herded into the path of the net by noise and disturbance of the sea bed (mud clouds, etc.) and by the turbulence created by the doors, bridles, and mudgear (Sainsbury 1996). These cause fish to aggregate directly in front of the mouth of the net (Jennings *et al*. 2001). The footrope may be strung with rollers, disks, or bobbins to help it move over the seabed.

A bottom (fish) trawl is generally towed at one and a half to two and a half knots on or above the ocean floor. The speed is dependent on the depth and the type of bottom being fished. For example, when fishing dover sole in sand and mud the speed may be 1.8 knots, in deeper mud it may be 2.5 knots (Thompson 2003, personal communication). Bottom trawl gear is shown in Figure 3-7.

<u>Flatfish and Bottomfish Trawls</u>

Flatfish and bottomfish bottom trawl nets are composed of a tapered top and bottom body of netting with the top panel, extending forward of the bottom panel. This top panel is called the hood or overhang. The side wings are often cut back to minimize damage to the wings of the trawl and reduce drag. Large meshes can be used in the top of the trawl as the fish tend to follow the twine back into the net rather than pass through the mesh. The minimum mesh size is set by regulations, and must measure 4.5" between knots throughout the net and cod end. However a larger mesh is often used in the forward upper part of the net.

The net portion of a bottom trawl is not intended to drag along the bottom. Groundfish bottom trawl regulations restrict the amount, size, and attachment of chafing gear (protective netting) that can be used on the cod-end. To help keep the net cod-end off the bottom, nets are buoyed with plastic floats (sometimes aluminum floats) that are attached to the headrope of the net and cod end to help the net stay buoyant. Keeping the net off the bottom helps avoid getting sand and mud in the catch (especially in flatfish trawls) to improve product quality and allows the net to rise over rocks. However, floats cause drag and decrease fuel efficiency, so there are many things to be considered (Larkin 2003, Thompson 2003, personal communication). Typically nets are designed to balance the floatation with resulting drag and decrease in fuel efficiency caused by the floats. Common net designs for shelf fisheries may have a total headrope length of about 85-95 feet (center and wings) (26-29 m) and footrope lengths of 50-110 feet (15-34 m). Shrimp nets are technically a bottom trawl because of the contact of the doors with the bottom. However these nets are sufficiently different to be described separately below.

The four seam Aberdeen trawl with a cut back wing, is commonly used by the deepwater commercial groundfish fleet throughout the West Coast. The net opens to a height of about 15 feet (4.6 meters) and is used for black cod and thornyheads, as well as petrale or dover sole. The footrope is composed of either 8-inch discs or 14-inch rockhopper gear, hung to chain (Skamser 2002).

The two seam eastern trawl is used primarily for flatfish fishing in shallow waters and by lower horse powered vessels. It is a low rise net with a wide bottom and a full wing (Skamser 2002). The traditional bottom net design for flatfish creates net mouth openings of 8 feet (2.4 m) in height or less (Sainsbury 1996). The footrope is now often a disc footrope hung to a cable. Older footropes are sometimes a cable wrapped with rope to which the web is directly attached.

New flatfish net designs are being tried in efforts to reduce bycatch of rockfish. In collaborative research projects, fishermen, agency scientists, and gear manufacturers are designing and testing various net configurations including low-rise trawl nets and nets with cut-back hoods.

Rockfish nets rigged with bobbins have been used to fish dover sole in deep water and round fish in shallower water. Prior to the small footrope regulation implemented in 2000, nets used for fishing rockfish generally used roller gear with 14-inch rollers. However, when fishing over very rough bottoms, 20-inch tire gear was also used.

Oregon, Washington, and California's groundfish fleet no longer use the traditional, higher rising rockfish net (also called Atlantic Western or snapper trawl). A few boats in Alaska still use this net and NMFS uses this net for surveys (Skamser 2003). This net, fished in areas of hard bottom, is used to catch higher swimming fish by creating a larger mouth opening, using a three-bridle system and a four seam net. One design uses a net with a W shape into the end of the wings, with a third bridle from the doors attached to the inside of this W. This allows the pull of the tow to be directed to the bottom and center legs of the wings, while allowing the top leg of the bridle that is attached to the top of the wing to be lengthened for the W to open up and the headrope to rise. This net usually has large roller gear or tire gear on the footrope (Sainsbury 1996, Skamser 2002). Tire gear are sections of tires greater than 14 inches that are fastened together in the center of the net with large bobbins on the outside of these tires. They are attached to the net with chains. This gear allows the net to get over very rough irregular bottom. The tire gear helps the net move over the bottom without snagging as do bobbins, but these are bigger and allow for fishing over even rougher bottoms. This gear is no longer used for rockfish fishing.

The cod-end of a bottom trawl net has two or four riblines made of synthetic rope that runs down the length of the cod-end. Additionally, the cod-end has expansion straps around the circumference of the cod-end to restrict the expansion of the netting and allow it to be hauled up the stern ramp. Protective pieces of synthetic rope called chafing gear (usually of P.E. fiber) can be attached to the cod-end to protect it from abrasion. Chafing gear is now restricted if fishing with a small footrope configuration to reduce incentives for fishing over high relief areas.

Bottom Trawl Doors

Bottom trawl doors are generally made of steel and slide along the seabed. Removable steel shoes are often also used on steel bottom doors and can be replaced as they wear.

The doors are designed so that the friction of the doors along the bottom and hydrodynamic force cause the doors to spread apart (Sainsbury 1996). The spreading ability of trawl doors is often reduced when fishing over hard ground compared to fishing over sand (Main and Sangster 1979). The distance between the doors (the door spread) in shelf fisheries is generally 110 - 165 feet (34-50 m); the door spread in deep water fisheries is generally from 165- 650 feet (50-200 m).

The mud cloud generated by trawl doors is not due to the "plowing" of the sediment. The mud is generated from the turbulence created on the back side of the door, which sucks sediment in behind the door into eddies that are formed (Brown 2003, personal communication). Increasingly, cambered doors are being used which reduces this mud cloud.

The all-steel "V" door is commonly used. This groundfish trawl door is a rectangular steel plate that has a shallow curve or bend along the middle of the length of the door (axis is horizontal for the bend). The V is shallow with a rise from the centerline to the outside of the door of about 8 inches (20 cm). When the vessel is towing the net, the apex of the V faces toward the boat. The main wire (the cable from the vessel that tows the doors) is attached to a heavy steel bracket (bail) on the doors at various angles chosen to get the desired towing angle (some doors do not use fixed or hinged bails, but use chains). This bracket is often hinged, allowing the main plate to swivel when an obstruction such as a large boulder is encountered. U bolts are welded onto steel plates that are set on the outside of the door close to the trailing edge of the door. Bridles or tail chains are secured between these U bolts on one end and attach to the mudgear on the other, which in turn are attached to the net.

V-doors are widely used on the West Coast and are manufactured by different companies. For boats 400-600 horsepower, V doors such as those made by NorEastern Trawl Systems (NETS), are about 6 feet x 9 feet (1.8-2.7m) in size and weigh about 1300 pounds (590 kg) on deck (but less under water). Boats less than 400 HP will use doors about 5 x 7 feet in size (1.5-2.1 m). This door weighs about 950 pounds (431 kg) on deck. Vented V doors and high aspect doors used for both bottom and mid-water trawling (where the doors are long and narrow, with the bend in the middle of the long side) are also in use. In California and Washington, the trawl doors made by U.S.A. Jet Door are also popular. These doors are like the V door though overall surface area to height differs slightly. A door that measures about 5.8 x 9.1 feet (1.8m x 2.8 m) weighs about 2100 pounds on deck (953 kg). Also in use on the West Coast is the Type 2 trawl door made by Thyboron, a vented V-door with a chain bail and removable magnesium shoes (Skamser 2002).

Fishermen on the West Coast are, increasingly using cambered doors, rather than the flatter V doors, as they are more fuel efficient (Brown 2003, personal communication). These are doors with a constant curve along the vertical axis of the door, similar to that of an airplane wing, which increases hydrodynamic efficiency. The cambered door not only reduces the drag per spreading force ratio (increasing vessel efficiency), but also reduces the mud cloud generated by the door (Brown 2003, personal communication). Slotted doors also create very little turbulence behind the door and very little mud cloud.

Bottom Trawl Footrope

The footrope or ground rope is directly attached to the lower leading edge of the mouth of the net. The footrope may be weighted with chain or may be rope-wrapped cable when used on a soft bottom. If the net is to be towed over rough bottoms (as for rockfish or spot prawns) rubber disks or rubber rollers (bobbins) are attached to the footrope under the center and wing sections of the net, to allow the net to ride over obstacles. "Bunt" bobbins are heavily structured, hard rubber half spheres with a 2.5 inch (6.4 cm) hole running through it horizontally (to allow them to be strung onto 5/8 inch or 3/4 inch steel cable (1.6 -1.9 cm) or to 3/8 to 4/8 inch chain (0.95-1.3 cm). This cable or chain (carrying the bobbins) is then shackled onto the fishing line at each wing tip of the net and at intervals along the footrope length it is hung to the fishing line with chain toggles that are generally 18 inches (46 cm) in length. They do not roll as do the bobbins strung on the center of the net, but are dragged along the bottom. A common size is 14 inches (36 cm) in diameter. These weigh about 25 pounds on deck (Skamser, 2003).

The bobbins on the center part of the net are designed to roll over the bottom and vary in size from 9 to 24 inches (23-61 cm), with 14-inch (36 cm) rollers being most commonly used. On deck a 14-inch roller weighs about 17 pounds. Bobbins on the center part of the net are spaced about two feet (.6 m) apart, those on the wings, about three feet (.9 m) apart. Spacers, which are either cylindrical or round, are made of various materials, commonly rubber. The rubber spacers commonly used weigh about 3 pounds on deck and are elongated in shape. On cable footropes cable clamps are often used on each side of the bobbin. These clamps lock tightly onto the footrope and prevent the roller from slipping to the right or left (Browning 1980). Rockhopper gear (also called “tire gear” or “western glider gear”) has a 14-inch (36 cm) rubber disk every two feet (61 cm) with seven-inch (18 cm) filler discs. The 14-inch disc has a hole near the top with another line (either chain or cable) running through it. This line is attached to the fishing line at two foot intervals (Skamser 2003). In contrast to the bobbin footrope that is designed to roll, rockhopper gear is designed to pivot, swinging up and back under the net to lift the net over obstructions.

In November 1999, in order to keep trawlers from capturing canary rockfish, bocaccio, cowcod, and lingcod that associate with high relief rocky habitat on the continental shelf, the Pacific Fishery Management Council adopted a proposal, suggested by the fishing industry, which limits large footrope size (that is the maximum size of the components on the footrope). Differential trip limits were assigned to the three categories of trawl gear configurations: large footropes greater than 8 inches (20.5 cm), small footropes less than or equal to eight inches (≤ 20.5 cm), and midwater or pelagic gear. This rule prohibited vessels from delivering nearshore and shelf rockfish species and many flatfish species if they use footropes with rollers larger than eight inches. Large footropes could still be used for deepwater shelf and slope species. Though only preliminary research has been done, it is widely believed that this gear restriction has been very effective in keeping boats from being able to fish in high relief habitat.

Bridles and Mud Gear

Trawl nets are attached by upper and lower bridles to the doors, or the bridles may be attached to mud gear that in turn is attached to the doors. Bridles are made of wire cable. They function to hold the net open as it is towed and help herd fish into the path of the trawl net. The bridles may be 20 fathoms (37 m) or more in length (McMullen 2003, personal communication). On bottom trawl gear, parts of the bottom bridle are strung with a contiguous series of rubber disks (also referred to as cookies or donuts) that are 1.5 to 5 inches in diameter (3.8-12.7 cm) (generally about 4 inches in size). These disks protect the cables and increase their herding effectiveness. Additionally mud gear (also called sweeps) help with herding. The cables of mud gear are also covered with disks, generally smaller than that on the bridles. The mud gear typically is 40 to 75 fathoms in length (73 to 137 m) (McMullen 2003, personal communication).

Flatfish trawls may be fished with long bridles, while trawls on rough ground, where there is a high risk of snagging on boulders or other obstructions, use shorter bridles.

Chains

Chain toggles may be attached directly to the footrope between the wing tips of flatfish trawls at intervals of about 20 inches (50.8 cm) and drop from the footrope in loops up to about 18 inches deep (0.46 cm) to help stir up the fish and have them rise into the net.

3.5.1.2 Midwater Trawl Gear

Midwater trawls, also called pelagic or off-bottom trawls, are trawls where the doors may be in contact with the seabed (although they usually are not), while the footrope generally remains suspended above the seafloor, but may contact the bottom on occasion. Midwater trawls are generally towed above the ocean floor, although they may be used near the bottom. They are also generally towed faster than bottom trawls to stay with the schooling fish they target. Towing time varies from a few minutes to several hours. Depths trawled can range from 60- 4200 ft (20 to700 fathoms) at distances from the surf line to about 40 miles off shore.

<u>Mid-water Trawl Nets</u>

Mid-water trawl nets require a large vertical as well as horizontal mouth opening to encompass schools of fish and give the net stability during operation. A midwater trawl net has very large meshes or parallel lines (ropes) in lieu of meshes in the front to allow it to open to its full width, decreasing in mesh size in the intermediate parts of the net and down into the cod end of the net. For example the mesh sizes in the front of a mid-water trawl may be 120' long. The wings of the net are very long and tall and additionally, to achieve the large opening, deep side panels in addition to the top and bottom belly panels commonly found in bottom nets are used (Skamser 2003). A mid-water trawl net may be 900 feet or more in length (274 meters) and have footropes 300 feet -600 feet (91-183 m) in length along the center and wings (Skamser 2003).

Net are usually rigged so that the towing forces are more evident in the headline and the net literally hangs from it (Sainsbury 1996). For mid-water trawl nets weights suspended from the lower bridle legs and footrope promote maximum vertical mouth opening. When fishing in the deep, an extension piece may be added to the lower part of the net to maintain a vertical square opening (Skamser 2003). When fishing close to the bottom, as with bottom trawls, an extension may be fitted to the top of the net, bringing the headrope forward of the footrope, to prevent the fish from swimming upward and over the top of the net (Sainsbury 1996).

The cod-end of the mid-water net generally has four riblines made of synthetic rope (or sometimes, in some cod ends for Pacific whiting, chain) that run down its length, and expansion straps around the circumference of the cod-end to restrict the expansion of the netting and allow it to be hauled up the stern ramp. Chafing gear (usually of P.E. fiber) is sometimes attached to the cod-end to protect it from abrasion on the stern ramp (or if the net touches the bottom).

<u>Semi-pelagic or hybrid nets</u>

These types of nets have not been commonly used in the Washington, Oregon, or California groundfish fleet, though some experimental nets of this type are being used for Pacific cod in Alaska (Skamser 2003). Semi-pelagic or hybrid nets can be used for either midwater or bottom trawling applications (Sainsbury 1996). These nets fish on or near the sea bed for fish schooling anywhere up to 66 feet (20 m) above the bottom and have a large mouth opening which can open to that 66 foot height. This net can also be fished off-bottom for fish much higher in the water column. These nets are relatively small so they are easily maneuvered. Some designs (such as the net made by NorEastern Trawl Systems) connect the doors only to the upper wings of the nets (which utilize rope or large meshes), with the footrope being kept down with weights. This type of net was designed to fish on the bottom and can operate well in shallower water. Other designs, such as those used by factory trawlers, use four bridles attached to the headrope, side panels, and footrope, allowing a very large mouth opening, for example one that is 102 x 54 feet in size (31 x 16.5 m). This net also employs floats attached to the top edge of the side panels and a long roller gear footrope. It can be fished either on or just off the bottom.

Mid-water Trawl Doors

Mid-water doors are usually made of steel, though some mid-water doors use aluminum alloy. When used in mid-water trawling, doors do not often come in contact with the ocean floor, but build up enough hydrodynamic force to spread the net by being pulled through the water at an angle. Mid-water doors are often taller than they are wide (with a height often twice the length) and are curved to increase spreading efficiency.

The door spread (distance between doors) in mid-water fisheries, the door spread may be 330-650 feet (100-200 m).

Mid-water Trawl Footropes

The mid-water trawling regulations prohibit footrope protection at the trawl mouth, and nets must not have rollers, bobbins, tires, wheels, rubber discs or any similar devices. Sweeplines, including the bottom leg of the bridle must be bare. Additionally, for at least 20 feet (6.15 m) immediately behind the footrope or headrope, bare ropes or mesh of 16 inch (40.6 cm) minimum mesh size must completely encircle net.

Mid-water Trawl Groundweights

Auxiliary weights are sometimes added to mid-water trawl gear to increase downward force at various points. Weight chains or small diameter weights are often attached to the footrope and are also used on the bottom bridles of the nets to help the net achieve its maximum opening size. Depending on the size and rigging arrangements these may range from 400 lbs (180 kg) for a 500 horsepower vessel up to 1100 lbs (500 kg) for a 1100 horsepower vessel. Other manufacturers, e.g. Gloria Trawl company make the bottom web with lead line for the same purpose, using 3/8th-7/16th braided rope (Skamser, 2003).

3.5.1.3 Shrimp and Prawn Trawl Gear

Shrimp trawls are a type of bottom trawl but have different configurations from other bottom trawl gear and so are described separately here. Most shrimp vessels on the West Coast fish are double-rigged, using one net suspended from large outriggers on each side of the vessel, and two pairs of doors, one door on each side of the net. The nets are set and retrieved over the side of the vessel or up the stern. Hydraulic drums, winches, and booms are used to retrieve the gear.

Shrimp trawls are generally towed at one and a half to two and half knots just above the ocean floor, usually about 12 inches off the seabed (Thompson 2003, personal communication; McMullen 2003, personal communication). Shrimp trawl gear is shown in figure 3-10.

Pink shrimp nets

The pink shrimp trawl fishery commonly uses a four seam net in a box trawl design. The net does not have a hood (that is there is no overhanging piece of the net in front of the headrope). It is a high-rise trawl, with the net opening being between 12 feet to 18 feet high (3.6-5.5 m). The footrope and headropes are of equal length (commonly 80 to 90 feet long (24-27 m)) with about a 50-55% rise ratio, that is the mouth of a net with these size components is about 45-50 feet wide when fishing).

Unlike other cod-ends, the cod-end of shrimp net is generally not constructed with riblines that run the length of the cod-end.

Spot prawn nets

The spot prawn trawl uses a short low design with a very strong footrope (that is, with large roller or tire gear). A description of this footrope is found above in the bottom trawl section.

Bycatch Reduction Devices

Some shrimp and spot trawls (pink shrimp trawls, spot prawns in California and Washington) are required to use a bycatch reduction device (BRD). Finfish excluders have been required in pink shrimp trawls in California since September 2001 and since July 1, 2002 in Oregon and Washington.

California rules allow fish eyes, soft panels, and Nordmore grates to be used. Fish eyes are football sized and shaped frames made of aluminum or steel that is inserted into a slit made in the top of the net about 80 inches up from the terminal end in front of the cod end. Soft panels are panels of net with meshes larger than the mesh of the net (e.g. commonly with meshes about 4.5 inches in size) that are sewn into the top of the net. A Nordmore grate is a rectangular or round rigid grate with aluminum or plastic tubes secured at spacings no larger than two inches. This grate has to fully cover the inside of the cod end in cross-section and is usually placed in the later part of the cod end.

In Oregon and Washington, rules requiring BRDs have been implemented seasonally since July 2002 to allowed fishermen and agency scientists to refine the devices and test effectiveness (Hannah 2002 personal communication). In April 2003 new rules defined what devices are legal. Nordmore grates are allows as well as soft panel devices, as long as the panels are made out of a single continuous piece of netting (that is, no “zippers” are allowed). Fish eye devices may no longer be used.

Testing in Oregon has shown that a modified Nordmore grate is more effective and has less shrimp loss than either fish eyes or soft panel BRDs. The grate design is a circular or elliptical-shaped panel, rather than the typical rectangular one with narrower bar spacings of 1 1/4 inches (3.2 cm). It is typically made out of plastic. This system excludes rockfish, whiting and some smelt and slender sole, thereby simplifying the task of sorting the shrimp. Additionally, fishermen are experimenting with using a “down panel” of net, a tapered panel of small meshed net attached inside the trawl net and hanging down from the top of the net about half-way into the net body to force shrimp to the bottom of the cod end, further decreasing shrimp loss in the BRD (Hannah 2002 personal communication). West Coast fishermen have also experimented with a very effective grate, sometimes called the “Logan Grate”, named after inventor Stan Logan, used in Canada’s West Coast pink shrimp fisheries. This grate is circular, shaped like a bar-be-que grill, is made of aluminum tubing, and has the bar spacings as noted above (Skamser 2003).

Other innovations, such as the one designed by Brad Pettinger in Oregon, include a hinged grate (in the middle of the longitudinal direction) to allow the device to be wrapped around the net reel without damage to the grate.

Bycatch reduction devices are shown in figure 3-11.

Doors

A single rigged shrimp vessel may use the same doors that are used by groundfish trawl vessels, while a double rigged shrimp vessel uses doors that are typically much larger than those used by groundfish trawlers. Shrimpers seek stable doors that can get down to the bottom fast. They are generally made of wood with a wide flat steel shoe (heavy plate) on the bottom. The weight of the door is spread over this wide shoe, reducing its pressure per square inch and allowing it to slide across the bottom (McMullen 2003, personal communication). The doors are rigged with short bridles to the net.

A typical shrimp door measures 9 foot by 9 foot (2.7 by 2.7 meters) in size (Brown 2003, personal communication), but can vary from 6 foot by 6 foot doors to those that are up to 10 foot long and 9 high (McMullen 2003, personal communication). A 7-foot by 7-foot door weighs about 950 pounds in air (McMullen 2003, personal communication).

In choosing doors, fishermen have to consider the trade-offs inherent in different gear. For example, while higher doors may catch more shrimp, there is a trade-off, as higher doors also requires a larger horizontal width to make them stable, which reduces the efficiency of the spreading force (Brown 2003, personal communication).

Footrope for the Pink Shrimp fishery

The footropes used in pink shrimp trawling are not protected with any rollers or bobbins or other gear and are generally rigged to run about 12-18 inches off the bottom (31-46 cm). That is, the footrope of shrimp nets is not designed to contact the bottom. A groundline with disks or bobbins that are two to five inches (5 cm-13 cm) in size may be suspended below the footrope by ladder chains that drag along the bottom and/or the net might have a tickler chain that runs slightly in front of the footrope (McMullen 2003, personal communication). The purpose of the disks or bobbins is to prevent the gear from digging into the soft bottom sediment (Brown 2003, personal communication). There are many considerations necessary when choosing gear. While smaller diameter disks or bobbins on the gear may fish better than larger diameter gear, larger diameter gear is better at keeping the gear from digging into the bottom. Smaller diameter disks may tend to dig in and could even stop the boat in soft sediment (Brown 2003, personal communication).

Footrope for the Spot prawn fishery

The spot prawn trawl fishery uses large tire gear and rollers on the footrope. Use of this gear is being phased out. In Oregon the footrope assembly consists of chain and roller gear up to 24 inches in diameter is connected to the net by dropper chains. In Washington, the rollers, bobbins, or discs on the footrope on spot prawn trawl nets must be between 8" and 28" in size, and must roll independently and freely. Additionally no tickler chains or any other gear that drags across the bottom in front of the mouth of the net may be used

The spot prawn trawl fishery in the states of Washington, Oregon, and California is in transition due to concerns about high groundfish bycatch levels, percentage of male prawns caught, and habitat impacts. In Washington spot prawn trawling was phased out in 2002 and closed in 2003, with fishermen allowed to transition to pot gear. Five trawlers held permits in 2002. In Oregon, six boats currently hold trawl permits. Phasing out the trawl gear and allowing these fishermen to transition to pot gear is currently being considered. In California the spot prawn trawl fishery was closed by the California Fish and Game Commission under an emergency closure rule in September 13th, 2002 for the duration of that season (through October 31, 2002). In 2003 the Commission will consider a variety of options for long-term regulation changes.

Bridles

The bridles that link the doors to the net are short, usually about 15-22 feet in length in a double rigged shrimp trawl (McMullen 2003, personal communication). A single rigged shrimp bridle may be up to 100 ft. in length (McMullen 2003, personal communication). Mud gear is not used.

Chains

Tickler chains or more commonly now, ladder chains with a 2.5-inch disc-covered belly section, are sometimes used in the shrimp trawl to drag along the muddy bottom to stir up the shrimp so they rise and enter the net.

3.5.1.4 Trawl Gear Components That Contact or Effect the Seabed

(The following information is excerpted with permission from Rose et al. 2002, except as noted in brackets)

Trawl gear has several components that contact or affect the seabed. Variations in the composition and design of these components influence their effects on benthic ecosystems.

Of the major components, trawl doors affect the smallest area of seabed, though trawl door marks are the most recognizable and frequently observed effect of trawls on the seabed. The doors travel across the seabed oriented at an angle to the direction of travel. The resulting track marks consist of the area of direct contact as well as a berm of sediment displaced toward the trawl centerline. These two swaths total a few meters in width. The design of the door significantly influences the degree of contact. The downward force exerted by the door on the seabed is influenced by the weight of door and the downward hydrodynamic forces generated by the door counteracted in part by the upward force from the cables attached to the towing vessel. The width of the door contact area with the seafloor is also a factor.

The traditional V door is designed and rigged to have only light contact with the seabed, especially on muddy grounds. The hinge on the door to which the main wire is attached is designed to swivel when an obstruction such as a large boulder is encountered. The door's inefficient hydrodynamic shape creates vortices that suspend seabed materials. In some fisheries this sediment cloud helps herd the fish and is an important part of the capture system. Advances have been made in trawl door design to increase their hydrodynamic efficiency. Changes include doors with higher aspect ratios and doors with slotting and cambering. These doors tend to rely very little on seabed contact for their spreading force, have a smaller contact footprint and suspend less sediment.

The bridles [and mudgear] are cables that connect the trawl doors to the trawl net. The bottom bridle [and mudgear] may be in contact with the seabed for a part of their distance. The length of these components and their angle of attack is based on the herding characteristics of the target species. For example flatfish trawls may be fished with bridles [and mudgear] longer than 109 fathoms (200 m) while shrimp trawls usually have short bridles. Additionally, the length of bridle wire is also dependent on seabed type, with short bridles being used on rough ground where there is a high risk of snagging on boulders or other obstructions. Sometimes bridles are covered with hose or strung with a contiguous series of rubber disks (cookies) up to 15 cm in diameter, to protect the cables and increase their herding effectiveness. When using long bridles [and mudgear], these components contact more seabed than any other trawl component. The force of contact of these sections with the seabed results from the weight of these bridles [and mudgear] (in water) per length. Unless chain is used or supplementary weights are added, the bridles [and mudgear] skim the surface of the seabed. Small-scale vertical features on soft substrates can be flattened by this action. Emergent structures and organisms can be vulnerable to penetration or undercutting by bridles, especially where the bridles have a small diameter. [However, it should be noted that on the West Coast, few, if any fishermen fish bottom bridles with small diameters, most all are covered by three or four inch disks, while mud gear disks are about two and a half to four inches (McMullen 2003, personal communication)]. The ease with which wires traveling across the seabed can be displaced upwards by these structures will be reduced as the tension in the wire increases.

[Note: mudgear 40-75 fathoms long and bridles of 17 fathoms are more typical on the West Coast (Skamser 2003, McMullen 2003, personal communication). The typical contact distance may be 55 fathoms or less (100 m). Additionally, hose is no longer commonly used to protect the bridles (Larkin 2003).]

Footropes, the components of the trawl attached directly to the lower, leading edge of the net, may also contact the seabed. [Though, for example, the footrope of shrimp nets does not (McMullen 2003, personal communication)]. Footropes are constructed similarly to bridles, composed of cable or chain that may be covered with protective material (rubber disks, bobbins, etc.). The diameter of the protective gear is commonly larger than bridles (up to 1 m) and often varies along the length of the footrope, so only part of the footrope may be in direct contact with the seabed.

Footrope effects are related in part to its contact force and the area over which this force is distributed. The force exerted downward on the seabed from the footrope is dependent on the weight per unit length (which may vary along the length of the footrope)[3] and by the up-pull from the netting to which it is attached. Allowing footrope components to roll may reduce effects, but these rollers are generally only located in the center section of the footrope. In fact, some footrope components are designed specifically so that the components do not roll. These components, e.g. rockhopper gear, are designed so that when they hit an obstacle they turn back under the belly of the net and lift the net over the obstruction. Large diameter footrope components can also produce vortexes in their wake, contributing to sediment suspension. This large diameter also makes a component less likely to undercut smaller emergent structures or organisms or to penetrate the substrate, but is more likely to run over these structures. When footrope components are eight inches (20 cm) or greater, these larger diameter components are separated by lengths of smaller diameter components, creating spaces where some seafloor features are not directly contacted as the trawl passes. This may reduce effects on emergent structures and organisms.

On most trawls, the netting itself is not designed to directly contact the seabed and anything that protrudes far enough above the seabed to contact the netting has already been contacted by the footrope. The netting may retain objects and organisms that are undercut or suspended off the seabed by the passage of the footrope. If rocks enter a cod-end or the cod-end becomes loaded with dense fish (e.g. flatfish), the cod-end may be weighed down enough to drag on the seabed. [It should be noted that use of roller gear makes it uncommon for rocks to enter the cod-end. (McMullen 2003, personal communication)].

Auxiliary weights added to the lower corners of pelagic trawls may contact the seabed when these are fished near or on the seabed. The pressure that these weights exert on the seabed is the resultant of their weight in water and the upward forces exerted on them by other gear components.

3.5.1.5 Beam Trawls

The beam trawl is the oldest of all trawling types. The gear derives its name from the rigid beam (once made of wood, now of aluminum or steel) that is supported at each end by a vertical 'sled' structure called the trawl head. This beam is used to keep the mouth of the net open horizontally.

Beam trawl gear is no longer common due to the unwieldy nature of the long beam and their lower efficiency, but it is well suited for small boats fishing inshore areas and for inshore areas with steep slopes. For harvesting some bottom-dwelling species, beam trawls have some advantages over door trawls. The opening of the net remains constant in size during turns, effectiveness is less affected by soft muddy bottoms, there is less drag, and vessels having restricted warp capacity (the amount of net towing line) can fish deeper waters since only about half the warp (length) is needed as compared to gear where doors are used. The warp length/depth ratio is 3:1 (Rose et al. 2002).

Beam trawl gear was the only trawl gear allowed in California from 1952 to 1963 to harvest pink shrimp (*Pandalus jordani*), when trawls using doors were allowed to begin fishing. Currently in California, beam trawls are only used in San Francisco Bay, mainly for California bay shrimp (*Crangon franciscorum*) which is used as live bait for sturgeon and striped bass sport fishing and provides a small market for human consumption. There are currently 11 permits. Staghorn sculpin, yellowfin goby, and long jaw mudsucker may also be caught with a commercial bay shrimp permit.

Beam trawl gear is the only trawl gear currently being used for shrimp in Puget Sound. Tribal fishers may use trawl gear (with doors) to fish for shrimp, though this fishery has not been pursued in the last couple of years (Cain 2003 personal communication). There are currently eight active permits (approximately five permits are used to fish pink shrimp in the Straits of Juan de Fuca and three for coonstripe shrimp in the San Juan Islands). These shrimp are used for human consumption, the pink shrimp being peeled for cocktail use, the coonstripe sold whole. Beam trawl gear is not used in Oregon.

Beam trawls use simple funnel shaped nets without wings that are made of polypropylene fibers. Net mesh sizes are set by regulation. On the West Coast, one trawl is generally used at a time. Some vessels retrieve the net over the side, while others use a stern ramp. The horizontal opening of the net is set by the length of the beam. In Puget Sound, beam lengths up to 60 feet (18 m) are used for pink shrimp and up to 25 feet (7.6 m) for coonstripe shrimp, but this beam length will vary depending on vessel size. In San Francisco Bay the beam used is 20-25 feet wide (6-7.6 m).

The bottom of the net is attached to the beam that is supported on a fixed sled or skid called a trawl head (also called beam head). The sled, generally oval or triangular in shape, is made of heavy steel, the bottom of which is protected from wear by replaceable steel 'shoes' that are welded in place. To reduce wear of the plate, a 'heel' is welded to the aft end of the shoe. The skid lifts the net about four to six inches off the bottom (10-15 cm). The top of the net is buoyed with floats, so that the net mouth opening is about five feet wide (1.5 m).

When fishing on soft bottom, the beam trawl may be rigged (between the shoes) with tickler chains (also called mud ropes) to stir up the shellfish lying on or buried in the sand and mud. The number of chains varies depending on the target species and the bottom type. Small inshore vessels use shrimp beam trawls that are relatively light and rarely have more than one chain fitted between the shoes. This is sufficient in sandy bottoms to cause shrimp to flee into the water column and be caught in the net (Jennings et al. 2001). The addition of extra tickler chains has been shown to increase the bycatch of non-target organisms and flatfish that are buried more deeply by increasing bottom contact and penetration of the sediment.

The trawling wire (warp) from the vessel is attached to the towing bridle by a shackle. The towing bridle is formed of three or more chains, depending on the beam length, one from each shoe and the other from the beam, brought together at the shackle.

Towing speeds depend on the species being targeted. For pink shrimp, towing speeds are about two knots. For coonstripe shrimp, towing speeds are about one knot. For California bay shrimp towing speeds are about one to two knots. Tows are generally short in duration for both the coonstripe and bay shrimp fishery and shellfish and fish are generally alive when caught.

3.5.1.6 Beam Trawl Gear Components That Contact or Effect the Seabed

(excerpted from Rose et al. 2002)

During beam trawl fishing, the sole plates on the trawl head and the tickler chains are in direct contact with the seabed. The sole plates generally contact the seabed at a slight angle. The pressure exerted by the trawl head on the seabed is strongly related to the towing speed. As the speed increased the lift on the gear increases and the resultant pressure force decreases. A less firm bottom contact, e.g. on softer grounds, can also be obtained by shortening the warp length. A shrimp beam trawl weighs (in air) several hundred kilograms.

Tickler chains also contact the bottom. Generally only one tickler chain is used when fishing shrimp. The pressure exerted by the tickler chain is substantially lower than that exerted by the trawl heads, though the area covered is greater. When the tickler chain is towed over the seabed, sediments are transported. Smaller particles will go into suspension and may be transported away by currents or resettle in the track of the trawl. Local variations in morphology such as ripples may be flatted out. The amount of penetration into the seabed depends on sediment type, with the greatest amount of penetration occurring on very fine, to fine muddy sand. If more than one chain is used on the beam trawl, the added weight increases contact with the seabed and increases fluidization of the sediment as each chain passes, allowing following chains to penetrate deeper (Jennings et al. 2001).

3.5.2 Demersal Seines

Scottish seines, also know as a Scottish fly dragging seines, are considered demersal seines as they are nets that fish on the bottom and moves across the bottom when closing. On the West Coast it is used in the nearshore and shelf areas to fish flatfish such as sand dabs. Petrale sole, English sole and chili pepper rockfish are also caught with this method. There is currently one fisherman in California who uses this method.

This fishing technique uses a single boat that surrounds an area of water with a very long seine ropes (warps) with a net in the center. In some ways this gear is similar to trawl gear in that it harvests bottom fish by herding the fish with gear (the seine ropes) that is in contact with the seabed. However, this gear does not use doors to spread the net; the two warps spread the net. Additionally, the net is similar to a trawl net except it of lighter construction and has a small, light footrope.

The seine ropes, used both for herding the fish and then for hauling the net from the seabed to the boat, are made of polypropylene rope with a lead core, enough to attain negative buoyancy. It is about 2 miles (3.2 kilometers) in length with a shipping weight of about 1000 pounds (each 125 fathom (229 m) coil weighs about 180 lbs (82 kg) on deck, (16-20 coils are used per set). The net is a low rise net with the opening at the mouth is approximately 150 feet wide and 6 feet high. This low rise configuration better targets slow swimming flatfish that live on the bottom. The net's footrope (the leading lower edge of the net that comes in contact with the seabed) is approximately 150 feet (46 meters) in length and made of three-quarter inch synthetic fiber (polydacron). A grass (hemp) rope with approximately 80 to 100 pounds of seine leads is attached to the footrope to "tickle" the bottom front end of the net. Because of the small sized components on the footrope, for fishery management purposes it is considered a "small footrope trawl" and qualifies for a limited entry trawl permit (DeVore 2002, personal communication).

Because the long seine ropes are vulnerable to snagging, this gear is generally used only on relatively smooth seabed (Sainsbury 1996). Where snags are encountered, the location is marked and avoided in subsequent tows. In California this gear is used on smooth 'green mud' bottom in areas with good upwelling, with the fishermen returning to the same grounds year after year. At the slow speeds of the tow, water pressure helps the rope to skim over the bottom, just touching the sediment and raising a small mud cloud (Fitz 2002 personal communication).

The gear is set with or against the wind and tide off either side of the boat. The gear is set out in a diamond shape, with the net bag affixed to the middle of the base of the diamond. To set the gear a flag with a radar reflector, a marker buoy (dhan buoy) and floatation buoys is fastened to the end of the first coil of the seine rope. The seine rope is set out from the coil or reel around a vertical roller set above the rail. After half to two thirds of the seine rope from one side of vessel is set out (between 8 to 10 coils of 125 fathoms each) a turn of about 60 º is made and the rest of the first half of the remaining warp is set out. The vessel then slows down to set the net. The net bag and cod end is thrown clear of the mouth of the net as it is put off the vessel. The engine is put on full speed again and the vessel begins to set the second eight to ten coils of seine rope off the other side of the vessel turning back to the marker buoy.

The marker buoy is lifted aboard and the free ends of both warps placed through the rollers of the towing block. That is, both ends of the rope are hauled simultaneously as the boat moves forward at idle speed (approximately 550-600 rpm) (Fitz 2002 personal communication). The towing begins with the winch pulling in the warps at a very slow rate about 50ft/min (15m/min), gradually increasing to about 75 ft/min (Fitz 2002 personal communication). As the gear is hauled, the seine rope that is moving slowly along the ocean floor creates a mud cloud that the fish avoid by moving to the center of the closing gear. The fish enter the net at the end of the set when the ropes close (which also closes the mouth of the net). At that point the gear is retrieved as rapidly as possible, with the hauling rate increasing to about 200-300 ft/min (60-90m/min) (Sainsbury 1996). When the net is along side the vessel it is brought aboard by a net reel or power block. A "set" takes approximately two hours from the time the gear is set out to the time it is completely back on board. Fish spend only ten minutes or less in the net during retrieval from the ocean floor to the boat and are alive when they reach the deck. (Fitz 2002 personal communication).

Demersal Seine Gear Components That Contact or Effect the Seabed

The lead-core seine ropes of the Scottish seine gear are in contact with the seabed over a length of several hundred meters (as compared to the 100 m or less for bottom trawls). When the gear is hauled the ropes connected to each end of the net are gradually closed. The rate of closure is relatively slow, possibly allowing more time for mobile animals to avoid the rope rather than being overrun. The lighter construction of the net and the lower speed of hauling generate lower tensions in these ropes than in trawl sweeps and bridles. This lower rigidity makes these ropes more able to conform to substrate features instead of cutting through them. Where the rope contacts the substrate, its forward movement displaces sediment as it moves. The amount of tension on the rope determines the amount of displacement and the force exerted on objects that the rope passes over (excerpted from Rose et al. 2002).

The impact of Scottish seine gear on the seabed is minimal because of the slow, gentle movement of the ropes from the initial setting of the gear to the final closing stages of the net. The net itself actually only moves across the seabed a relatively short distance and because the net is very light when compared to a trawl, there is very little disturbance to the seabed (Amos 1985).

3.5.3 Round Haul (Seine) Gear

Purse seine, lampara, and drum seines (bait nets) are called round-haul gear. This gear captures fish by surrounding them in a wall of netting that is then closed off and hauled aboard. These round-haul nets, primarily purse seines, are used to catch market squid, sardines, herring, anchovy, mackerel, bonito, tuna, and salmon. Squid are fished in the Half Moon Bay to Monterey area and in southern California. Bonito and light-meat tunas such as yellowfin and skipjack are primarily caught in southern California. Other tunas caught in purse seine nets in California include northern bluefin and big eye. Round-haul fishermen also fish Pacific herring with purse seine nets in San Francisco Bay, California, Yaquina Bay, Newport and in Puget Sound, Washington. Purse seines are also used in the anchovy bait fishery in Washington coastal estuaries. An experimental purse seine fishery for sardines, regulated by the states of Oregon and Washington, is also being conducted off Oregon and Washington. A purse seine fishery for salmon is conducted in the Puget Sound. Purse seine gear is otherwise not legal in Washington. Seine gear is shown in Figure 3-12 and Figure 3-13.

In **purse seine** fisheries a net, usually made of nylon, is hung vertically, like a curtain, between a cork line at the top of the net and a heavy lead line at the bottom of the net. The vessel sets the net around a school of fish by traveling in a large circle around the fish, while a skiff holds the other end of the net while the vessel completes the circle. The lead line is about 10% shorter than the corkline, to allow for the easier pursing of the net. This design also prevents the corkline from sinking when the net is hauled (Browning 1980). The net has a landing bag at the bottom (which has smaller meshes than the rest of the net). Rings (purse rings) are attached with bridles 1 fathom (1.8 meters) long to the lead line. A cable “purse line” is run through the rings of the net as the net is set off the vessel. When it is time to haul the net, the vessel crew closes or purses the bottom of the seine by pulling on the purse line with a hydraulic deck winch. This closes the net below the fish preventing escape, like closing a drawstring purse. The seine is retrieved by the vessel through a hydraulic power block attached to the vessel’s boom or rigging. The bag is then boomed aboard or the fish are dip brailed or pumped from the seine into the vessel’s hold.

In the California fishery for market squid, two vessels are utilized in the fishing operations. A light vessel is used to locate and concentrate a school of squid using strong lights to attract squid to the surface; while the second vessel catches the fish using a round haul net.

The seine used for salmon (the only salmon seine fishery occurs in Puget Sound) is a long, deep seine, which cannot exceed 1800 feet (549 meters) in length along the cork line, and purse seine and lead combined cannot exceed 2200 feet (671 meters). Mesh sizes cannot be smaller than four inches (10.2 cm) except in the bag (bunt) of the net, which can have mesh of three and a half inches (8.9 cm). During the fall purse seine fishery for chum in some areas, the top 100 meshes below the cork line must have a five inch mesh to allow the escapement of immature king salmon. The depth of the seine depends on bottom conditions and water depth, but adding to or subtracting to the net is a time consuming task, and depth is not frequently changed. To offset the problem of the net snagging on the bottom, many salmon seines are built with a taper in one or both ends. This tapering narrows that part of the net and allows it to be fished in shallow water close to the beach with a minimum of fouling (Browning 1980).

The California seine fishery for mackerel and anchovy uses seines similar in size to the herring seines of Washington (Browning 1980) with mesh sizes appropriate to the species being fished.

The **lampara net**, also called bait net was the forerunner of the purse seine net. It is a shorter and shallower net than the purse seine and can be set and hauled in less time and with less power and was used for species such as sardines, anchovies, and mackerels (Browning 1980). It was the prime net used for the sardines in Monterey Bay and San Pedro in the early 1900s. It has a cork line and a lead line but does not use purse line, purse ring bridles or purse rings. It has a large central bag of webbing (bunt) and short wings of larger mesh, hung so the leadline at the bottom of the net is pulled in advance of the corkline at the top. The net is set with one tow line secured to a buoy or to a skiff, the other to the fishing vessel itself. The set is made rapidly around a school of fish, with the haul quickly begun to keep the catch in the net. With both wings pulled simultaneously, the leadline closes, forming a floor through which the fish cannot escape and drawing the net into a scoop. The lampara is not commonly used anymore in California except for in the bait fishery for smelt and other species and to take white croaker, perch, and queenfish. (CDFG 2001). In Washington lampara gear is used to fish herring and is also sometimes used in the coastal anchovy bait fishery.

The **drum seine vessel** uses a 6ft. -8 ft. (1.8-2.4 m) hydraulic drum to set and retrieve a shorter, shallower, narrow purse seine net with cork and lead lines of equal or almost equal length, rather than the shorter leadline of the standard seine. The nets are generally 250-300 fathoms in length (457-549 m) and are about 18 fathoms (33 m) deep (Sainsbury 1996). It is used in California for baitfish fishing.

Beach seines or drag seines (Washington). These seine nets are used to catch salmon in Puget Sound and are also used to harvest smelt and perch. The long rectangular drag seine net, with its float line on the top and a lead line on the bottom to assure good contact with the bottom, are set by boat off the beach, riverbank, or sandbars. Tow lines are fitted to both ends of the net as working lines.

One end of the net is fastened to a stake, anchored to the beach, or held onshore by people. The other end of the net is taken away from the shore by a boat ahead of migrating fish. The net is set in an arc around the fish, trapping the fish as that end of the net is then brought back again to shore and also fastened to the beach. The weighted part of the net sinks to the bottom while the top remains buoyant. The net is then hauled back in by manpower, power winches, tractors or four-wheel drive vehicles from the end that was anchored to the beach last. As the net is hauled, the weighted end of the net drags along the bottom trapping fish in its path. Nets can also be set with two boats each carrying half the net out off the beach and then simultaneously dropping the nets as the boat arcs each end back to shore. Nets can have a bunt or bag in the middle of the two wings, or be a straight wall of webbing.

<u>Round-Haul Gear Components That Contact or Effect the Seabed</u>

The leadlines of beach seine nets are designed to be in contact with the bottom and move across the bottom when being hauled. The leadlines of other round haul nets may be in contact with the bottom when fished in shallow water or close to shore (e.g. for salmon).

3.5.4 Gillnets and Trammel nets

Gillnets are flat, rectangular nets that hang vertically in the water from a buoyed cork line that is weighted with a lead line. The cork and lead lines and the nylon nets are much lighter than those used in seine netting, while the anchors used on set gillnets are often heavier or larger than those used with longlines (Rose et al. 2002). The nets are made of a lightweight multifilament nylon or monofilament strands with certain specific mesh sizes to select the catch. The size is selected so the heads of the desired fish go through the mesh, but their bodies do not. When the fish tries to escape they tend to become entangled in the net. The mesh size is set by regulation with the goal that undersized fish of the desired species can pass through the net without being caught. Therefore, mesh sizes vary considerably depending on species. For example the California swordfish fishery uses a minimum mesh size of 14 inches (36 cm) (more commonly 18 to 22 inches), while salmon fisheries may use a mesh size of five to seven inches (13-18 cm) depending on the salmon species.

Gillnet webbing hangs fairly vertically in the water column, but it tends to bulge under current effects. Much slack is built into the net because the fish swimming into a taut section of webbing tend to bounce away from the net rather than become entangled in it. (Browning 1980) The percentage of slack built into the net depends on the shape and configuration of the fish. For example, salmon nets may have 40% slack, swordfish nets need 45% slack, and California halibut need about 75% slack (West 2003).

A trammel net is a gillnet made with two or more walls joined to a common float line. On the Columbia River for example trammel nets use three walls of webbing. The inner net hangs deeper than the outer webbing. When a fish hits the net it passes through the outer webbing, strikes the inner webbing with its smaller mesh and carries through to the larger webbing on the opposite side, trapping itself in the pocket formed by the intertwined webbing. Trammel nets were once in use for California Halibut but it is no longer used, having been replaced by monofilament nets that are not as easily fouled by kelp, sticks, and plastic trash.

Gillnets can either be fished as a set or anchor net **(setnet)** (where ends are anchored in place) or as a drift net **(driftnet)**, where the net drifts freely in the water, unattached to the ocean floor, though one end may also be tied off to a vessel which also drifts. Trammel nets are only fished as **setnets**.

The **setnet** is banned in Washington and Oregon except for small numbers of treaty set net fishermen on the Columbia River above Bonneville Dam and on certain smaller rivers of western Washington. This treaty fishery takes salmon, dogfish and true cod; lingcod and rockfish are caught as bycatch.

In California, setnets are only allowed outside of three miles. Setnets can be fished at all water depths depending on the behavior of the fish being pursued. For example white seabass can be pursued by setnets both when they reside near the bottom (during some parts of their life cycle) as well as when they are in the upper parts of the water column. There is a setnet fishery for bonito, flying fish, and white croaker (mesh sizes of 2.75- 3 inches, 7.0 cm-7.6 cm), fishery for white seabass (using minimum mesh sizes of six inches, 15.2 cm), and a fishery for barracuda with a 3.5" (8.9 cm) mesh size. In California setnets are also used for angel shark, California halibut, lingcod, mullet, and perch. While trammel nets are also allowed to be used in these fisheries, these nets are not currently known to be in use (West 2003).

In nearshore California waters, outside of three miles, setnets for rockfish are also regulated by depth restrictions; however, they are currently not being used because of the strict limits for certain rockfish such as bocaccio (West 2003). Additional regulations require the California halibut setnets to have breakaway panels strung between each section (gang) of net to assure mammals will be able to break through nets they encounter.

Setnets are held in place by anchors. The bottom of the net is held down by the use of leadlines that utilize about 100 pounds of weight per 100 fathoms of line.

Driftnets are banned in Washington ocean waters. Driftnets are prohibited in California coastal waters (inside three miles). Driftnets are used to catch salmon (and sturgeon) in Puget Sound**,** Grays Harbor, Willapa Bay, and on the lower Columbia River. They are also used in the Columbia River for shad and smelt. Driftnets are also used in Washington estuaries and inland waters for roe herring, sturgeon and smelt. Driftnets are used for common thresher shark and swordfish in California and Oregon in waters 50 to 100 miles offshore (80-161 kilometers). This fishery also takes shortfin mako shark and pelagic and bigeye thresher shark. Blue shark and striped marlin are occasionally caught but not sold. Driftnets also are used for white seabass, barracuda, yellowtail fishing in California in waters from three to ten miles offshore (4.8-16 kilometers).

Regulations also control the length of the gillnet. For example, swordfish driftnets can be no longer than one nautical mile (1000 fathoms or 1.8 km) in length in California. In Washington salmon gillnets can be a maximum length of 300 fathoms (0.55 km) in length. In Oregon the maximum length for Columbia River salmon gillnets is 250 fathoms (0.46 km).

The driftnet can be fished at the surface or in midwater. The depth of the net in the water column is determined by the length of the tether lines (also called support lines) that are hung from each buoy (buoy ball). The net has a slight negative buoyancy and these tether lines allows the net to drop down through the water column to a desired depth. Additional negative buoyancy for the net is achieved by a small weighted lead line (typically 40 pounds of weight over a 100 fathom leadline, (West 2003 personal communication)). The swordfish fishery is required to be conducted with nets 36 feet below the surface (11m) to minimize marine mammal and seabird interactions. "Pingers" (plastic pieces that emanate a sound frequency that marine mammal sonar systems can pick up) are added to the tether and leadlines of swordfish gillnets at intervals of 25 fathoms (48 m) to further minimize marine mammal interactions.

Driftnets are deployed in various ways; from a stern-mounted reel and roller, from a box roller with no reel (with nets being folded on deck or into boxes), or from a bow mounted reel and roller. They are allowed to fish for a number of hours before retrieval, with the fish being removed from the net as the net is hauled back aboard the vessel. The gillnets fished for salmon are generally set close to the beach, setting the net in a similar procedure to that used by fishermen using a drum seine net. That is, the fishermen drops the float (with a light) close to the beach and motors offshore in a straight line, letting out the line for the float and then playing out the net off the vessel's power reel. As the end of the cork line comes into sight on the reel, the fisherman brakes the reel and brings his vessel to a stop. In order to avoid fouling at least four to five fathoms (7 -9 meters) of tow line is then played out between the net and the boat. The net and vessel then drifts with the currents and are influenced by the tides. Drifts can last through one tidal cycle or less depending on current conditions and the amount of fish. Driftnets must be fished in "substantially a straight line"; encircling of fish is prohibited. To haul the net the procedure is reverse, hauling the towline and net in with the reel, while "picking" the fish from the net as it comes aboard.

<u>Gillnet and Trammel Net Gear Components That Contact or Effect the Seabed (Excerpted from Rose et al. 2002)</u>

The benthic effects of a set gillnet fishing operation occurs during the retrieval of the gear. At this point the nets and leadlines are more likely to snag bottom structures or the exposed sedentary benthos. The anchoring system can also affect bottom organisms and structure if they are dragged along the bottom before ascent. Lost nets can tear organisms from the seabed or overturn cobble and small boulders to which organisms may be attached if they are moved along the seabed by currents. Gillnets may be lost during bad weather or through interaction with mobile gears. Retrieval of gear lost to inclement weather is now high due to the increased use of GPS (global positioning systems), while gillnets lost to interactions with other gear is less likely to be retrieved. Once lost, gear may continue to fish. The extent of this 'ghost fishing' will be related to factors such as water depth, light levels, and water movements as well as vertical profile. A lost gillnet can provide a new surface for epibenthic organisms such as bryozoans to settle on and niches for fish and crabs. Although these organisms will help make the net visible to finfish, it can also provide a food source as certain organisms settle on the net or are caught in the net. This will commonly attract fish or other scavengers to eat those caught and the scavenger species can also get entangled. Over time, especially in areas of high water flow, nets become bundled up, reducing their ability to entangle fish. In deep water, where fouling is very limited and currents slower, derelict nets may fish for longer periods.

Because nets are expensive and can easily become torn if they are snagged on hard or rough bottoms, the goal of setnetters is to avoid these areas, while setting their nets just off to the side and parallel to these areas, on mud or sandy bottoms. Similarly for fear of snagging, efforts are also made to avoid dragging the anchor on retrieval (West 2003 personal communication). A 1000 fathom long swordfish net, cut loose during a storm to avoid the sinking of a vessel, when retrieved 6 days later had already bunched up into a dense mass the size of a small house and was not catching fish (West 2003 personal communication).

3.5.5 Dip Net Fisheries

Dipnets have small nets attached to the end of a long shaft. They are used for harvesting salmon in tribal fisheries in the Columbia River. They are also used for harvesting herring and smelt. Herring is harvested using dip nets in bays and the ocean. Dip nets are used to harvest smelt in rivers.

3.5.6 Salmon Reef Net

Natives of the Puget Sound have been using reef nets for centuries and they continue to be used effectively today in a highly selective fishery by both Native U.S. and other Puget Sound residents. The net is fished among the reefs, set out horizontally in the narrow passages the salmon must traverse to get into fresh water. Fish are guided by two 200-foot leads over the webbing into the bunt (bag) part of the net that collects the fish. Nets are 300 meshes long. Fishermen stationed on a low watch tower built atop a boat or raft watch the fish go into the net and determine the right time to pull the net up. The lead line of the net is raised and the fish are trapped in the bunt and can be brailed (removed with a large sized dip net) from it or the net can be lifted and the fish spilled into holding pens. As the fish do not gill or surround the salmon with a net the fish are kept in excellent shape and non-target salmon species can be released. Pictures of reef nets are available on the Washington Department of Fish and Wildlife website: www.wa.gov/wdfw/fish/regs/commregs/reefnet.htm

3.5.7 Dredge Gear

New Bedford Style Dredge

The only dredges used on the West Coast are used for the Weathervane Scallop fishery. This fishery uses large dredge gear known as the New Bedford style dredge, which scrapes up complete scallops in their shells from the seabed as the dredge is towed behind the vessel with a steel cable. Scallops are fished in waters up to 60 fathoms deep (109 m), usually in areas of firm sand or rocky bottom where scallops will not be bothered by silting (Browning 1980).

The dredge is composed of a low, rectangular heavy steel frame attached to a bag made of four-inch (10 cm) heavy steel rings on the bottom and on the top of the rear end of the bag where the shells gather. Further forward on the top of the bag, the bag is generally polypropylene mesh (generally six inch (15 cm) stretched mesh). The bag is a constant width throughout its length, being held out at the rear by a steel bar called the clubstick.

The dredge frame is between seven and fifteen feet wide (2.1 - 4.6 m) and is attached by a triangular shaped frame to a single towing wire. An 11 foot (3.3m) dredge weighs approximately 1400 lb (636 kg) when empty (air weight) and up to 4000 lb (1818 kg) when full (Sainsbury 1996). A 15-foot dredge weighs 2400 lbs (1089 kg) dry weight (bag and frame), with the frame alone weighing about 1900 lb (862 kg) (NPFMC 2002).

Unlike other types of dredges, the New Bedford scallop dredge does not use a pressure plate to hold the bottom bar of the frame on the bottom nor does the lower bar have ‘teeth’ used to penetrate the substrate. The lower bar of the frame is suspended above the sediment by runners or ‘shoes’ on each side. These shoes are about four inches by nine inches in size (10 cm-23 cm). Tickler chains are strung along the frame and disturb the bottom (and the scallops) ahead of the chain footrope, encouraging the scallops to rise and enter the net. Over rocky bottoms, a chain matrix may be used. Some dredges are designed to produce a vortex behind a baffle to assist in raising the scallops off the seabed.

Both shoes and chain links wear from the abrasion of bottom contact and must be frequently replaced. Shoes are changed every four to five days because they bear most of the weight (NPFMC 2002).

Vessels used for scallop harvesting are often converted double-rigged shrimpers that deploy the dredges one from each outrigger off the sides of the vessel. As scallops can swim quickly for short distances by expelling water fore and aft from its shell, towing speeds are generally faster than those used to harvest flatfish or bottom fish, about 4.3-4.8 knots. Tows last about an hour.

The dredge fishery for scallops developed in 1981 in Oregon, landing millions of pounds of scallops initially, but the resource was quickly depleted. Landings have averaged about 50,000 lbs annually in recent years (McCrae 2002 personal communication). Scallops are shucked either on board or at the processing plant. In Oregon, shells cannot be discarded into bays (Hettman 2002 personal communication).

3.5.7.1 Dredge Gear Components That Contact or Effect the Seabed (Excerpted from Rose et al. 2002)

The effect of dredge gear on the seabed is dependent on the power and capability of the fishing vessel, the towing speed, the weight of the dredge and its size and design. The principal contact with the seabed is made by the shoes, tickler chains and footrope, with the lower edge of the frame only encountering higher sand waves and emergent structures. The chain bag also is pulled across the seabed. Hydraulic baffles may increase the suspension of sediment, while reducing the need for elements in direct contact with the bottom.

3.5.8 Pot and Trap Gear

The words “pot” and “trap” are used interchangeably to mean baited boxes set on the ocean floor to catch various fish and shellfish. They can be circular, rectangular or conical in shape. The pots may be set out individually or fished in stings. On the West Coast, live sablefish, Dungeness crab, spot prawns, rock, box, and hermit crabs, spider crabs, spiny lobster and finfish (California sheephead, cabezon, kelp and rock greenling, California scorpionfish, moray eels, and many species of rockfish) are caught in pots.

All pots contain entry ports and escape ports that allow undersized species to escape. Additionally, all pots used must have biodegradable escape panels or fasteners that prevent the pot from holding fish or crab if the pot is lost. All pots are marked at the surface. The markings are set by regulation. Pots fished in a line need to be marked at each terminal end, with a pole and flag, and sometimes, additionally, a light or radar reflector. Dungeness pots must be fished individually and each is marked by a buoy.

3.5.8.1 Dungeness Crab Pots

The pots used for the Dungeness crab fishery are circular, from three to four feet in diameter (0.9-1.2 m), 1 foot high (0.3 m) and weigh from 75 to 160 pounds (34-73 kg) (most 85-115 lbs) (Austin 1984, Eder 2002). The frames of most all West Coast pots are made from three-quarter inch welded steel, wrapped with strips of used inner tube to protect the steel from corrosion. (A few fishermen use vinyl coated steel; fewer still use pots with stainless steel frames). Stainless steel wire is used to weave a three to four inch diameter mesh over the steel frame. A bait holder is secured to the inside of the pot. Bait is generally squid, mackerel, sardines and sometimes razor clams or herring. Sometimes additionally a mesh bag or stainless pin with bait is secured (hanging bait) so that the crab can access the bait. Each pot contains at least two escape rings in the upper part of the sides of the pot 4.25 inch (10.8 cm) ring and two rectangular or oval tunnels generally 8" x 4" (20.3 by 10.2 cm) (sometimes larger) on opposite sides of the pot to allow crabs to crawl in after the bait. Triggers close the tunnels so it is difficult for large crabs to escape. A ring on the upper half of the sides gives undersized crabs an escape route. Once the fresh bait is gone the traps hold very little or no attraction to crabs or most animals. An escape panel, mostly of 120 thread cotton, sometimes of iron or other biodegradable tie, will decay over time, keeping the pots from holding crabs if pots are lost.

Pots are baited and set out (pushed overboard by the crew) one at a time as the vessel follows a particular depth contour (depths fished generally range from 3 to 80 fathoms (5.5- 146.3 meters). (Occasionally outside of 100 fathoms or shallower than 3 fathoms). Because crabs prefer soft bottom habitat, they are mostly fished on open flats of mud or sand, sometimes habitat with some gravel, and sometimes are set close to rocky outcrops or other edges (Eder 2002). A single line (generally 3/8th inch polypropylene) and bullet shaped buoy or buoys attached to each pot marks its position on the bottom. Typically 30-100 pots (but sometimes many more) are fished in a "string" (a series of individual pots consecutive along a fathom curve), and with several strings being deployed. These strings are usually set parallel to each other and approximately parallel to the beach. A common spacing is about 15 pots per mile (varying from 10-25 pots/mile).

Crab pots are left to fish from one to seven days, depending on fishing conditions. Pots are retrieved individually by snagging the buoy line with a hooked pole as the boat moves forward at about two knots, into the prevailing current, placing the line in the hydraulic power block (crab block) and lifting the pot onto the vessel. The pot is emptied, with the crabs sorted, the legal crabs put into seawater (either into a 'live tank' inserted into the hull, or into the flooded hull itself. The pot is re-baited and reset. The retrieval and re-setting of the pots is a rapid, coordinated art, with pots being retrieved at a rapid rate of about one to two minutes per pot, as the boat moves forward, with the re-baited pot being put back into the water just before the pick-up of the next pot is reached. The pot is generally reset in the same area, but if that area is not productive, the fishermen may pick up their pots and search around to set in another spot. (The new location may be chosen based on a history of knowledge of the area, information from other fishermen, information from the productivity of the fisherman's gear in other locations).

Crabs are alive when sold and are kept alive in the fishermen's hold by pumping seawater through the circulating seawater tanks, at about a 15 minute exchange rate. (In a very few ports, e.g. Port Orford and Trinidad, California, where crabs are sold daily, live crabs may be kept in dry containers (e.g. totes), instead of seawater tanks.)

3.5.8.2 Blackcod Pots

The pots used for the blackcod pot fishery are highly selective for blackcod and are fished off a long-line in series (a set of pots) at various depths. They are generally fished in waters up to o 600 fathoms, though sometimes as deep as 760-800 fathoms. Up to 50 pots are attached to each groundline line. The groundline is usually ¾ inch polypropylene (ranging from 5/8" to 1 1/8"). Pots are spaced every 15 to 40 fathoms along the line, with 20 fathoms being average. An anchor weighs each end of the line. About 60 pounds (27 kg) of weight is used (varying from 50 to 80 pounds) and are often round weights wrapped in mesh bags. Surface buoys and flagpoles mark the location of the lines. Pots are set and retrieved using line haulers and hydraulic blocks and overhead hoists. The pots are large and rectangular, trapezoidal, basket-shaped, or cylindrical in shape and usually weigh less than 50 pounds. Pots are set and retrieved using line haulers and/or drums.

The pots are rectangular, trapezoidal or conical in shape. The most common, trapezoidal pots are approximately 6' x 2.5' in size and weigh about 55 pounds. The conical pots are usually about four to five foot bottom diameter and three foot high and weigh roughly the same as a trapezoidal pot. The bigger rectangular pots may be over 100 pounds in weight. The trapezoidal and conical pots have collapsible bottoms so more pots can be stacked on deck. Pots are usually baited with pacific whiting or sometimes whiting and squid. A single or, more commonly, a double tunnel system allows the fish to enter, but not easily escape. Pots are steel frame covered with mostly 3.5" nylon web (Eder 2002), tunnels are of knotless nylon web. A panel of cotton webbing usually about nine inches square, but no less than eight inches (20.3 cm), is built into the pots to eliminate the retention of fish if they get lost. 21 thread cotton webbing rots away in less than five months (Browning 1980). Many sablefish pot fishermen are now using escape rings to allow the escape of smaller fish while the pot is fishing. This reduces the number of fish the fishermen have to handle and reduces fish mortality due to handling in the release of small fish (Hettman 2002 personal communication).

3.5.8.3 Prawn Pots

Pots used for the prawn fishery (e.g. spot prawns, coonstripe) have a smaller mesh than other types of pots.

The coonstripe shrimp trap uses various trap configurations (CDFG 2001), the most common being a rectangular trap covered in 1 3/8 inch mesh shrimp trawl webbing, with two circular openings. The traps are set in depths ranging from 15-30 fathoms in strings composed of between 20 and 30 traps per string. Fishermen will use 300 to 400 traps during the fishing season. The traps are baited with a variety of baits including herring, sardine, and mackerel. Each pot string is marked with a surface buoy on each end.

The mesh of spot prawn traps in California must be at least one inch by one inch (2.5 cm) in size and the number of traps per vessel is limited to 500 in the Southern California Bight and to 300 pots per vessel within northern California state waters during peak egg-bearing season. In Washington, there is also a maximum number of 500 pots per permit and pot size is limited to a maximum 153 inch (3.9 m) bottom perimeter and a maximum 24 inch (0.6m) height. At least 50% of the net webbing or mesh on the pots must easily allow passage of a 7/8" diameter dowel. Each end of a pot string must be marked with a surface buoy on each end.

3.5.8.4 Other Pot Fisheries

Pots used for any **groundfish fishery** must have escape panels constructed with 21 thread or smaller untreated cotton twine that will result in at least an 8 inch diameter (20.3 cm) opening when the twine deteriorates. Pots are often rectangular or conical in shape and are generally constructed of twine meshes on a steel framework (Hettman 2002 personal communication). Finfish traps are used in nearshore waters off southern California are used to take California sheephead, cabezon, kelp and rock greenling, California scorpionfish, several species of rockfish and moral eel. They are also used in central and northern California for cabezon, greenling, and nearshore rockfish. At least one fisherman in Astoria, Oregon is using pots for cabezon, greenling, nearshore rockfish and wolf eel.

Hagfish pots are tubular traps with an inward tapering tunnel. One or more pots may be attached to a single line.

Spiny lobster traps (in southern California) and the central and southern California **red rock crab** traps use coated wire traps that are generally lighter than a Dungeness crab pot and are weighted with brick weights.

3.5.8.5 Pot Gear Components That Contact or Effect the Seabed

The effect of a pot on the seabed is related to its weight and structure as well as to how far and fast it moves along the seabed before ascending. The weight of the trap is increasingly countered by the lift from the hauling line as the pot comes off of the seabed (Rose et al. 2002).

For pots on a groundline with weights at each end, if the vessel isn't above the part of the gear being retrieved the gear groundline and weights or anchors can effect bottom organisms and structure if they are dragged along the bottom before ascent (Rose et al. 2002). Fishermen however make a conscious effort to get right over the gear as they pull each pot, so as to lift the fewest number of pots off the bottom off the bottom at a time (Eder 2002). This results in much less strain on the line, which can part, if pots are dragged. Because black cod pots aren't always fished on a depth contour, they are sometimes placed on sloping ground. In these cases, pots will be pulled from the downhill, deeper end so that the pots don't drag along the hillside. This allows the pots to be picked up easier, minimizing strain on the gear and equipment, while taking better care of the bottom (Eder 2002).

Lost pots can continue to fish after they are lost, though fouling reduces the fishing effectiveness of lost pots (Rose et al. 2002). Additionally, biodegradable panels are required in all pots to provide escape routes to the fish if a pot is lost.

Dungeness pots are hauled in rapidly by the crab block, generally resulting in little disturbance. If there is a long scope (e.g. if have 30 fathoms of line in 10 fathoms of water), the gear will tend to drag more than if there is shorter scope. Because the boat is moving towards the pot as it picks up the gear, drag is minimized. If the crab pots are tacky (partially buried in sediment), it is especially important to get right over the pot to pick it up (Eder 2002).

3.5.9 Hook and Line Gear

There is a variety of commercial fishing gear that uses hooks and lines in various configurations to catch finfish. These include longline, vertical hook and line, jigs, handlines, rod and reels, vertical and horizontal setlines, troll lines, cable gear and stick gear.

3.5.9.1 Longline Gear

This fishery involves the setting out of a horizontal line to which other lines (gangions) with baited hooks are attached. This horizontal line is secured between anchored lines and identified by floating surface buoys, bamboo poles and flags. The longline may be laid along or just above the ocean floor (a bottom longline) or may be fished in the water column (floating or pelagic longline).

Blackcod, Pacific halibut, groundfish, dogfish, and sturgeon (on the lower Columbia River) are targeted on the bottom longline. The longline also takes lingcod and rock fish.

Pelagic longline is used to target swordfish, shark and tunas. California and Washington do not allow the use of pelagic longline gear in waters off their coast (out to 200 miles). However these species caught with longline gear can be landed in their ports. California requires vessels to file an offshore fishing declaration to land longline-caught fish in their ports (Goen and Hastie 2002). Oregon allows fishing with pelagic longline gear under a Developmental Fisheries Program Permit (for swordfish and blue shark) outside of 25 miles, but currently there is no participation in this program.

To deploy the longline gear, the vessels sets the first anchor and then steams ahead, following a selected pathway (e.g., a depth contour, so that the other lines can be set parallel to the first) with the ground line poles and baited hooks being set off the stern of the boat usually down a chute. (Hooks are baited either by hand or by automatic baiting machines. Common baits are squid, herring, octopus, and cod.) Hooks of various sizes are attached to gangions of various lengths that are tied on or snapped onto the line at the desired interval. Hook size and spacing (ranging from 3-12 feet apart), depth, and soak time (fishing time) vary.

The number of groundlines set and the spacing of the 'strings' on each line is highly variable (Hettman 2002 personal communication). Gear is hauled with a gurdy and roller complex, with fish being taken off the hooks as the groundline comes aboard, and skates being separated from each other and gangions removed for re-baiting.

3.5.9.2 Bottom Longlines

Bottom longline gear fits into two categories: gear that targets fish living directly on the bottom (halibut, cabezon, lingcod etc.) and gear that targets fish living very near the bottom (sablefish, rockfish etc.). Marking buoys, buoy lines and anchors are the same for both types of bottom longline. Additionally hook spacing and size, gangion size and length can also be the same. The difference in longlines for fish living directly on the bottom as opposed to fish living near the bottom comes between gangions and the groundline and in the composition of the groundline itself.

3.5.9.3 Common features of bottom longline gear

<u>Buoys and Anchors</u>

The longline is marked on both ends with a cane flagpole with a radar reflector and a flotation buoy.

Below the buoys the buoy line (30-50 fathoms longer than the water depth) travels from the surface down to the anchor on the bottom.

The anchor is usually 25-50 lbs. and has two or more legs extending from a main shank. A length of chain extends from the base of the anchor's legs along the main shank to a few inches past the attaching eye. This chain serves to dislodge the anchor from being hung up on rocky bottom. The chain is fixed securely to the legs end of the main shank of the anchor and is tied with a relatively weak 'string' to the eye end of the anchor. The lower end of the buoy line has an anchor gangion spliced into it. The anchor gangion is tied into the loose end of the anchor chain, a few links past the eye. If the anchor becomes stuck in rocky ocean bottom, the string 'weak link' breaks, and the pull from the buoy line is then transferred from the eye end of the anchor to the legs end of the anchor and the anchor is pulled out backwards (Pettis 2002 personal communication).

<u>Gangions</u>

Gangions for halibut are usually #72 thread braided nylon. Lighter material is used for smaller fish. The length of the halibut gangion varies from 30 inches and longer, based on the height of the vessel's railing, as the railman will want to have the gangion in hand before the fish is pulled from the water. Gangions can be either tied on "stuck" or snap-on. Gangion spacing with snap gear depends on the expected density of halibut in the area to be fished. A "hot spot" may have the gangions snapped on just far enough apart that the fish will not tangle each other, whereas a scouting set may be spaced 60 feet or more apart, though 9-15 feet would be standard. Gangion spacing on stuck gear is a blend of expected fish density, groundline lay (stiffness) and gear storage methods. For instance if the gear is to be coiled into wash tubs and the line is somewhat stiff, the hook spacing will be a multiple of the length of the line it takes to make a comfortable fit coil in the tub. With very soft lay line (i.e. line with 'no memory') the spacing would be based on expected fish density (Pettis 2002 personal communication).

Hooks

Nearly all modern longline operations use 'circle' hooks. These hooks are shaped somewhat like the clenched talon of a bird of pery in that the point of the hook circles back toward the shank and ends up pointing well below the eye of the hook. Hooks range from #16 halibut hooks, that are about three inches tall (7.6 cm) to #7 hooks about that are about one and a quarter inches tall (3.2 cm) for black cod and other smaller fish (Pettis 2002 personal communication).

Longline Gear for fish living directly on the bottom

Groundline

The ground line used to fish for fish living on the bottom is usually about 5/16th inch diameter and is made of nylon or another non-buoyant material. Also ground line made of polypropylene with some lead fibers mixed in is used.

Ground line is stored either wound on a hydraulic powered reel, for snap on gangion gear sets or is coiled up in round 'wash tubs' for tied-on or 'stuck' gangion gear (Pettis 2002 personal communication).

Weights

Weights of one to five pounds are sometimes attached to the groudline either to speed sinking rate through upper waters that might house non-desired species, or when fishing uneven bottom contours to ensure the groundline does not 'clothesline' from high point to high point missing the lower ground completely (Pettis 2002 personal communication).

Longline Gear for fishing living near the bottom

When fishing for fish that live directly on the ocean bottom, the fisherman must put his gear where the fish live, directly on the bottom. One problem with doing this is that many other 'hungry' sea creatures live there as well. In an attempt to save his bait for the desired species, and keep it above the rest (starfish, crabs, etc.), the fishermen seeking fish species that live just off the bottom will use a modified groundline and a series of weights and small floats (Pettis 2002 personal communication).

Groundline

Groundline used slightly off the bottom is made of materials that have positive buoyance (e.g. polypropylene). This helps the floats hold the hooks and bait above the bottom.

Floats and Weights

A series of weights are used along the groundline to sink the groundline to the bottom. The floats have enough buoyancy to lift the groundline, hooks and gangions, but not enough to hold up the weights. The floats keep most of the hooks above the bottom. The height off the bottom can be regulated with the amount of line used between the groundline and the weights. Another way to control 'fishing height' is the number of hooks between weights and floats (Pettis 2002 personal communication).

<u>Advantages of each type of bottom longline</u>

The direct on the bottom longline gets the gear down and fishing faster. This is beneficial during short duration fisheries such as West Coast halibut with only ten hour seasons. This gear sinks faster and is less affected by surface currents, so fishing very close to other fisheries on 'hot spots' creates fewer tangles. Sinking faster also reduces marine bird bycatch (Pettis 2002 personal communication).

The just above the bottom longline keeps the bait 'fishing' much longer. It also allows the hooked fish to swim around a little above the bottom. This helps keeps predators from damaging desired fish and allows unwanted fish (those without swim bladders) to be released alive when hauling. Fewer opportunities to snag the bottom exist when only the anchors and small groundline weights contact the bottom. This reduces the impact of the gear on the ocean floor environment (Pettis 2002 personal communication).

<u>Examples of gear configurations for some groundfish longline fisheries</u>

A Pacific halibut ground line is generally composed of ten skates of 300 fathoms (548.6 meters), covering 18,000 feet (5.6 km or 3 nautical miles). It is generally composed of #72 nylon twine with a test of 1800 pounds. Each skate weighs 32 pounds (on deck). Each gangion, also composed of #72 thread braided nylon, averages about 58 inches (1.5 meters) long, is attached to the groundline with snap gear, with a hook at the other end.   Each groundline might contain up to 800 hooks and take three hours to retrieve (hook spacings of 26 feet (7.9 meters) are common, but spacings between 18 feet (5.5 meters) and 36 feet (11 meters) also have been used.). Halibut longlines are generally set at depths ranging from 30-150 fathoms (but some may be fished down to 600 fathoms) and are left to fish for six to twelve hours before hauling (Browning 1980).

A blackcod ground line might cover one and a half nautical miles (2.8 km) and contain 3,000 hooks. Hook spacings of about three feet (0.9 meters) is about standard. The groundline and gangions are similar to that used for the halibut fishery (generally #72 nylon twine). Blackcod gear is generally hauled after four to six hours due to the propensity of black cod to escape or to be taken by predators. Blackcod is fished year round from inside 100 fathoms to 500 fathoms, with most of the fishery historically taking place in 350-400 fathoms (Browning 1980).

A groundfish ground line typically covers one nautical mile (1.9 km) and is composed of ten skates of groundline, each 100-150 fathoms long. Gangions are snapped onto the groundline at three to four foot intervals. Herring and squid are used for bait on the hooks. Intermediate weights are used on the groundline to minimize the movement of the groundline across the bottom. The gear is left to fish for two to twelve hours before hauling (NPFMC 2002).

A sturgeon longline fishery takes place on the lower Columbia River. Gillnet boats are used, and groundlines are wound on the net reel. The seasons are variable but may run for two months in early spring and a month or more in the summer.

3.5.9.4 Gear Components of Bottom Longlines That Contact or Effect the Seabed

The principal components of the longline that can produce effects on the seabed are the anchors or weights, the hooks and the mainline. The key determinant of the effects of longlines is how far they travel over the seabed during setting or retrieval. Significant travel distance is more likely during retrieval. If the hauling vessel is not above the part of the line that is being lifted, the line, hooks and anchors can be pulled across the seabed before ascending. If the hooks and line snare exposed organisms they can be injured or detached. Lines may undercut emergent structures or roll over them. The relatively low breaking strength of the line may limit damage to more durable seafloor features (Rose et al. 2002).

The mainline can also be moved numerous feet along the bottom and up into the water column by fish, particularly halibut during escape runs. Objects in the path of the groundline can be disturbed (Johnson 2002).

3.5.9.5 Pelagic Longlines

As noted above, pelagic longline gear is currently not in use in the U.S. waters off Washington, Oregon, or California. It is prohibited gear in Washington and California and while allowed under a developmental fishery permit in Oregon, no permits are currently in effect.

Though the gear is not in use currently, it is described here for informational purposes. Pelagic longline gear can be fished either near the surface or at a certain depth. Several lines may be fished at the same time, kept separated with the help of outriggers. Pelagic longlines can be fixed (anchored to the seafloor) or can be drifted. The nets can be kept near the surface or at a specified depth in the water column by a series of floats and weights. Drift longlines may remain attached to a vessel, but the vessel drifts with the gear as it is being fished (Goen and Hastie 2002).

3.5.9.6 Handline and Jig Gear

Handline and jig fisheries use vertical, weighted monofilament lines on which baited hooks are attached at intervals using wire spreaders or individual leaders attached with swivels. In a typical jig arrangement, a line is 400 pound (181 kg) test monofilament and the jig weighs eight pounds. The hooks are attached to the mainline and are dressed up with colorful segments of rubber surgical tubing, hoochies, or bait (herring or other fish). By hand, or with mechanical gear, the jig is dropped to the bottom to determine the depth. The line is then usually lifted a short distance off the bottom and then jigged vertically up and down to produce movements of the hoochies or bait and induce the fish into biting. This type of gear is used to harvest lingcod and rockfish.

With mechanical jigs, the gear is automated and lets out and reels in line as programmed. It can also be programmed to sense when the gear hits the sea bed and automatically pull in enough line so that the hooks stay a few feet above the bottom without snagging (Sainsbury 1996). When a pre-set weight of fish has been hooked, the jigger can automatically reel in the monofilament line. Mechanical jiggers will generally utilize between six and sixteen hooks on gangions and many lines can be actively jigged. Squid jigging vessels may utilize up to 30 jigs and attract the squid with bright lights.

Handlines can also be fished without active jigging.

3.5.9.7 Handline/Jig Gear Components That Contact or Effect the Seabed

The jig (weight) is dropped periodically to the seabed to determine depth.

3.5.9.8 Stick (Pipe) Gear

Stick gear uses a plastic (PVC) or aluminum pipe which is suspended from a mainline and weighted with about a three pound weight (1.5 kg). Wire spreaders are attached at a selected distance up and down the pipe. Leaders are attached with a swivel clip to these wire spreaders. This gear can move along the bottom and is often set near the edge of kelp beds (Riley 2002, personal communication).

3.5.9.9 Stick Gear Components That Contact or Effect the Seabed

The weight contacts the seabed and can bounce along the bottom.

3.5.9.10 Rod and Reel Gear

Fishing poles rigged with monofilament line of various strengths and hooks of various sizes and designs are used to fish salmon and groundfish in commercial, recreational and charter boat (also called party boat or commercial passenger vessel) fisheries. Flashers, hoochies, and bait are used to attract fish to the hooks. Lines may be cast or trolled. Lines are weighted with sinkers that generally range from half an ounce to six ounces (0.23-2.7grams). These may be round or pyramid or crescent shaped. Weighted lines and hooks are cast overboard and allowed to descend to the desired depth. When a fish is on the line, fish are reeled back in. The number of hooks and lines fished may be regulated. When multiple hooks are fished, each hook may be fished from an eight to twelve inch “dropper” line attached with a three way swivel to the leader from the main fishing line. Multiple leaders may be attached to each other. Leaders are generally 24” long with one dropper line attached to each end.

3.5.9.11 Rod and Real Gear Components That Contact or Effect the Seabed

When fishing near the bottom or near reefs, the sinkers may come in contact with the substrate.

3.5.9.12 Vertical Hook and Line (also called vertical longline, buoy or Portuguese long line)

Vertical longline gear is used in Southern California and Oregon to target rockfish. This hook-and-line gear involves a single line anchored at the bottom and buoyed at the surface so as to fish vertically. Baited circle hooks are spaced about 12 inches apart (30.5 cm) and are tied, with monofilament leader, to the mainline. Wind and waves jiggle the buoy, which wiggles the line and the hooks.

3.5.9.13 Vertical Hook and Line Gear Components That Contact or Effect the Seabed

The anchor contacts the seabed.

3.5.9.14 Troll Gear

Trolling involves towing multiple lines with multiple hooks behind a vessel moving at speeds suited to the fish desired (e.g. a speed of one to four knots for salmon, four to eight knots for albacore). Fishing lines are rigged to a pair (or more, depending on regulations) of three inch to six-inch diameter outriggers (trolling poles) that are lowered to approximately 45-degree angles from the boat. Tag lines which are attached to the trolling pole hold the fishing lines away from the boat. A wedge-shaped stabilizer made of steel or wood and lead is often also hung on steel wire or chain from each outrigger to help stabilize the boat. These stabilizers ride from 10-20 feet (1.5-3.0 meters) below the surface.

Fishing lines are set and retrieved using gurdies (powered spools or reels) mounted on the vessel in sets of two, three or four. Each gurdy spool, usually powered by hydraulics, contains and works one main line.

3.5.9.15 Salmon Troll Fishery

Salmon troll vessels ranges in size from 18 to 60 feet. Steel lines (main lines), attached to the poles by a tag line, are weighted with 20-65 pound (9-29 kg) lead weights called cannonballs. The main lines and cannonballs are used to control fishing depth and to keep the lines apart. Up to four main lines are used on each outrigger, though two or three mainlines are most common. Each line may have four to ten spreads per line depending on the species of salmon targeted. A spread consists of monofilament leaders with attractants and hooks attached. Spreads are placed every two to five fathoms up from the cannonball, generally by being snapped onto the main line between stops set onto the main line. Troll fishermen have used longer and fewer spreads to better target chinook while avoiding coho salmon (Heikkila 2002 personal communication). Fish are attracted to the hooks with a flasher and terminal gear usually consists of plugs, spoons, plastic squid hoochies or hooks baited with herring or anchovy. Hooks must be single point, single shank, and barbless.

Fishing lines are set and retrieved using gurdies (powered spools or reels) mounted on the vessel in sets of two, three, or four. Each gurdy spool contains and works one main line.

Salmon are fished pelagically as well as close to the bottom in water depths up to about 80 fathoms (146 meters) and up to 50 miles (85 kilometers) offshore, from central California to the U.S./Canadian over bottom habitat of any type. The fishery occurs intermittently between March and October, subject to area restrictions.

While many salmon fishermen will stay at sea for many days before delivering their iced product, the addition of freezer capacity has allowed other vessels to stay at sea much longer and go much further away from port.

3.5.9.16 Salmon Troll Gear Components That Contact or Effect the Seabed

Most salmon troll gear never comes in contact with the seabed. However, in shallow areas (less than 10 fathoms (18 m)) with flat sandy bottoms near the surf zone, the cannonballs and hooks may be fished in contact with the bottom (Tracy 2002 personal communication). However, most fishermen will avoid contact with the bottom because of loss of gear, safety concern, and encounters with lost crab pot gear (Heikkila 2002 personal communication). In order to avoid loss of line and outriggers if hang-ups occur, the cannonball weights may be attached to the lines by leather straps or other lighter line which is designed to break should the weight hang up on the seabed or gear.

3.5.9.17 Albacore Troll Fishery

Vessels targeting albacore tuna range in size from 40 to 70 feet and tow up to 13 lines of varying lengths from the outrigger poles and the stern. A lure called a jig is attached to the end of each generally unweighted line (unless ocean conditions require weights to keep lures from bouncing free of the water). One or two lines on each pole may also be weighted with chain heavy enough to sink line and lure so that outside lines may be hauled over them without snagging. Jigs have metal heads, plastic skirts or feathers, and large, barbless double hooks. Fish are pulled aboard by hand or by line haulers (pulleys) located on the stern.

Albacore jigs are fished on the surface of the water. While the season is open year round, albacore are usually fished from July through October, when the water is warmer not too far offshore (e.g. 20-60 miles (32-96 km)). Albacore prefer water from 58 - 64 º Fahrenheit (14-18 º C). However, some fishermen will venture out much further, as far as 1500 miles (2413 km) offshore (Goblirsh 2002 personal communication). The development of vessels with large fuel capacity and on-board freezing systems has allowed this far-ranging fishery. Some of these fishermen deliver back to the West Coast, others go to Midway, Hawaii and the South Pacific, delivering to at-sea tenders or to ports in these places.

3.5.9.18 Albacore Troll Gear Components That Contact or Effect the Seabed

Albacore gear does not come in contact with or affect the seabed.

3.5.9.19 Groundfish Troll Fishery

Troll gear is also used to harvest groundfish. One type of gear is often called ‘dingle bar’ gear, so named because when the five to seven foot iron bar (1.5-1.75" in diameter) touches bottom there is a distinct ‘ding’ transmitted up the steel trolling wire. The gear is designed to be fished three to six feet above rocky bottom and the iron weight is allowed to touch the bottom only occasionally to adjust for varying depths. This gear is used primarily to target lingcod (sometimes halibut) and is very selective. It has been used to target lingcod for over 50 years (Heikkila 2002 personal communication).

The gear is attached to trolling wire with double troll snaps usually two to three feet above where the iron bar is attached. The mainline is normally 400-pound test monofilament line (181 kg) with small brass spreaders with three swivels spread six feet apart. Two four to five inch (10-13 cm) hard plastic floats are placed in the middle and end of the gear. The fishing lures, six to eight ounce (170-227 gram) lead-head jigs, are hung on five foot, 200 lb/test monofilament gangions attached to the center swivel of the spreaders. The jigs are baited with large plastic worms called ‘scampies’ and are sometimes tipped with bait. Normally four to eight jigs are used (Heikkila 2002 personal communication).

Other groundfish trolling gear is similar to the above described ‘dingle bar’ gear, except it uses a bent steel bar about four feet in length (1.2 m) that weighs about 40 pounds (18 kg) rigged at the end of the steel main line (trolling wire). The bend in the bar assists the bar slide over the seabed or rocks. It is attached to the main line by a breaking strap which will break if a hang-up occurs. The gear consists of a snap link attached to a swivel, followed by 1 fathom (1.8 m) of monofilament line, then about 2 ft of thicker spreader bar. This combination is repeated a number of times to form a string. Gangions of monofilament and heavy stainless wire with weighted hooks are connected to each swivel of the string. At the end of the string, a rigid plastic float is rigged to provide drag and flotation to keep the string and hooks horizontal and suspend the hooks just above the bottom. Ten to fifteen of these strings may be attached to main line above the bent weight bar at various depths to target rockfish congregating at different depths around rock pinnacles (Sainsbury 1996, CDFG 2001).

To fish a number of depths near the surface, floats are rigged on the main lines, followed by a number of leaders and a heavy weight (CDFG 2001). By adjusting the weights, length of main line and location of leaders, the hooks can be rigged to fish a range of depths within the desired band. (Sainsbury 1996)

3.5.9.20 Groundfish Troll Gear Components That Contact or Effect the Seabed

The iron and steel “dingle” bars can contact the seafloor. The hooks and line can snag on rocks, corals, kelps and other objects during retrieval. This may upend smaller rocks and break hard corals, while leaving soft corals unaffected. Invertebrates and other lightweight objects can also be dislodged.

3.5.9.21 Mooching

Mooching is a fishing technique used for catching salmon. It involves fishing multiple fishing poles with baited hooks behind a vessel while the vessel either drifts or stays stationary in the current. This is not legal commercial gear in Oregon and Washington where the gurdies or poles have to be fixed to the vessel, but it is used for recreational fishing. Salmon mooching is both a commercial and recreational fishery in California, primarily south of Point Arena and particularly in Monterey Bay and San Francisco Bay. This fishery is usually pursued by small outboard boats owned by recreational fishermen who also hold a commercial permit. This fishing gear is described in the recreational fishing section below. Mooching gear does not generally come in contact with or affect the seabed.

3.5.10 Other Fishing Gear

3.5.10.1 Dive, Hand/Mechanical Collection Fisheries

In Washington and Oregon sea urchins, clam, octopus, oyster, sea cucumber, scallop, and ghost shrimp are harvested by hand, dive, or mechanical collection methods. Finfish are also taken by divers using a spear or speargun and live fish are taken in California by divers using a short fishing line deployed underwater near the target fish. In California, sea urchin are taken in dive fisheries, as are crab, scallops, and lobster. Swordfish are taken with harpoons, and other fish (e.g. skates, rays, certain sharks are taken with spears, spear guns, harpoons, and bow and arrows). Bow and arrow gear may also be used to take certain finfish.

Dive fisheries (using either a self contained air tank, or breathing off a hose “hooka” from a low pressure air compressor vessel) are used to pursue various fish and shellfish such as urchins, lobsters, and sea cucumbers which are hand collected, sometimes using rakes or other hand carried implements. Regulations may control the number of divers in the water by permit. Scuba gear is also used to pursue finfish with a spear or speargun.

Free-dive fisheries prohibit the use of scuba and surface-supplied air, or “hookas”. This creates a depth refuge for portions of the target stock because free divers generally cannot dive deeper than 28 ft (8.5m) (Karpov et al. 1998 in CDFG 2005).

Harpoons, spears and sticks are shafts with sharp, pointed, or barbed tips. These may be propelled by hand or by mechanical means. Harpoons are not legal gear in Washington. The harpoon is attached by line to an inflatable buoy and to the fishing vessel by a recovery line (tag line) that spools out of line on board the vessel. The movement of the fish, once struck is shown by the buoy, so that the vessel may follow its movements. Swordfish harpoon vessels in California work in conjunction with an airplane to spot swordfish basking at the surface.

Harpoons are hand propelled. Modern harpoons may employ electrical shocks to kill or stun the fish so it can be brought on-board without excessive fighting activity.

Urchin harvest occurs at depths of five to 100 feet (1.5- 30.5 m), with most dives taking place in 20-60 feet (in Oregon and Washington, dives must be in water depths greater than 10 feet (3.5 m) from the mean-lower low water). Red, purple, and green urchins are harvested commercially. Red and green are primarily harvested in Washington, red in Oregon, and red and purple in California. Urchins are harvested from the ocean bottom with a hand-held rake or hook and put into a hoop net bag or wire basket. The basket is winched onto the boat and emptied into a larger net bag. Limited entry permits and lower size limits are used in Washington, Oregon and California to control the harvest for red sea urchins (additionally upper size limits and seasonal and area restrictions are used in Washington, and seasonal requirements and log book requirements are in place for regulating this fishery in California).

Red abalone are taken in free-dive sport fisheries in northern California using hand held abalone irons. Specialized abalone irons and caliper-type measuring gauges are required to reduce damage to the foot of abalone, and reduce incidental mortality to abalone of non-legal size (CDFG 2005).

Clams are taken in shallow estuarine waters or along the nearshore by hand-held hoes and rakes, and in some cases (e.g. geoduck clams) by using hand held water hoses with a one inch (2.5 cm) nozzle at the end that is attached to an 11 hp motor. This water hose liquefies the sediment around the clam and allows it to be captured.

There is currently interest in Oregon to harvest bay clams using a water hose similar to that used in the geoduck fishery, but with a smaller pump (5hp) that pushes air through a nozzle that is a half inch in diameter. Lack of capability to monitor effects has put a hold on these experimental fishery permits. Gapers are generally found in a combination of sand, mud and shell habitat from the intertidal zone to depths of 17 fathoms (30m). If allowed in Oregon, mechanical gear would be limited to depths greater than ten feet (3 m) to protect the intertidal zone.

3.5.10.2 Gear Components of Dive and Hand/Mechanical Collection Gear That Contact or Effect the Seabed

The urchin collection bags may sit on the bottom during harvesting. Clam rakes and hoes and water from hoses disturb the bottom to dislodge the shellfish. Hooks used to dislodge abalone from their substrate can contact the substrate.

3.5.10.3 Herring spawn on kelp

A fishery for herring eggs (roe) that have been laid on naturally growing kelp is conducted in Puget Sound, Washington and in California. The kelp fronds with their clinging eggs are cut by hand from small skiffs. The weight of the catch (including the plants) is limited to twenty-five pounds in California. Oregon also had a fishery for eggs on kelp, with Macrocystis (giant kelp) shipped in from California and hung on rocks for the herring to spawn on (Hettman 2002 personal communication).

3.5.10.4 Herring brush weir

In Puget Sound, Washington, fishermen also construct structures that are placed in bays where herring spawn. The weir is removed from the water and the eggs collected.

3.5.10.5 Ghost shrimp pumps

Commercial fishermen use gas-operated pumps or hand propelled pumps in the nearshore to harvest mud and ghost shrimp from tidal mudflats. The mouth of these pumps mechanically evacuates smallish diameter holes in portions of the sediment.

3.5.10.6 Poke Pole

Poke poles are long bamboo poles with baited hooks attached to the end that are used in intertidal areas by recreational fishermen along the northern California coast to capture cabezon, greenling, and an occasional shallow water rockfish or prickleback.

3.5.10.7 Bait Pens

List of continuing fisheries notes WA, OR, and CA bait pens with about 13 participants. Information needed.

3.5.10.8 Live Groundfish

Only legal commercial fishing gear of certain types is allowed to be used to harvest live finfish and shellfish. The gears have already been described, but further information is provided here to define the gears used in the live fish fishery.

Live groundfish are caught in the open access groundfish hook and line fishery, with limited entry longline gear and with limited entry pot gear, and a variety of other hook gears (e.g. stick gear). Additionally, California halibut and rockfish taken in gill and trammel nets have increasingly appeared in the live/premium fish fishery (CDFG 2001). A new development is California urchin divers fishing with hooka gear underwater during the off-season for urchins. They fish a short line (18" line) underwater to target the same fish that are targeted by the other hook and line gear. Landings of 80-100 pounds (36-45 kg) of fish have been made at times by the three or four fishermen who currently are using this gear in California (Calvis 2002 personal communication).

In California hook and line gear for the live-fish fishery within one mile of the mainline shore has been limited, since 1995, to a maximum of 150 hooks per vessel and 15 hooks per line (CDFG 2001). Traps are limited to 50 per fisherman.

In Washington, it is illegal to possess live bottom fish taken under a commercial fishing license.

In Oregon, nearshore rockfish and species such as cabezon and greenling are the target of the live fish fishery. Only sablefish and rockfish have certain limits on their catch (the catch is credited against the federally set limited-entry allocations). This fishery occurs in waters of ten fathoms or less (18 m). In early 2002, an Oregon Development Fisheries Permit was required for fishermen landing live fish species (e.g. cabezon, greenling (except kelp greenling), brown, gopher, copper, black and yellow, kelp, vermilion, and grass rockfish (among others), buffalo sculpin, Irish lords, and many surfperch species). Additionally commercial fishing for food fish is prohibited in Oregon bays and estuaries and within 600 feet (183 m) seaward of any jetty. Only legal gears must be used to catch nearshore live fish.

3.5.10.9 Live Finfish (non-groundfish), Live Shellfish Fisheries

Baited traps, no larger than three feet in its largest dimension, are used for shiner perch, Pacific staghorn sculpin and longjaw mudsuckers in California.

Dip nets and baited hoop nets not greater than three feet (0.9 m) in diameter may be used to take herring, Pacific staghorn sculpin, shiner surfperch, surf smelt, topsmelt, anchovies, shrimp, and squid in California. Hawaiian type throw nets are also used to take these species north of Point Conception.

Beach nets not over 20 feet (6 m) in length with meshes at least 7/8ths of an inch in length are allowed to be used to take surf smelt north of Point Conception, California.

Prawns (spot and ridgeback primarily) are taken with a trap fishery as are Dungeness crab.

3.5.11 Gear Used in Tribal Fisheries

The Gear Used in Tribal Fisheries is the same as the gear used in the commercial and recreational fisheries described above and below.

3.5.12 Gear Used In Recreational Fisheries

Recreational fishing is fishing with authorized gear for personal use only and not for sale or barter.

The only gear legal to use for groundfish in the area between 3 and 200 miles from shore (4.8-322 km) are hook and lines and spears.

Rockfish and cabezon are generally fished off lines with multiple hooks suspended. Baits include sand and ghost shrimp, pile worms, herring and squid. Alternatively a quarter of an ounce to a one-ounce “leadhead jig” with a rubber worm is used. Lingcod is fished using dead bait or live greenling.

In California recreational groundfish fishermen are restricted to one line and three hooks. Rod and reel gear and handlines are used.

In Washington only one line with two hooks is allowed to be used for all species taken in marine waters. In some Puget Sound areas (Marine Areas 5-13) anglers are required to use only barbless hooks for all species. The exception to this rule is that anglers may use another line equipped with a forage fish jig with up to nine barbed hooks in certain areas (Marine areas 5-13) (WDFW 2002). Dip nets are allowed to be used to land legally hooked fish.

Flatfish are fished in areas with sandy or muddy bottom with rod and reel gear using a small jig or a hook baited with shrimp, marine worm, or mussels.

Pacific Halibut is taken with rod and reel gear using large herring, jigs, spoons or shrimp flies deployed on wire or very heavy monofilament leaders.

The only recreational gear allowed to be used for salmon is hook and line gear that is cast, trolled or mooched. Shore and boat anglers use spinners or bait; offshore anglers troll or mooch. Ocean coho are fished in the upper layers of the water while chinook are deeper and caught with larger plugs (greater than six inches) herring, spoons, spinners or metal jigs.

Trolling involves towing lines from fishing poles behind a vessel. Salmon mooching uses different terminal gear (gear at the end of the line than trolling) though lines are also drifted behind the vessel from fishing poles. In Washington, primarily Puget Sound, and in Oregon, a technique called motor mooching is used. The vessel uses a trolling motor to keep the boat relatively stationary in respect to the current. The gear is rigged to create a spinning bait (herring, sardine or anchovy). The pole is secured in a pole holder on board, or the line may be cast and reeled. In California, drift mooching is practiced. The boat motor is turned off and the boat drifts with the current. The hook is turned around backwards in the bait, usually anchovy (that is the hook is embedded in the biggest part of the fish) and the intent of the technique is to gut hook the fish.

Large tuna poles are generally used and once the fish hits the bait, more fishing line is fed to allow the hook to go deeper, and then the rod is jerked. Circle hooks have been required (instead of J hooks for a number of years to reduce hooking mortality when prohibited fish are released, but hooking mortality remains very high (46%) in comparison to sport trolling hooking mortality rates of about 14% (Grover 2002 personal communication).

Both boat and shore anglers using shrimp, smelt and herring fish green and white sturgeons.

Striped bass (an introduced species) is fished in San Pablo and San Francisco Bays and the ocean area offshore these bays. Gear is generally caught by bait fishing or trolling, though sometimes fly-fishing or casting plugs or jigs is used. Trolling or bait fishing gear is generally used although some fishers may cast jigs or plugs or flyfish. Dead baits include threadfin shad, anchovies, sardines, staghorn sculpins, gobies, shrimp, bloodworms and pile worms. Drift fishing with live anchovies or shiner perch occurs in San Francisco Bay and the ocean, while live golden shiner minnows or threadfin shad are sometimes used in the delta. Trolling methods are specialized for striped bass and many types of plugs, jigs, and spoons are used, frequently in combination.

There are no federal regulations for recreational take of coastal pelagic species (e.g. sardines, anchovy, herring, smelt, squid or mackerel); state regulations apply. Surf smelt are taken from beaches with dip and A frame nets. Pacific herring, northern anchovy, sardine and smelt are caught in bays with multiple-hook herring jigs or nets. Bait includes sand and kelp worms, sand shrimp, clam necks and mussels. Dip nets are allowed to be used to harvest these forage fish in Washington for recreational purposes.

Recreational fisheries for highly migratory species (billfish, sharks, tunas, dorado) use hook and line gear fished from private or charter vessels.

For albacore tuna, anglers use live bait or metal-headed plastic or feather jigs trolled at five knots or faster. Handlines are often used instead of a rod and reel.

There are numerous surfperch species targeted by sport fishermen. Redtail and silver surfperch are found mostly in the surf. Striped seaperch, pile perch, white seaperch, shiner surfperch all live near rocks, docks or pilings in bays. Baits include sand and kelp worms, sand shrimp, clam necks and mussels. Surfperch are fished with rod and reel gear using gear that has multiple hooks.

In California, beach nets may be used to take surf smelt north of Point Conception.

Spears harpoons, bow and arrow fishing tackle may be used to take rays, skates, and sharks (except the white shark).

Clams, mussels, limpets, and other invertebrates are collected from tidal and nearshore waters by hand or using rakes, shovels or other implements allowed by law. In Washington, oysters taken in all areas must be shucked with the shells left on the beach where they were harvested. Herring rakes and smelt rakes are prohibited gear in Washington.

Crabs are allowed to be taken by rings (baited hoop nets) or with baited traps or with dipnets, tangle lines, or snares. The pots are lightweight.

There is a recreational pot fishery for coonstripe shrimp in California and for both coonstripe and spot shrimp in Puget Sound. The pots are lightweight.

Recreational fishermen in San Francisco Bay are allowed to use a hand powered shrimp trawl no greater than 18" by 24" at the mouth and a daily bag limit of five pounds.

3.5.12.1 Components of Recreational Gear That Contact or Effect the Seabed

The principal components of the hook and line gear that could produce benthic habitat effects are the weights, hooks and line. Potential impacts could be related to the line snagging on rocks, corals, kelps and other objects during retrieval. This may upend smaller rocks and break hard corals, while leaving soft corals unaffected. Invertebrates and other light weight objects can also be dislodged. If during escape runs large bottom fish, e.g. halibut, remain on or near the bottom, objects in their path can also be disturbed (Johnson 2002).

Pot gear used by recreational fishermen contacts the seabed.

Rakes and shovels used for harvest of shellfish and shrimp pumps are intended to disturb the seabed to dislodge the shellfish.

3.6 Current Habitat Protections

There are many areas off the West Coast where marine habitat is afforded some level of protection through existing regulations. A detailed analysis of these areas is contained in Appendix 21 to the Risk Assessment and is incorporated here by reference. These areas have been established by federal, state, and local agencies or other organizations. Areas may have been established to regulate navigation, restrict access (e.g., for security or fishing purposes), protect certain natural resources, regulate use, or for other purposes. These areas are known generally as marine managed areas (MMAs), but are more specifically called such things as National Wildlife Refuges, National Marine Sanctuaries, fishery closure areas, State Parks, oil platform navigation safety zones, national security zones, marine protected areas, or marine reserves.

NOAA’s Marine Protected Area Center is working to establish a standardized definition of a marine managed area. Their proposed definition, which will be subject to public comment in 2005, suggests that MMAs be areas that have a conservation purpose and that have the same set of coordinates for at least two consecutive years. Others have considered MMAs to be any specified area that is managed or regulated differently than the surrounding waters. For the purposes of aiding the Pacific Fishery Management Council in assessing if current MMAs influence fishing activities and fish habitat protection, the later definition is used.

There are about 321 distinct areas noted in Appendix 21 to the Risk Assessment. Fifty-nine of these areas may be considered marine reserves where all fishing is prohibited due either to specific fishing regulations or to access restrictions. That is, the majority of sites included in the table do not prohibit all fishing activities. Some sites may, for example, prohibit commercial fishing but allow recreational fishing; others allow fishing for some, but not all species of fish or invertebrates. Still others may only regulate fishing for one type of organism. The fishing regulations that do affect the sites often regulate the species of fish that may be caught. Less commonly, the rules specify or limit the type or sizes of gear that may be used. This makes it difficult, unless one is familiar with different fishing techniques for different species, to understand the potential impacts of fishing on habitat. For example, in some areas bottom trawl gear is not allowed, but mid-water trawl gear (which sometimes may be fished on or near the bottom) may be, or groundfish bottom trawl gear might be prohibited but shrimp or prawn or California halibut trawl gear may be allowed, or bottom trawls that have small footropes (which discourages access to areas with rough rocky bottoms) might be allowed, but those with large footropes might be prohibited.

Additionally, there are other more general fishing rules that apply to the larger area, including the MMA. Those rules are not captured in the Risk Assessment (but would be applied as a part of a GIS analysis that overlays the more general fishing rules that apply). That is, an entry in the table only deals with site-specific rules regarding the site. For example, the table entry regarding a specific Washington wildlife refuge will not reflect that Washington State doesn't allow most trawling or that fishing for groundfish in federal waters on the continental shelf requires a small footrope. Information on these more general fishing rules are included in the background material that accompanies the table.

Site-by-site information has been documented for hundreds of such areas and mapped within a GIS as part of the Risk Assessment process. Regulations change frequently, so this information is just a snapshot in time, representing information current through 2004 regulations[3]. The MMAs described in the Risk Assessment include areas that were not necessarily set up for conservation purposes (e.g., oil platforms, navigational safety areas) and areas where boundaries have changed over time. The information has been gathered to assess the extent to which some areas of habitat may already be protected from certain fishing effects. Using GIS, these areas can be further analyzed in terms of geographic location, areal extent, benthic habitat, depth, species preferences, and other information.

Federally Designated Marine Managed Areas:

- 28 National Wildlife Refuges, covering approximately 89,000 hectares. Regulations vary by refuge, but generally, commercial fishing is not allowed in most refuges.

- 7 National Parks, covering approximately 570,000 hectares (although only a small fraction of this area is the marine portion of the parks). Regulations vary by park.

[3]: New rules further regulating bottom trawling in California state waters were passed September 23, 2004, through Senate Bill 1459. These rules further regulate fishing for California halibut, sea cucumbers, pink shrimp, ridge-back, spot, and golden prawns. Provisions will be phased in beginning April 2006 and are not included in the table.

- 5 National Marine Sanctuaries covering approximately 3,000,000 hectares. Regulations vary by sanctuary, but in general, all types of fishing are allowed in federal waters of the sanctuaries

- 4 National Estuarine Research Reserves (NERR), covering approximately 8,000 hectares. All fishing and fishing gear are prohibited from the Tijuana River NERR and the Elkhorn Slough NERR (which doesn't include the Slough's main channel). All other NERR sites allow or do not address specific fishing regulations.

Other Federal Areas:

These are some additional areas under federal jurisdiction that may have restrictions to vessel access, rather than specific regulations having to do with fishing or fishing gear. These data were developed in 1998 by Al Didier for the Pacific States Marine Fisheries Commission (PSMFC), so the total number of areas may have changed since these data were compiled.

- 22 Regulated Navigation Areas (33CFR165) cover approximately 17,000 hectares, and are located generally in urban areas such as Puget Sound, Columbia River, San Francisco Bay, Los Angeles and San Diego.

- 49 Danger Zones and Restricted Areas (33CFR334) cover approximately 170,000 hectares. These are located in Puget Sound, San Francisco Bay, Monterey Bay, between Morro Bay and Point Conception, off some of the Channel Islands, and a few additional southern California locations

- 27 weather and scientific buoys. Two buoys are located off the Washington coast, one is located off the Oregon coast, twenty buoys are located off the California coast, with 6 of these located off Monterey Bay. Four of these buoys are located outside the Exclusive Economic Zone (EEZ)

Fishing Regulated Areas Established by Pacific Fishery Management Council:

- Rockfish Conservation Area (RCA): These areas have changed over time, as well as having a seasonal component to their locations. In addition, there are specific areas for trawl gear and non-trawl gear. Not all of the historical RCA areas have been developed into GIS data, but most of the areas from 2003 are mapped as an example (Figures 3-20 through 3-25). A chronology of changing trawl and non-trawl RCA's for the year 2003 is included below.

- Cowcod Conservation Areas (CCA): Sections of the CCA cover a total area of 1,372,447 hectares (Figure 3-26).

- Darkblotched Conservation Area (DBCA): The Dark Blotched Conservation Area covered 1,029,415 hectares (Figure 3-26).

- Yelloweye Rockfish Conservation Area (YRCA): This area encompasses 59,285 hectares (Figure 3-26).

- Two National Marine Fisheries sites (Pacific Whiting Salmon Conservation Zones), covering approximately 44,000 hectares. These two sites, one off the Columbia River and one off the Klamath River, prohibit fishing for Pacific Whiting with commercial mid-water trawl gear.

Trawl RCA Chronology:

April 2003: 2,380,610 ha

May 2003: 5,530,861 ha; North of 40°10’ latitude, the eastern boundary moved to shore. Other boundaries same as April.

June 2003: 3,850,239 ha; South of 40°10’, the western boundary was moved further west. North of 40°10’, the eastern boundary moved away from shore to a location between the April’s eastern boundary and May’s eastern boundary.

July–August 2003: 2,865,640 ha; North of 40°10’, the eastern boundary was moved away from shore.

September–October 2003: 3,592,844 ha;

November 2003: 3,590,423 ha;

Non-Trawl RCA Chronology:

April 2003: 4,864,260 ha

May 2003: 4,864,260 ha; Same boundaries as April 2003

June 2003: 4,864,491 ha; Same depth boundaries as May 2003 with a small change in coordinate locations

July–August 2003: 4,855,405 ha; Same boundaries as June 2003, with modification in southern California for Newport/South Jetty open area.

September–October 2003: 4,956,611 ha; South of Point Conception, eastern boundary moved towards slightly towards shore. Additional areas added around Channel Islands.

November 2003: 4,956,611 ha; Same area as September–October.

State Marine Protected Areas

California: MPA boundaries for sites in California were downloaded from the California Department of Fish and Game website. In these data, there are 79 sites covering approximately 59,000 hectares. The California sites have been categorized into 13 designations. California is currently renaming and recategorizing these sites into 3 designations (marine reserve, marine park, and marine conservation area), however the existing designations are used here for descriptive purposes (Figure 3-27).

- 10 State Marine Reserves: These areas are located adjacent to the Channel Islands. No commercial or recreational fishing is allowed in these areas.

- 2 State Marine Conservation Areas: These areas are also located adjacent to the Channel Islands. Most commercial fishing, except for spiny lobster fishing, is prohibited in these areas.

- 7 State Parks: 5 of these coastal state parks are located north of San Francisco, one is south of Monterey, and one is near Irvine. Fishing regulations vary by park.

- 4 State Beaches: One is located north of San Francisco and the other 3 are south of Point Conception. Fishing regulations vary by site.

- 1 State Historic Park: This site is located north of San Francisco. There are no prohibitions on fishing gear of any type.

- 9 Reserves: Several areas in, near or north of San Francisco Bay. A few areas in southern California. Regulations are highly variable by site–some prohibit all fishing, and some allow all fishing.

- 22 Ecological Reserves: These sites are located all along the coast. Regulations are highly variable by site–some are designated as no-take reserves, meaning all fishing is prohibited, and some are designated to prohibit certain type of fishing. Some allow all fishing, but prohibit take of other types of resources.

- 4 MRPA Ecological Reserves: 3 sites are located along the central California coast, and one is north of San Francisco. Recreational and commercial fishing is prohibited at all sites

- 1 Invertebrate Reserve: This site is located on the central coast. Recreational fishing is allowed for finfish. Commercial fishing is allowed for finfish, lobster, abalone and crab.

- 1 Natural Preserve: This site is located in northern California. No access allowed to the site.

- 3 Clam Preserves: These sites are located on the central coast, just north of Point Conception. No clams may be taken, but all commercial and recreational fishing and fishing gear are allowed.

- 1 Marine Gardens Fish Refuge: This site is located in Monterey Bay. Most commercial fishing gear is prohibited, except nets. Recreational pot gear is prohibited, other recreational gear is allowed.

- 14 Marine Life Refuges: These sites are located primarily along the central and southern coast. Most commercial gear, except pot and 'other' gear, is prohibited from these sites. All recreational gear types are allowed.

Oregon: MPA boundaries for three types of sites in Oregon were provided by Oregon Department of Fish and Wildlife. These are all small intertidal sites encompassing approximately 460 hectares (Figure 3-31).

- 7 Marine Gardens: Generally, commercial and recreational pot gear is prohibited, other gear types not restricted.

- 6 Research Reserves: Generally, commercial pot gear is prohibited
- 1 Habitat Refuge: All commercial and recreational fishing activities are prohibited.

Washington: The Washington State GIS data for MPA's contain 68 individual sites covering approximately 28,000 hectares. The areas are managed by one of the following organizations: Washington Department of Fish and Wildlife (WDFW), Washington Department of Natural Resources (WDNR), San Juan County Marine Resource Committee (MRC), Washington State Parks and Recreation Commission (WSPRC), or The Nature Conservancy (TNC). The total area figure is a bit of an overestimate because some of the areas, such as state parks and TNC areas, include the upland portions of the sites as well as the marine portions (Figures 3-32 and 3-33).

- 9 WDFW, Marine Preserves: generally prohibit most types of commercial fishing gear.
- 2 WDFW, Wildlife Refuges; generally closed to all access.
- 9 WDFW, Conservation Areas: most restrictive of fishing–all fishing and gear are prohibited from nearly all of these sites.
- 2 WDFW, Sea Cucumber Closures: closed to commercial harvest of sea cucumbers and urchins.
- 6 WDNR, Aquatic Reserves: no restrictions on commercial or recreational fishing
- 7 WDNR, Natural Areas Preserves: highest level of restriction–only allowable activities are scientific or education functions. Therefore, no commercial or recreational fishng allowed.
- 2 WDNR, Natural Resource Conservation Areas: No specific prohibition of fishing activities.
- 8 San Juan County MRC, Bottomfish Recovery Zones: These are voluntary bottomfish no-take zones–no specific prohibition of fishing activities.
- 7 State Parks: Prohibited to take non-game invertebrates and seaweed. No specific prohibition of fishing activities.
- 2 TNC Conservation Easements
- 14 TNC Nature Preserves: Limitation on public access and all fishing activities prohibited

3.7 West Coast Fisheries

For this affected environment description, fisheries that occur within the action area of the West Coast EEZ represent fishing and fishing-related activities that are both a risk factor to EFH and the subject of costs or benefits as a result of regulation and the environmental consequences of EFH conservation. The term "fishery" is defined in the Maguson-Stevens Act as: " a) one or more stocks of fish which can be treated as a unit for purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational, and economic characteristics; and, b) any fishing for such stocks" (16 U.S.C. 1802 et. seq.). This section describes each fishery within commercial, tribal, and recreational categories. Community-specific information on the geographic distribution of landings and revenue are detailed for the West Coast fisheries where applicable and where data are available.

Commercial, tribal, and recreational fishermen harvest over 89 species of groundfish managed under the Pacific Groundfish FMP off the coasts of Washington, Oregon, and California. Two of the FMP's objectives affect the management of other West Coast fisheries in addition to the management of groundfish: 1) maintaining year-round groundfish fishing and 2) reducing bycatch of the eight overfished groundfish species within the groundfish fishery and in other fisheries. These other fisheries include salmon, highly migratory species, coastal pelagic species, shrimp, and crab, amongst others. West Coast fishermen often participate in several of these fisheries throughout the year. All of these fisheries contribute to a wide range of commercial, recreational, and tribal activities that have economic, social, and cultural significance to those engaged in harvesting fish resources. Fish buyers and processors, suppliers of commercial and recreational fishing equipment and services, and fishing communities depend on these fisheries.

Active participation in West Coast shore-based commercial fisheries has generally declined over the years 2000 to 2003. In 2003, 1,511 vessels landed West Coast groundfish, 314 landed coastal pelagic species, 1,203 landed crab, 1,034 landed highly migratory species, 1,203 landed salmon, and 215 landed shrimp. In 2003, coastal pelagic species accounted for 33% of all landings by weight, crab 10%, groundfish 23%, shellfish 17%, shrimp 4%, highly migratory specieis, 5%, salmon 6%, and other species accounted for 3% (not including at sea activity).

Table 3-8 Count of Vessels Making Landings by Species Group

Species Group	2000	2001	2002	2003
Coastal Pelagic	487	381	355	314
Crab	1,387	1,239	1,311	1,288
Groundfish	1,993	1,800	1,619	1,511
Highly Migratory	958	1,116	875	1,034
Other	1,624	1,642	1,558	1,404
Salmon	1,255	1,265	1,271	1,203
Shellfish	110	95	228	81
Shrimp	328	301	296	215
Total Unique Vessels	4,276	4,010	4,020	3,811

Source: PacFIN FT and FTL tables. July 2005

The FMP classifies commercial activities as either limited entry, open access, or tribal. Under authority of the FMP, NOAA Fisheries has issued limited entry permits since 1994 for commercial groundfish fishing vessels to control the capacity of the groundfish fishing fleet by limiting the number of fishing vessels, limiting the number of vessels using each of the three major gear types (trawl, trap/pot, longline), and limiting increases in harvest capacity by limiting vessel length. Open access fisheries may catch and land groundfish. Open access trawl gear may not target groundfish, but may land incidental groundfish caught while targeting other species. Open access trap/pot and longline vessels may target groundfish under certain restrictions. Open access vessels may possess limited entry licenses for other, state-managed nongroundfish fisheries such as pink shrimp or Dungeness crab. The Council allocates harvest limits (expressed as optimum yields, or OYs) among different regulatory and fishery sectors, including limited entry and open access fisheries, with the majority of groundfish allocated to the limited entry sector. Indian tribes in Washington, primarily the Makah, Quileute, and Quinault, have treaty rights to harvest Pacific groundfish. NOAA Fisheries will implement the rights either through an allocation of fish that will be managed by the tribes, or through federal groundfish regulations that will apply specifically to the tribal fisheries.

Marine recreational fisheries consist of charter vessels, private vessels, and shore anglers. Charter vessels are larger vessels for hire, which typically can fish farther offshore than most vessels in the private recreational fleet. Shore-based anglers often fish in intertidal areas, within the surf, or off jetties. Fishing opportunity both in nearshore areas and farther out on the continental shelf are important for West Coast recreational fishermen. (According to Pacific States Marine Fisheries Recreational Fishery Information Network [RecFIN], there are virtually no records of recreationally caught continental slope species; thus, recreational groundfish fishing occurs almost exclusively along the continental shelf or nearshore). Recreational fishers targeting nongroundfish species such as tuna and billfish may travel longer distances, even to areas outside the U.S. EEZ.

3.7.1 Commercial Fisheries

Commercial fisheries make up the largest portion of West Coast landed catch by weight. Coastal pelagic species, followed by groundfish, crab, and highly migratory species have made up the largest landings by weight since 2000. Crab, followed by groundfish, coastal pelagic species, and highly migratory species comprise the highest-value groups from 2000–2003. The four largest gear groups by weight have been gill and trammel net, trawl, trap/pot, and troll gear.

Table 3-9. Shoreside Landings and Exvessel Revenue by Species Category and Year

		Year			
Species Group	Data type	2000	2001	2002	2003
Coastal Pelagic Species	Landed weight (lbs)	498,232,740	431,544,771	403,146,744	266,368,388
	Exvessel Revenue ($)	42,069,760	32,494,118	32,732,787	33,824,432
Crab	Landed weight (lbs)	30,562,479	26,645,343	37,156,344	75,126,504
	Exvessel Revenue ($)	64,575,735	54,017,788	62,570,332	118,393,209
Groundfish	Landed weight (lbs)	268,754,713	226,402,046	164,010,829	180,765,829
	Exvessel Revenue ($)	62,689,248	52,034,893	43,438,224	48,945,438
Highly Migratory Species	Landed weight (lbs)	23,217,661	27,365,996	23,269,259	38,071,415
	Exvessel Revenue ($)	22,790,849	24,253,397	17,256,645	28,126,563
Other	Landed weight (lbs)	21,579,099	19,705,423	20,890,419	16,868,699
	Exvessel Revenue ($)	27,123,067	23,982,459	23,098,380	20,616,940
Salmon	Landed weight (lbs)	7,122,757	6,458,681	9,790,983	11,493,417
	Exvessel Revenue ($)	13,962,096	10,605,885	14,345,088	20,959,564
Shellfish	Landed weight (lbs)	18,101,109	18,552,442	27,117,595	26,746,585
	Exvessel Revenue ($)	45,577,879	44,101,002	61,294,480	69,678,867
Shrimp	Landed weight (lbs)	35,906,296	40,960,953	57,818,606	32,160,356
	Exvessel Revenue ($)	20,543,414	16,753,777	21,407,954	11,479,887
Total Landed weight (lbs)		903,476,854	797,635,655	743,200,779	647,601,193
Total Exvessel Revenue ($)		299,332,048	258,243,320	276,143,890	352,024,899

Source: PacFIN ftl table. August 2004

Note: Data shown is for PFMC management areas and does not include inside waters such as Puget Sound and Columbia River.

Table 3-10. Shoreside Landings and Revenue by Gear Type and Year

		Year			
Gear	Data type	2000	2001	2002	2003
Dredge	Landed weight (lbs)			C	
	Exvessel Revenue ($)			C	
Hook and Line	Landed weight (lbs)	11,802,585	11,020,956	12,614,636	10,825,355
	Exvessel Revenue ($)	20,935,838	19,225,187	17,679,231	19,776,877
Misc	Landed weight (lbs)	35,380,715	33,635,105	42,904,188	38,561,396
	Exvessel Revenue ($)	62,944,925	58,034,808	74,019,410	79,445,478
Net	Landed weight (lbs)	502,470,237	435,111,623	406,345,771	268,877,740
	Exvessel Revenue ($)	48,226,898	36,665,962	36,382,949	36,919,258
Pot	Landed weight (lbs)	33,746,129	29,263,663	39,942,815	78,765,977
	Exvessel Revenue ($)	75,724,736	64,286,487	71,891,553	129,824,380
Troll	Landed weight (lbs)	25,541,566	28,789,324	27,054,341	45,832,676
	Exvessel Revenue ($)	29,247,312	29,245,055	25,667,562	43,931,473
Trawl	Landed weight (lbs)	259,658,663	220,003,436	157,474,652	173,261,044
	Exvessel Revenue ($)	43,868,230	36,547,531	31,428,967	33,034,613
Shrimp Trawl	Landed weight (lbs)	34,876,959	39,811,548	56,862,974	31,477,005
	Exvessel Revenue ($)	18,384,109	14,238,290	19,072,882	9,092,821
Total Landed weight (lbs)		903,476,854	797,635,655	743,199,377*	647,601,193
Total Exvessel Revenue ($)		299,332,048	258,243,320	276,142,553*	352,024,899

Source: PacFIN ftl table. August 2004
Note: Data shown is for PFMC management areas only and does not include areas such as Puget Sound and Columbia River for example.
C means data was restricted due to confidentiality
* totals do not include confidential data

In at least some sectors of the west coast commercial fishing industry, the age of fishermen has been increasing, and there are very few new entrants into the fishery (McKorkle, 2005. public comment; Port of San Luis, 2005. public testimony). This trend has been blamed on lost economic opportunities and increasing restrictions in some existing fisheries. As current fishers retire, future repercussions may occur as a result of lost knowledge of the fishery, and fewer fishermen prosecuting the fishery. Fewer fishermen participating in the fishery may result in less demand for support services and lower catch on a regional or total basis. Reduced catch may have secondary impacts to processors which purchase from these fishers, and tertiary effects to consumers that purchase those seafood products.

3.7.1.1 Limited Entry Groundfish Trawl Sector

West Coast limited entry trawl vessels use midwater trawl gear, and small and large footrope bottom trawl gear (defined at 50 CFR 660.302 and 660.322(b)) (See Section 3.5.1). Midwater trawl gear is not designed to touch the ocean bottom and is therefore used to target groundfish species–such as Pacific whiting and yellowtail rockfish–that ascend above the ocean floor. Small and large footrope trawl gear are designed to remain in contact with the ocean floor and are used to target species that reside along the ocean bottom such as flatfish on the continental shelf and slope, or DTS species (dover sole, thornyhead and sablefish complex) in deep water. Fishers generally use small footrope trawl gear in areas that have a regular substrate–few rocks or outcroppings–and more widely on the continental shelf than on the continental slope (due in large part to regulatory requirements). Fishers use large footrope trawl gear most commonly in areas that may have an irregular substrate, and along the continental slope and in deeper water.

The limited-entry shore-based trawl vessels primarily deliver their catch to processors and buyers located along the coasts of Washington, Oregon, and California, and tend to have their homeports located in towns within the same general area where they make deliveries. Larger vessels in the shore-based limited entry trawl sector focus more heavily on the DTS complex in deep water, while smaller trawl vessels focus more heavily on the shelf. Large trawl vessels also tend to participate in the trawl fishery for more months of the year than small trawl vessels. The shore-based vessels range in size from less than 40 feet to over 90 feet in length (Table 3-11).

Table 3-11. Count of Limited Entry Trawl Vessels Making Landings by State, Year, and Vessel Length

		Vessel Length (feet)						
State	YEAR	0–40	41 - 50	51 - 60	61 - 70	71 - 80	81 - 90	> 90
CA	2000	1	13	24	20	18	6	2
	2001	4	10	16	15	12	7	1
	2002	2	5	5	8	12	3	0
	2003	3	8	8	4	5	1	0
OR	2000	1	3	21	35	30	15	7
	2001	2	7	19	34	31	13	3
	2002	2	5	17	32	29	14	3
	2003	2	5	17	33	28	15	3
WA	2000	0	3	5	5	10	4	3
	2001	0	5	5	4	12	3	1
	2002	0	2	6	3	8	4	1
	2003	0	1	2	4	9	3	1

Source: PacFIN ftl and cg tables. July 2004

In addition to the shore-based limited entry trawl fishery, an at-sea limited entry trawl fishery exists off the coast of Washington, Oregon, and California. The high-volume at-sea fishery targets Pacific whiting with the use of midwater trawls. Pacific whiting commands a relatively low price per pound in the market place. The limited entry at-sea sector is made up of a catcher-processor fleet and a mothership/catcher vessel fleet. A catcher-processor participates in both catching and processing; a mothership engages only in the processing of a particular catch, and relies on catch made by catcher vessels. Many of the catcher vessels that deliver to the West Coast mothership sector may also fish as West Coast shore-based trawl vessels outside the Pacific whiting season; other catcher vessels fish in West Coast waters only during Pacific whiting fishery and return to North Pacific fisheries when the Pacific whiting season closes.

According to PacFIN data, the at-sea sector annually catches over 100 million pounds of Pacific whiting, as well as several hundred thousand pounds of other types of West Coast groundfish

(Table 3-12). Unfortunately, readily available data do not exist for estimating the value of at-sea activities.

Table 3-12. At - Sea Sector Catch by Year, Species Aggregation, and Sector (Units are in pounds)

Species Aggregation	At - Sea Sector	2000	2001	2002	2003
Non-Whiting Groundfish	Catcher/Processor	1,227,955	869,326	532,717	230,094
	Non - Tribal Mothership	1,188,862	427,932	69,445	13,610
Pacific Whiting	Catcher/Processor	149,505,480	129,251,616	80,119,007	90,862,066
	Non - Tribal Mothership	103,265,104	78,976,106	58,628,095	57,367,288

Source: PacFIN NPAC4900 table. February 2004

In 2003, a fishing capacity reduction program was implemented off the Pacific coast which retired 91 vessels from the limited entry trawl sector. These 91 vessels represented less than 40 percent of the number of boats actively engaged in the limited entry trawl sector, but approximately 50 percent of historic catch. The purpose of the program was to reduce the number of vessels and permits endorsed for the operation of groundfish trawl gear in order to increase and stabilize economic revenues for vessels remaining in the groundfish fishery and conserve and manage depleted groundfish species. Vessels that participated in the buyback program were sold, scrapped, or converted to nonfishing purposes, and those vessels cannot be used for fishing again.

3.7.1.1.1 The Limited Entry Trawl Capacity Reduction Program

In 2003, a fishing capacity reduction program (buyback) was implemented off the Pacific coast which retired 91 vessels from the limited entry trawl sector. These 91 vessels represented less than 40 percent of the number of boats actively engaged in the limited entry trawl sector, but approximately 50 percent of historic catch. The purpose of the program was to reduce the number of vessels and permits endorsed for the operation of groundfish trawl gear in order to increase and stabilize economic revenues for vessels remaining in the groundfish fishery and conserve and manage depleted groundfish species. Vessels that participated in the buyback program were sold, scrapped, or converted to nonfishing purposes, and those vessels cannot be used for fishing again.

The impact of the trawl vessel buyback appears to have been positive in terms of exvessel revenue per vessel. Average trawl exvessel revenues generated by non-Pacific Hake groundfish increased from approximately $108,000 to $151,000 in the years 2003 to 2004 respectively even though total exvessel revenues for the fleet decreased from approximately $25,000,000 to $22,000,000 during the same period.

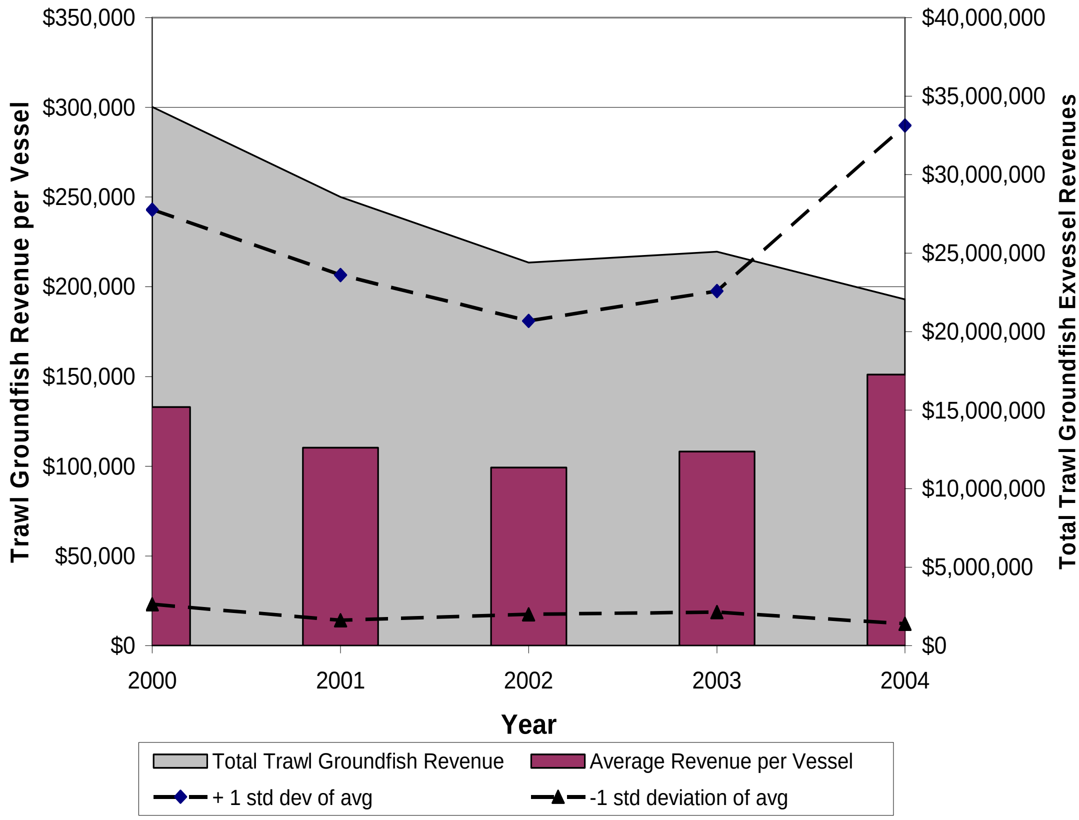

Figure 1. Annual Trawl Vessel Revenues per Year where the Catch is Non-Hake Groundfish

The impact of the trawl vessel buyback differed by region. Some ports lost a disproportionate share of their trawl fleet, while others lost relatively few trawl vessels.

Table 3-13. Count of Trawl Vessels Landing Non-Hake Groundfish by Port and Year

PORT	2000	2001	2002	2003	2004
ASTORIA	54	48	41	44	32
AVILA	13	15	16	13	7
BELLINGHAM BAY	7	16	6	9	6
BROOKINGS	11	11	11	13	8
CHARLESTON (COOS BAY)	30	30	25	28	21
CRESCENT CITY	26	21	24	19	4
EUREKA	27	32	30	28	15
FIELDS LANDING	15	14			
FORT BRAGG	17	19	29	14	11
MONTEREY	5	4	5	5	3
MORRO BAY	17	10	11	10	10
MOSS LANDING	16	15	14	16	16
NEAH BAY	11	11	5	8	5
NEWPORT	41	41	31	33	27
PORT ANGELES	7	8	10		5
PRINCETON / HALF MOON BAY	14	14	12	11	12
SAN FRANCISCO	26	18	17	12	10
SANTA BARBARA	5	14	14	8	4
SANTA CRUZ	6	5	6	6	4
VENTURA	5	7	10	8	3
WESTPORT	19	11	10	9	9

Note: ports with fewer than three trawl vessels in any year were excluded for confidentiality purposes
Source: PacFIN ft and ftl tables

By weight, some ports appear to have lost relatively more groundfish catch than other ports. Not surprisingly, those ports that lost relatively more trawl vessels also appear to have lost relatively more catch of groundfish.

Table 3-14. Landed Weight of Groundfish made by Trawl Vessels by Port and Year (lbs)

PORT	2000	2001	2002	2003	2004
ASTORIA	15,733,074	12,128,458	8,265,559	9,742,986	11,691,379
AVILA	834,680	616,016	1,563,590	1,542,126	982,240
BELLINGHAM BAY	5,567,902	4,250,213	5,239,046	4,971,017	3,356,161
BROOKINGS	2,564,206	1,942,570	1,263,150	1,973,492	1,070,491
CHARLESTON (COOS BAY)	8,753,192	6,613,222	4,692,898	6,261,152	5,307,643
CRESCENT CITY	2,867,758	2,613,821	2,789,286	1,903,833	1,089,460
EUREKA	4,113,867	4,065,846	3,905,964	4,373,074	3,696,474
FIELDS LANDING	2,448,302	1,241,606			
FORT BRAGG	4,055,532	3,429,009	4,506,717	3,028,961	2,902,846
MONTEREY	862,084	692,836	573,330	547,952	409,290
MORRO BAY	285,861	195,718	167,050	248,413	777,682
MOSS LANDING	1,350,408	1,321,558	1,447,451	2,039,384	1,138,278
NEAH BAY	2,332,979	1,422,344	36,017	1,906,337	616,595
NEWPORT	7,918,289	5,823,743	4,023,203	4,997,183	4,414,402
PORT ANGELES	170,573	80,998	2,550,679		396,169
PRINCETON / HALF MOON BAY	1,537,386	1,210,273	927,221	651,677	561,930
SAN FRANCISCO	2,067,686	1,677,797	1,294,075	1,311,881	1,820,147
SANTA BARBARA	10,314	6,514	12,914	965	8,356
SANTA CRUZ	100,694	58,211	25,959	10,172	4,524
VENTURA	1,785	4,680	3,131	683	344
WESTPORT	1,803,584	1,873,952	9,075,180	1,032,300	1,006,859

Note: ports with fewer than three trawl vessels in any year were excluded for confidentiality purposes
Source: PacFIN ft and ftl tables

3.7.1.1.2 Distribution of Effort by Limited Entry Groundfish Trawl Vessels

Limited entry trawl vessels focus much of their effort on DTS species along the slope, flatfish species along the shelf, and Pacific whiting above the seafloor. Historically, much effort was focused on rockfish species, but recent regulatory requirements–such as RCAs and various cumulative limits - have curtailed rockfish opportunities to protect overfished stocks. In 2005, a specific small footrope trawl designed to avoid rockfish (the selective flatfish trawl) will work to further avoid the catch of rockfish along the shelf while increasing opportunities for flatfish north of 40º 10' latitude. Opportunities to harvest DTS and flatfish species–largely in the form of differential cumulative limits and RCAs–dictate the location of much of the trawl effort, though not all effort is dictated by regulation. Vessels differ in size and technical capacity. For example, small vessels may find it more difficult to fish during the winter months because of weather and other vessels may not have the capacity to fish in deep water where DTS species primarily reside. In other cases, some vessel captains may be more knowledgeable and more successful in certain areas. This knowledge would also influence the location and timing of effort by certain vessels. Furthermore, some species are known to migrate and aggregate during certain months of the year. For example, Petrale and Dover sole are known to aggregate for spawning during the winter months, and several types of flatfish are known to migrate onto the shelf during the summer months. Fishers may target the location of their efforts according to species aggregations and the tendencies of certain fish species to migrate. Differences in knowledge, capital constraint, fish migration, and the regulatory environment can–in large part–affect the location and time of effort by commercial fishing vessels.

Table 3-15 shows the depth-based annual distribution of catch made by non-shrimp trawl vessels and Table 3-16 shows the monthly distribution of catch as recorded in trawl logbook data within PacFIN. These data include bottom trawl and midwater trawl gear.

Table 3-15. Depth Based Distribution of Landed Groundfish Catch by Limited Entry Trawl Vessels Using Midwater or Bottom Trawl Gear (Pounds by Year and Depth Range)

Depth Range (fathoms)	2001	2002	2003
0-50	22,930,260	40,048,627	15,919,762
51-100	215,155,125	158,543,798	135,411,711
101-150	62,788,477	45,254,962	61,445,691
151-200	13,325,986	7,713,513	18,157,965
201-250	8,322,800	6,198,206	12,817,069
>250	20,664,041	23,096,810	30,265,559

Source: PacFIN logbook data. July 2005
Note: not all logbook records have an associated depth and depth is recorded as the average or start tow depth.

Table 3-16. Monthly Distribution of Groundfish Landed Catch by Limited Entry Trawl Vessels Using Midwater or Bottom Trawl Gear (Pounds by Month and Year)

	Year		
Month	2001	2002	2003
January	5,280,981	4,051,019	4,589,094
February	6,560,832	5,870,089	5,062,798
March	7,103,004	6,090,047	3,726,461
April	11,361,478	9,881,215	9,423,497
May	13,248,925	11,022,904	10,856,262
June	56,177,784	97,157,431	114,340,896
July	115,519,050	113,615,466	103,952,685
August	89,458,920	20,530,848	13,742,628
September	32,274,454	3,193,638	8,614,816
October	2,661,432	6,597,853	4,965,831
November	3,091,795	4,987,239	4,241,793
December	2,001,895	2,465,965	1,990,757

Source: PacFIN logbook data. July 2005

3.7.1.1.3 Landings and Revenues from Groundfish Trawl Vessels

Trawlers catch a wide range of species. By weight, the following species account for the bulk of landings (other than Pacific whiting): Dover sole, arrowtooth flounder, petrale sole, sablefish, thornyheads, and yellowtail rockfish. Management measures intended to reduce the directed and incidental catch of overfished rockfish and other depleted species have significantly reduced rockfish catches in recent years substantially below historical levels.

Table 3-17. Trawl Shoreside Landings and Exvessel Revenue by State and Year

State	Species Aggregation	Data Type	2000	2001	2002	2003
CA	Non-Whiting Groundfish	Landed weight (lbs)	21,332,461	17,533,624	17,684,047	16,119,987
		Exvessel Revenue ($)	11,742,269	9,579,192	10,064,667	8,593,528
	Pacific Whiting	Landed weight (lbs)	10,991,151	5,083,027	6,113,247	3,736,459
		Exvessel Revenue ($)	765,155	171,099	273,550	165,508
OR	Non-Whiting Groundfish	Landed weight (lbs)	35,196,227	26,791,342	18,539,890	22,958,844
		Exvessel Revenue ($)	17,989,249	14,686,968	10,150,420	12,766,460
	Pacific Whiting	Landed weight (lbs)	151,460,973	117,673,122	71,219,860	80,647,902
		Exvessel Revenue ($)	6,081,274	4,131,962	3,219,324	3,642,455
WA	Non-Whiting Groundfish	Landed weight (lbs)	12,408,949	11,071,405	19,458,230	11,283,851
		Exvessel Revenue ($)	4,635,366	4,449,096	4,688,602	4,634,791
	Pacific Whiting	Landed weight (lbs)	26,799,684	39,087,616	23,434,208	37,506,184
		Exvessel Revenue ($)	1,121,763	1,438,685	1,061,440	1,709,533

Source: PacFIN ftl data. July 2004
Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

By weight, the vast majority of trawl vessel groundfish is caught with midwater trawl gear. This is due to the fact that Pacific whiting is targeted with midwater trawl gear. In contrast, the majority of trawl exvessel revenues are attributed to the bottom trawl sector (Table 3-18).

Table 3-18. Shoreside Trawl Groundfish Landings and Exvessel Revenue by Year, State, and Trawl Type

			YEAR			
Trawl Type	State	Data Type	2000	2001	2002	2003
Bottom Trawl	CA	Landed weight (lbs)	19,450,020	16,461,234	17,468,986	16,097,882
		Exvessel Revenue ($)	10,837,133	9,067,273	9,956,840	8,586,131
	OR	Landed weight (lbs)	25,029,598	22,072,494	17,508,908	22,867,904
		Exvessel Revenue ($)	13,518,662	12,544,088	9,660,636	12,678,106
	WA	Landed weight (lbs)	9,919,916	8,353,238	9,947,471	10,157,735
		Exvessel Revenue ($)	3,554,208	3,413,438	3,633,637	4,186,790
Midwater Trawl	CA	Landed weight (lbs)	12,873,592	6,155,417	6,328,308	3,758,564
		Exvessel Revenue ($)	1,670,291	683,018	381,377	172,905
	OR	Landed weight (lbs)	161,627,602	122,391,970	72,250,842	80,738,842
		Exvessel Revenue ($)	10,551,861	6,274,841	3,709,107	3,730,809
	WA	Landed weight (lbs)	29,288,717	41,805,783	32,944,967	38,632,300
		Exvessel Revenue ($)	2,202,921	2,474,343	2,116,405	2,157,534
Total Landed Weight			258,189,445	217,240,136	156,449,482	172,253,227
Total Exvessel Revenue			42,335,075	34,457,002	29,458,003	31,512,275

Source: PacFIN FTL table. July 2004

Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

Limited entry trawlers take the vast majority of the groundfish harvest measured by weight but somewhat less if measured by value. In 2003, groundfish trawlers landed over 95% of total groundfish harvest by weight but only 64% by value (Table 3-19). The difference in trawl weight and revenue proportions is mostly due to the catch of Pacific whiting. Since whiting are caught almost exclusively by limited entry trawl vessels, they skew the overall value per unit weight calculations for this sector.

Table 3-19. Shoreside Groundfish Landings and Revenue by Trawl and Non-Trawl Vessels

Gear Group	Data type	2000	2001	2002	2003
Non-Trawl	Landed Weight (lbs)	10,565,268	9,161,910	7,561,347	8,512,602
	Landed Revenue ($)	20,354,173	17,577,891	13,980,221	17,433,163
Trawl	Landed Weight (lbs)	258,189,445	217,240,136	156,449,482	172,253,227
	Landed Revenue ($)	42,335,075	34,457,002	29,458,003	31,512,275
Trawl Portion	Landed Weight (lbs)	96%	96%	95%	95%
	Landed Revenue ($)	68%	66%	68%	64%

Source: PacFIN ftl data. July 2004
Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

Trawl vessels make most of their landings in Oregon. Newport, Astoria, and Charleston (Coos Bay), Oregon make up three of the largest four ports for landed weight and exvessel revenue during the 2000–2003 period (Table 3-20). Westport and Ilwaco, WA, Eureka and Crescent City, CA, Brookings, OR, and Bellingham Bay and Neah Bay, WA comprise the remaining top 10 largest ports for trawl vessel landings.

Table 3-20. Largest Ports for Limited Entry Trawl Vessel Groundfish Landings and Exvessel Revenue (2000–2003)

Rank	Rank by Weight	Rank by Exvessel Revenue
1	NEWPORT	ASTORIA
2	ASTORIA	NEWPORT
3	WESTPORT	CHARLESTON (COOS BAY)
4	CHARLESTON (COOS BAY)	WESTPORT
5	ILWACO	BROOKINGS
6	EUREKA	BELLINGHAM BAY
7	CRESCENT CITY	NEAH BAY
8	BROOKINGS	PRINCETON / HALF MOON BAY
9	BELLINGHAM BAY	EUREKA
10	NEAH BAY	BLAINE
11	FIELDS LANDING	CRESCENT CITY
12	PRINCETON / HALF MOON BAY	ILWACO
13	BLAINE	SAN FRANCISCO
14	SAN FRANCISCO	FIELDS LANDING
15	PORT ANGELES	GARIBALDI (TILLAMOOK)

Source: PacFIN FTL table. July 2004

3.7.1.2 Limited Entry Groundfish Fixed Gear Sector

West Coast limited entry fixed gear vessels typically use longline and fish pots (traps) for catching groundfish. Groundfish longline activities involve anchoring a stationary line with multiple baited hooks attached to it (groundline) to the ocean floor (See Section 3.5.9.1). A buoy line attaches the groundline to a surface float, usually a buoy and pole. Fishermen leave the longline in the water for several hours to a day. The vessel returns to the gear, retrieves the buoy, and hauls the line to the surface to retrieve the gear and fish.

Fish pots or traps used to harvest groundfish are generally square and have mesh or twine encompassing the exterior (See section 3.5.8). Fishermen drop baited traps to the bottom of the ocean connected to a surface pole or buoy with a vertical line. The fish enter the trap through a door, but cannot exit the trap unless they are small enough to escape through the mesh, or back out the door. These pots are retrieved by the vessel several hours after being set. Both longlines and fish pots can be set across diverse ocean bottom types, though longlines can get hooked on rocky areas or reefs, causing some gear loss.

Limited entry fixed gear fishers typically use shore-based vessels that range in size from 30 feet to 65 feet in length, with some vessels exceeding 100 feet, and some as small as 23 feet (Table 3-21). Limited entry fixed gear vessels may also participate in open access fisheries or in the limited entry trawl fishery. Like the limited entry trawl fleet, limited entry fixed gear vessels deliver their catch to ports along the Washington, Oregon, and California coast.

Table 3-21. Count of Limited Entry Vessels Making Landings with Hook and Line or Pot Gear by State, Year, and Vessel Length

		Vessel Length (feet)						
State	Year	< 40	40 - 49	50 - 59	60 - 69	70–79	80 - 89	> 89
CA	2000	23	25	14	2			
	2001	13	28	9	2			
	2002	14	23	10		2		
	2003	14	18	8				
OR	2000	24	46	18	14		1	
	2001	17	31	16	13	1	1	1
	2002	15	19	14	11		1	
	2003	15	21	10	9	1	2	1
WA	2000	11	21	16	5	2	1	
	2001	6	18	13	3	2	1	
	2002	7	14	10	6	2	1	
	2003	7	16	13	5	2	1	

Source: PacFIN FTL table. July 2004

3.7.1.2.1 Distribution of Effort by Limited Entry Fixed Gear Vessels

Limited entry fixed gear vessels principally target sablefish, a species that tends to reside in relatively deep water. The limited entry fixed gear sector is subject to rockfish conservation areas; however, the boundaries are somewhat different from those of the limited entry trawl sector. Fixed gear vessels are more prone than trawl vessels to catching some overfished rockfish species, such as yelloweye rockfish, and are therefore restricted from fishing on the continental shelf. Unfortunately, logbook data showing location and depth of effort for limited entry fixed gear vessels is not readily available. However, the areas of highest sablefish abundance and the boundaries of the fixed gear RCA generally determine the location of limited entry fixed gear effort. The RCA boundaries in July 2004 for limited entry fixed gear have a seaward boundary of approximately 100 fathoms. North of 40º 10' N latitude, the population abundance of sablefish declines notably seaward of 150 fathoms, and is notably higher at 100 fathoms (NMFS 2004, PFMC 2004), meaning that a large amount of limited entry fixed gear effort north of 40º 10' latitude is exerted along depth contours between 100 and 150 fathoms.

Not unexpectedly, this sector has been plagued by overcapacity, although a series of management initiatives have addressed the problem. In the early to mid 1990s, the fully open access (derby) fishery was managed by short seasons of two weeks or less. Two groundfish FMP amendments, Amendment 9, requiring a permit endorsement to participate in the primary sablefish fishery, and Amendment 14, introducing permit stacking, have helped to alleviate the symptoms of overcapacity in the fixed gear sablefish fishery, effectively eliminating the short, derby season. Permit stacking allows up to three sablefish-endorsed permits to be used per vessel. Through a tier system, landing limits vary with the number and type of permits held.

Limited entry fixed gear vessels exert most of their effort during the late spring, summer, and early fall. The monthly distribution of effort has become more spread out over the year, and the number of vessels participating has declined as the tier system and permit stacking provisions were put in place in 1998 and 2001 respectively (Table 3-21 and Table 3-22).

Table 3-22. Limited Entry Vessel Groundfish Landings made with Fixed Gear by Month and Year

	Year							
	2000		2001		2002		2003	
Mth	Landed wt (lbs)	Revenue ($)	Landed wt (lbs)	Revenue ($)	Landed wt (lbs)	Revenue ($)	Landed wt (lbs)	Revenue ($)
1	67,326	132,487	90,463	119,114	132,364	163,145	112,472	215,344
2	108,890	71,447	152,470	154,001	222,151	169,911	139,408	170,878
3	151,900	141,260	136,058	201,181	317,009	243,697	171,134	214,311
4	256,103	190,067	195,109	198,431	445,992	399,176	357,136	396,859
5	361,945	246,369	310,071	269,816	578,767	763,776	489,877	976,868
6	172,531	211,962	141,985	233,775	373,550	716,493	573,040	1,403,875
7	144,956	265,388	208,843	315,779	336,405	754,497	678,224	1,592,493
8	3,616,594	7,790,820	1,147,999	2,404,248	442,965	968,219	546,730	1,313,028
9	387,210	778,563	1,322,139	2,734,656	576,482	1,246,036	817,926	1,965,899
10	205,454	374,881	764,189	1,622,828	387,172	883,103	405,198	942,079
11	180,519	335,921	94,793	162,831	118,599	222,777	111,521	249,621
12	137,895	252,048	54,052	98,561	62,708	127,611	44,003	102,500

Source: PacFIN VSMRFD files. July 2004

Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

3.7.1.2.2 Landings and Revenue from Limited Entry Fixed Gear Vessels

Vessels deploying longlines and traps (pots) comprise the bulk of the limited entry fixed gear sector. These gear types also may be used by vessels in the open access sector, but preferential harvest limits favor limited entry permit holders. Fixed gear vessels primarily target the high-value sablefish; this species accounts for a large share of landings, especially when measured by exvessel value.

According to PacFIN data, the majority of limited entry fixed gear landings occur in Oregon and Washington. Oregon and Washington also have a higher price per pound for sablefish, while California has a higher price per pound for other types of groundfish. This is most likely representative of the higher amount of high valued live fish landings that occur in California, as opposed to Oregon and Washington.

Table 3-23. Landings and Exvessel Revenue made by Limited Entry Vessels with Fixed Gear by State and Year (Hkl and Pot Gear)

			Year			
State	Species Aggregation	Data Type	2000	2001	2002	2003
CA	Non-Sablefish Groundfish	Landed Weight (lbs)	558,671	544,400	527,015	609,251
		Exvessel Revenue ($)	1,089,097	973,961	938,230	1,264,475
	Sablefish	Landed Weight (lbs)	1,209,816	961,551	776,349	859,625
		Exvessel Revenue ($)	1,867,147	1,448,199	1,146,177	1,508,804
OR	Non-Sablefish Groundfish	Landed Weight (lbs)	163,965	227,351	112,882	83,201
		Exvessel Revenue ($)	242,990	366,559	200,186	117,054
	Sablefish	Landed Weight (lbs)	2,170,149	1,549,376	958,843	1,329,379
		Exvessel Revenue ($)	4,874,550	3,426,052	2,278,876	3,339,126
WA	Non-Sablefish Groundfish	Landed Weight (lbs)	845,502	573,704	991,433	503,736
		Exvessel Revenue ($)	240,463	161,697	221,228	119,652
	Sablefish	Landed Weight (lbs)	843,220	761,788	627,641	1,061,477
		Exvessel Revenue ($)	2,476,966	2,138,753	1,873,744	3,194,644

Source: PacFIN FTL table. July 2004
Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

Table 3-24 shows the top 15 ports (of the 62 receiving landings) for limited entry fixed gear landings and exvessel revenue from 2000–2003. The largest ports for limited entry fixed gear landings and exvessel revenue, located within Washington, Oregon, and northern California, differ only slightly in the order of landings by rate and of exvessel revenue. The top five ports for landings make up approximately 54% of total landings, while the top five ports for revenue make up approximately 49% of total exvessel revenues for limited entry fixed gear vessels.

Table 3-24. Largest Ports for Limited Entry Fixed Gear Landings and Exvessel Revenue (2000 - 2003)

Rank	Top Ports for Exvessel Revenue	Top Ports for Landings
1	NEWPORT	BELLINGHAM BAY
2	BELLINGHAM BAY	NEWPORT
3	ASTORIA	MOSS LANDING
4	CHARLESTON (COOS BAY)	ASTORIA
5	MOSS LANDING	PORT ORFORD
6	WESTPORT	CHARLESTON (COOS BAY)
7	PORT ORFORD	WESTPORT
8	PORT ANGELES	PORT ANGELES
9	EUREKA	EUREKA
10	CRESCENT CITY	CRESCENT CITY
11	OCEANSIDE	SAN FRANCISCO
12	FORT BRAGG	FORT BRAGG
13	SAN FRANCISCO	OCEANSIDE
14	FLORENCE	FLORENCE
15	SEATTLE	NEWPORT BEACH

Source: PacFIN FTL table. July 2004

3.7.1.3 The Groundfish Open Access Sector

The open access sector consists of vessels that do not hold a federal groundfish limited entry permit and target or incidentally catch groundfish using a variety of gears. The open access appellation can be confusing because vessels in this sector may hold limited entry permits for other, nongroundfish fisheries issued by the federal or state governments. However, groundfish catches by these vessels are regulated under the groundfish FMP. For example, open access vessels must comply with cumulative trip limits established for the open access sector and are subject to the other operational restrictions imposed in the regulations, including general exclusion from the RCA.

Fixed gear catch most open access groundfish, although non-shrimp trawl gear and net gear also make substantial landings (Table 3-25). Sablefish and rockfish generally comprise the largest source of open access landings by weight and revenue, followed by other groundfish, flatfish, and skates (Table 3-27).

Table 3-25. Open Access Groundfish Landings and Exvessel Revenue by State, Year, and Gear Group

			Year			
State	Gear Group	Data Type	2000	2001	2002	2003
CA	Dredge	Landed Weight (lbs)			C	
		Exvessel Revenue ($)			C	
	Hook and Line	Landed Weight (lbs)	1,218,626	1,053,789	865,280	818,292
		Exvessel Revenue ($)	2,871,120	2,521,246	1,864,774	1,644,510
	Misc.	Landed Weight (lbs)	2,140	148	229	63
		Exvessel Revenue ($)	3,151	448	1,154	65
	Net	Landed Weight (lbs)	100,870	128,117	98,048	106,461
		Exvessel Revenue ($)	85,625	106,763	88,543	97,987
	Pot	Landed Weight (lbs)	361,750	305,553	263,532	387,890
		Exvessel Revenue ($)	852,555	704,248	557,881	677,169
	Shrimp Trawl	Landed Weight (lbs)	18,084	8,932	8,508	4,532
		Exvessel Revenue ($)	18,753	10,806	11,885	7,045
	Non-Shrimp Trawl	Landed Weight (lbs)	54,701	15,949	19,232	4,563
		Exvessel Revenue ($)	45,766	12,511	20,727	5,253
OR	Hook and Line	Landed Weight (lbs)	421,803	563,759	615,247	642,047
		Exvessel Revenue ($)	749,701	995,381	1,280,502	1,160,157
	Net	Landed Weight (lbs)	C	C	C	C
		Exvessel Revenue ($)	C	C	C	C
	Pot	Landed Weight (lbs)	10,449	28,488	24,453	41,978
		Exvessel Revenue ($)	19,093	54,702	57,569	89,877
	Shrimp Trawl	Landed Weight (lbs)	21,978	19,527	9,376	8,904
		Exvessel Revenue ($)	19,824	15,193	7,291	7,785
	Non-Shrimp Trawl	Landed Weight (lbs)		173,020		
		Exvessel Revenue ($)		85,548		
WA	Hook and Line	Landed Weight (lbs)	182,386	206,037	184,726	376,393
		Exvessel Revenue ($)	258,062	278,436	303,130	538,521
	Net	Landed Weight (lbs)	C	C	C	C
		Exvessel Revenue ($)	C	C	C	C
	Pot	Landed Weight (lbs)	864	477		11,132
		Exvessel Revenue ($)	1,817	1,284		28,035
	Shrimp Trawl	Landed Weight (lbs)	23,355	17,145	20,332	25,063
		Exvessel Revenue ($)	11,537	9,774	12,577	12,905
	Non-Shrimp Trawl	Landed Weight (lbs)	73,597	236,614	604,280	823,468
		Exvessel Revenue ($)	32,382	112,078	288,282	410,344
Total Landed Weight (lbs)			2,490,891	2,757,572	2,714,645	3,251,081
Total Exvessel Revenue ($)			4,969,431	4,908,420	4,495,652	4,679,666

Source: PacFIN VSMRFD files. July 2004
Note: C represents data restricted due to confidentiality
Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

Fishery managers divide the open access sector into directed and incidental categories. The directed fishery consists of vessels targeting groundfish while the incidental fishery category applies to vessels targeting other fish but landing some groundfish in the process. In practice, segregating the vessels into these two categories may not represent fisher intentions. Over the course of a year–or even during a single trip–a fisher may engage in several different strategies, switching among the directed and incidental categories. Such changes in strategy likely result from a variety of factors, but especially from the potential economic return from landing a particular mix of species. Because of these complexities, managers typically distinguish directed from incidental vessels by applying a value threshold to the landings composition for a particular vessel (or trip, depending on the kind of analysis): open access vessels with more than half of their total landings value coming from groundfish are included in the directed fishery, with the remainder assigned to the incidental category. Based on this criterion, 2,723 unique vessels targeted groundfish in the open access fishery between 1995 and 1998 coastwide, while 2,024 unique vessels landed groundfish as incidental catch (1,231 of these vessels participated in both) (SSC Economic Subcommittee 2000).

Fisheries generally occur along the coast in patterns governed by factors such as location of target species, presence of ports with supporting marine supplies and services, and restrictions or regulations imposed by state and federal governments. The majority of landings by the directed groundfish fishery, by weight, occur off California, while Oregon shows the next highest landings (Hastie 2001). Washington has the lowest groundfish landings for directed and incidental fisheries. Participation in the open access fishery is much greater in California than in Oregon and Washington combined. In 1998, 779 California boats, 232 Oregon boats, and 50 Washington boats participated in the directed open access groundfish fishery; and 520 California boats, 305 Oregon boats, and 40 Washington boats participated in the incidental open access fishery (SSC Economic Subcommittee 2000).

Fishers generally use hook-and-line gear, the most common open access gear type, to target sablefish, rockfish, and lingcod; they generally use pot gear when targeting sablefish and some thornyheads and rockfish. Regulations currently restrict Southern and Central California setnet gear, previously used to target rockfish, including chilipepper, widow rockfish, bocaccio, yellowtail rockfish, and olive rockfish, and to a lesser extent vermillion rockfish.

Higher prices for live groundfish have stimulated landings in this category: in 2001, 20% of fish landed (by weight, coastwide) by directed open access fishers was alive, compared to only 6% in 1996.[4] Fishers use pots, stick gear, and rod-and-reel to catch live fish, and keep them aboard the vessel in a seawater tank. Fishers deliver them to foodfish markets–such as the large Asian communities in California–that pay a premium for live fish. Currently, Oregon and California are drafting nearshore fishery management plans that would move some species of groundfish landed in the live fish fishery from federal to state management.

Many fishers catch groundfish incidentally when targeting other species because of the kind of gear they use and the co-occurrence of target and groundfish species in a given area. Fisheries targeting pink shrimp, spot prawn, ridgeback prawn, California and Pacific halibut, Dungeness crab, salmon, sea cucumber, coastal pelagic species, California sheephead, highly migratory species, and the mix of species caught in the gillnet complex account for the incidental segment of the open access sector.

4/ Managers are faced with a similar problem as discussed above in determining landings from this fishery. Landings data do distinguish live fish sales, but the price information suggests that this classification is inaccurate. Therefore, in practice, only those sales of species other than sablefish that garner a landed price above $2.50 per pound are classified in the live fish sector.

3.7.1.3.1 Distribution of Effort by Groundfish Open Access Vessels

Limited information exists on the distribution of effort by open access vessels. The open access sector is made up of many different gear types, along with directed and incidental catch, which makes it difficult to discern the location of effort, though based on the diversity of this sector, it is reasonable to assume that effort is widespread across the West Coast. The open access sector has an increasing large live-fish fishery component; because nearshore species make up most of the live fish landings, effort located near shore likely accounts for most live fish landings. The live fish fishery is a quickly growing component of the open access sector and will likely continue to grow in the nearshore areas.

As shown in Table 3-26, open access landings and revenue tend to occur primarily during the spring, summer, and fall months. Assuming that landed catch represents directed open access, and that landed catch is a function of effort, then more open access related fishing activity occurs during the spring, summer, and fall months than winter months.

Table 3-26. Open Access Groundfish Landings and Exvessel Revenue by Year and Month

		Year			
Month	Data Type	2000	2001	2002	2003
Jan	Landed Weight (lbs)	93,701	112,254	181,903	110,711
	Exvessel Revenue ($)	145,656	223,168	306,917	205,300
Feb	Landed Weight (lbs)	41,385	165,665	182,796	163,689
	Exvessel Revenue ($)	65,017	302,154	414,606	340,653
Mar	Landed Weight (lbs)	73,791	143,817	252,550	160,549
	Exvessel Revenue ($)	146,782	233,427	336,792	185,578
Apr	Landed Weight (lbs)	159,222	167,204	179,382	245,277
	Exvessel Revenue ($)	288,795	289,676	302,902	254,953
May	Landed Weight (lbs)	183,220	258,256	262,229	292,340
	Exvessel Revenue ($)	375,394	548,591	533,438	579,894
Jun	Landed Weight (lbs)	254,531	261,425	312,602	270,832
	Exvessel Revenue ($)	536,131	500,489	548,528	532,533
Jul	Landed Weight (lbs)	317,609	515,377	273,616	291,337
	Exvessel Revenue ($)	577,348	757,606	476,710	573,222
Aug	Landed Weight (lbs)	293,626	360,067	303,725	344,512
	Exvessel Revenue ($)	683,134	638,477	504,046	549,447
Sep	Landed Weight (lbs)	256,663	306,550	305,507	536,720
	Exvessel Revenue ($)	548,398	538,645	357,348	627,820
Oct	Landed Weight (lbs)	250,241	191,702	184,380	392,800
	Exvessel Revenue ($)	477,569	418,312	315,544	401,556
Nov	Landed Weight (lbs)	271,041	193,812	196,511	359,501
	Exvessel Revenue ($)	522,012	302,037	292,301	344,660
Dec	Landed Weight (lbs)	295,861	81,443	79,445	82,812
	Exvessel Revenue ($)	603,194	155,837	106,519	84,050

Source: PacFIN VSMRFD files. July 2004

Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

3.7.1.3.2 Landings and Revenue from Groundfish Open Access Vessels

Rockfish, thornyheads, and sablefish make up most of the open access landings and revenue (Table 3-27), and hook and line accounts for the largest gear type for open access landings (Table 3-25). Open access landings in the state of California have a large live fish component, which is made evident by the relatively high unit value of rockfish in that state compared to the unit value of rockfish in Oregon and Washington. Many of the largest ports for open access landings and revenue are located in California (Table 3-28).

Table 3-27. Open Access Groundfish Landings and Exvessel Revenue by Year, State, and Species

			Year			
State	Species Aggregation	Data Type	2000	2001	2002	2003
CA	Flatfish and Skates	Landed Weight (lbs)	93,158	48,856	42,579	15,140
		Exvessel Revenue ($)	87,688	63,929	61,621	20,649
	Rockfish(a)	Landed Weight (lbs)	705,190	652,021	486,113	461,812
		Exvessel Revenue ($)	1,789,851	1,750,273	1,259,855	1,027,475
	Other Groundfish	Landed Weight (lbs)	300,719	253,393	185,577	169,155
		Exvessel Revenue ($)	1,070,487	775,543	533,652	506,268
	Sablefish	Landed Weight (lbs)	657,104	558,217	541,963	675,694
		Exvessel Revenue ($)	928,945	766,276	691,173	877,637
OR	Flatfish and Skates	Landed Weight (lbs)	310	22,435	1,034	1,750
		Exvessel Revenue ($)	69	12,341	159	391
	Rockfish(a)	Landed Weight (lbs)	241,363	455,647	309,452	260,633
		Exvessel Revenue ($)	292,445	428,552	478,855	329,766
	Other Groundfish	Landed Weight (lbs)	123,930	176,758	242,546	150,631
		Exvessel Revenue ($)	329,379	462,625	678,185	399,524
	Sablefish	Landed Weight (lbs)	88,627	129,954	96,044	280,209
		Exvessel Revenue ($)	166,725	247,306	188,163	528,151
WA	Flatfish and Skates	Landed Weight (lbs)	2,899	6,052	3,045	23,268
		Exvessel Revenue ($)	814	1,453	1,067	4,533
	Rockfish(a)	Landed Weight (lbs)	172,836	338,792	670,658	662,355
		Exvessel Revenue ($)	80,701	164,664	323,228	319,673
	Other Groundfish	Landed Weight (lbs)	31,187	26,426	36,572	369,093
		Exvessel Revenue ($)	15,785	15,262	20,284	172,052
	Sablefish	Landed Weight (lbs)	73,567	89,021	99,063	181,340
		Exvessel Revenue ($)	206,543	220,195	259,410	493,547
Total Landed Weight (lbs)			2,490,890	2,757,572	2,714,646	3,251,080
Total Exvessel Revenue ($)			4,969,432	4,908,419	4,495,652	4,679,666

a) The "Rockfish" aggregation includes thornyheads and scorpionfish

Source: PacFIN VSMRFD files. July 2004

Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River for example.

Table 3-28. Top Ports for Open Access Groundfish Landings and Revenue (2000 - 2003)

Rank	Top 15 Ports for Landed Revenue	Top 15 Ports for Landed Weight
1	MORRO BAY	MOSS LANDING
2	PORT ORFORD	NEAH BAY
3	MOSS LANDING	FORT BRAGG
4	FORT BRAGG	PORT ORFORD
5	GOLD BEACH	PORT ANGELES
6	AVILA	MORRO BAY
7	SANTA BARBARA	GOLD BEACH
8	PORT ANGELES	WESTPORT
9	CRESCENT CITY	EUREKA
10	NEAH BAY	CRESCENT CITY
11	SAN FRANCISCO	ASTORIA
12	MONTEREY	SAN FRANCISCO
13	ASTORIA	AVILA
14	EUREKA	CHARLESTON (COOS BAY)
15	WESTPORT	BROOKINGS

Source: PacFIN VSMRFD files. July 2004

3.7.1.4 NonGroundfish Fisheries

Fisheries targeting nongroundfish species can affect groundfish management in the following ways:

- Fisheries targeting groundfish may incidentally catch other species, thus management measures that change total fishing effort in groundfish fisheries could increase or decrease fishing mortality of incidentally-caught non-groundfish species;
- Management measures affecting groundfish fisheries may create a secondary effect by inducing additional effort in non-groundfish fisheries on the part of any groundfish fishermen displaced by groundfish regulations;
- Management measures intended to reduce or eliminate incidental catches of overfished groundfish species may affect nongroundfish fisheries that catch the overfished species; and
- The spatial distribution of effort within non-groundfish fisheries may overlap with habitat areas that are of interest to this EIS.

This section describes these nongroundfish fisheries.

3.7.1.4.1 Dungeness Crab Fishery

The states of Oregon and California, and the State of Washington in cooperation with Washington Coast treaty tribes manage the Dungeness crab fishery. The PSMFC provides inter-state coordination. The Dungeness crab fishery is divided between treaty sectors, covering catches by Indian Tribes, and a non-treaty sector. This fishery is managed on the basis of simple

"3-S" principles: sex, season, and size. The commercial fishery may retain only male crabs (thus protecting the reproductive potential of the populations); the fishery has open and closed seasons; and the commercial fishery must comply with a minimum size limit on male crabs. Washington manages the Dungeness fishery with a limited entry system with two tiers of pot limits and a season from December 1 through September 15. In Oregon, 306 vessels made landings in 1999 during a season that generally starts on December 1. In California, distinct fisheries occur in Northern and Central California, with the northern fishery covering a larger area. California implemented a limited entry program in 1995, and as of March 2000 about 600 California residents and 70 non-residents had limited entry permits. Nonetheless, effort has increased with the entry of larger multipurpose vessels from other fisheries. Landings have not declined, but this effort increase has resulted in a "race for fish" with more than 80% of total landings made during the month of December.

Both personal use fishers and commercial fishers target Dungeness crab. At the commercial level, the Dungeness crab fishery generates $67 to $130 million in exvessel revenue (Table 3-29); in recent years (2002 and 2003) the amount of exvessel revenue generated by the fishery has been increasing due in part to increases in stock biomass. For many vessels, the Dungeness crab fishery is the largest source of exvessel revenues. For example, in 2003 approximately 30% of the limited entry trawlers made more money from Dungeness crab than from groundfish activity.

The majority of Dungeness crab fishing effort and catch occurs during the months of December and January. Many types of vessels participate in this fishery including vessels that may otherwise be limited entry groundfish trawlers, limited entry groundfish fixed gear vessels, or other types of vessels that may be considered albacore trollers for example.

The Dungeness crab fishery tends to occur in areas nearer to shore than the limited entry trawl and fixed gear fisheries. To avoid gear interactions with the Dungeness crab fishery, the Councils's Groundfish Management Team has made a conscious effort to allow groundfish trawl vessels access to waters deeper than 60 fathoms during winter months.

All three states are comparable in terms of landed weight and revenue in coastal management areas, and Washington has a substantial additional component in Puget Sound. Washington had the highest landings recent years for coastal Dungeness crab, followed closely by Oregon and California. The ports with highest landings are distributed among the three states (Table 3-30).

Table 3-29. Landings and Exvessel Revenue of Dungeness Crab by Area, State, and Year (2000 - 2003)

			YEAR			
Area	State	Data type	2000	2001	2002	2003
Coastal Management Areas	CA	Landed weight (lbs)	6,482,913	3,546,106	7,297,676	22,196,754
		Exvessel revenue ($)	13,751,700	9,009,756	13,458,089	35,270,665
	OR	Landed weight (lbs)	11,180,845	9,689,804	12,442,612	23,480,735
		Exvessel revenue ($)	23,710,261	19,291,484	20,759,342	36,399,904
	WA	Landed weight (lbs)	11,700,416	12,049,827	16,101,625	28,191,992
		Exvessel revenue ($)	25,609,842	24,003,463	26,707,196	45,129,820
Other Management Areas	CA	Landed weight (lbs)				C
		Exvessel revenue ($)				C
	WA	Landed weight (lbs)	6,732,220	7,522,403	6,944,948	6,941,032
		Exvessel revenue ($)	14,084,886	14,752,254	13,548,402	13,259,518
Total Landed weight (lbs)			36,096,394	32,808,140	42,786,861	80,810,513*
Total Exvessel revenue ($)			77,156,690	67,056,957	130,059,907	130,071,468*

Source: PacFIN ftl table. August 2004
Note: C represents data restricted due to confidentiality
"Other management areas" includes inside waters such as Puget Sound and Columbia River
* totals do not include confidential data

Table 3-30. Top 15 Ports for Dungeness Crab Landings and Revenue (2000 - 2003)

Rank	Top Ports for Dungeness Crab by Weight	Top Ports for Dungeness Crab by Value
1	WESTPORT	WESTPORT
2	ASTORIA	ASTORIA
3	CRESCENT CITY	CRESCENT CITY
4	NEWPORT	NEWPORT
5	BELLINGHAM BAY	BELLINGHAM BAY
6	CHARLESTON (COOS BAY)	CHARLESTON (COOS BAY)
7	EUREKA	EUREKA
8	BROOKINGS	BLAINE
9	BLAINE	BROOKINGS
10	ILWACO	SAN FRANCISCO
11	SAN FRANCISCO	LACONNER
12	CHINOOK	ILWACO
13	LACONNER	CHINOOK
14	TAHOLAH	TAHOLAH
15	ANACORTES	PRINCETON / HALF MOON BAY

Source: PacFIN FTL table. July 2004

3.7.1.4.2 Highly Migratory Species Fisheries

Highly migratory species (HMS), including tunas, billfish, dorado (dolphinfish), and sharks, range great distances during their lifetime, extending beyond national boundaries into international waters and among the EEZs of many nations in the Pacific. In 2003, the Council adopted a Highly Migratory Species FMP (PFMC 2003) to federally regulate the take of HMS within and outside the U.S. West Coast EEZ. NMFS approved the FMP, allowing implementation, on January 30, 2004. Complex management of HMS results from the multiple management jurisdictions, users, and gear types targeting these species, and from the oceanic regimes that play a major role in determining species availability and which species will be harvested off the U.S. West Coast in a given year.

The management unit consists of five tuna species, five shark species, striped marlin, swordfish, and dorado. Albacore tuna account for a large majority of the landed weight and value (Table 3-31). NMFS will monitor the numerous species caught by the HMS fishery, but which are not part of the fishery management unit.

Commercial fishers use five distinctive gear types used to harvest HMS: hook-and-line, driftnet, pelagic longline, purse seine, and harpoon (Table 3-32).

While hook-and-line gear catches many HMS species, traditionally it has been used to harvest tunas. The principal target species for hook-and-line fisheries include albacore and other tunas, swordfish and other billfish, several shark species, and dorado. Albacore make up the highest hook and line landings landings, with the majority taken by troll and jig-and-bait gear (92% in 1999). Gillnet, drift longline, and other gear take a small portion of fish. These gear types vary in the incidence of groundfish interception depending on the area fished and time of year. Overall, nearly half of the total coastwide landings of albacore, by weight, were landed in California.

Fishers use pelagic longline to target swordfish, shark and tunas; drift gillnet gear to target swordfish, tunas, and sharks off California and Oregon; purse seine gear to target tuna off California and Oregon; and harpoon to target swordfish off California and Oregon. Some vessels, especially longliners and purse seiners, fish outside of the EEZ, but may deliver to West Coast ports. Drift gillnets intercept most groundfish, including whiting, spiny dogfish, and yellowtail rockfish. Most landings occur in Washington and Oregon (Table 3-27), and the top several ports occur in these states (Table 3-28).

Table 3-31. Landings and Revenue of HMS by Species and Year

		Year			
Species Type	Data Type	2000	2001	2002	2003
Albacore	Landed weight (lbs)	19,848,814	24,495,425	22,063,692	36,485,624
	Exvessel revenue ($)	17,103,010	20,577,991	14,272,304	24,305,367
Shark	Landed weight (lbs)	547,195	567,274	517,745	491,807
	Exvessel revenue ($)	720,450	670,249	629,727	588,697
Other Tuna	Landed weight (lbs)	1,559,831	1,644,104	78,491	113,077
	Exvessel revenue ($)	900,461	833,464	90,157	100,998
Dorado and Marlin	Landed weight (lbs)	8,946	18,394	C	C
	Exvessel revenue ($)	12,633	13,501	C	C
Swordfish	Landed weight (lbs)	1,252,875	640,799	609,248	980,229
	Exvessel revenue ($)	4,054,296	2,158,192	2,264,288	3,131,158
Total Landed Weight (lbs)		23,217,661	27,365,996	23,269,176*	38,070,737*
Total Exvessel Revenue ($)		22,790,849	24,253,397	17,256,476*	28,126,220*

Source: PacFIN FTL table. July 2004
Note: C represents data restricted due to confidentiality
* totals do not include confidential data

Table 3-32. HMS Landings and Exvessel Revenue by State, Year, and Major Gear Group

			YEAR			
State	Gear Group	Data Type	2000	2001	2002	2003
CA	Hook and Line	Landed weight (lbs)	2,323,968	2,402,114	4,534,829	2,697,411
		Exvessel revenue ($)	2,741,226	2,334,606	2,945,594	2,741,955
	Net	Landed weight (lbs)	2,902,991	2,802,769	1,090,415	930,255
		Exvessel revenue ($)	3,975,012	2,850,343	2,225,363	1,741,480
	Troll	Landed weight (lbs)	1,964,550	3,907,886	1,364,167	1,360,872
		Exvessel revenue ($)	1,872,012	3,063,523	1,024,421	988,564
OR		Landed weight (lbs)	C	76,513	323,497	C
	Hook and Line	Exvessel revenue ($)	C	41,340	198,261	C
	Net	Landed weight (lbs)	C		C	86,604
		Exvessel revenue ($)	C		C	13,720
	Troll	Landed weight (lbs)	8,755,933	8,948,222	4,036,735	9,039,680
		Exvessel revenue ($)	7,488,326	7,545,405	2,752,640	6,115,181
WA		Landed weight (lbs)	C	C	C	
	Hook and Line	Exvessel revenue ($)	C	C	C	
	Net	Landed weight (lbs)	C			
		Exvessel revenue ($)	C			
	Troll	Landed weight (lbs)	7,020,617	9,145,451	11,776,387	23,792,124
		Exvessel revenue ($)	5,836,813	7,947,279	7,418,555	15,706,940

Source: PacFIN FTL table. July 2004.
Note: C represents data restricted due to confidentiality

Table 3-33. Top Ports for HMS Landings and Exvessel Revenue (2000 - 2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	ILWACO	ILWACO
2	NEWPORT	NEWPORT
3	WESTPORT	WESTPORT
4	ASTORIA	ASTORIA
5	CHARLESTON (COOS BAY)	SAN DIEGO
6	TERMINAL ISLAND	MORRO BAY
7	EUREKA	SAN PEDRO
8	MORRO BAY	CHARLESTON (COOS BAY)
9	MOSS LANDING	TERMINAL ISLAND
10	BELLINGHAM BAY	EUREKA
11	SAN PEDRO	MOSS LANDING
12	SAN DIEGO	BELLINGHAM BAY
13	OCEANSIDE	SAN FRANCISCO
14	FIELDS LANDING	OCEANSIDE
15	CRESCENT CITY	CRESCENT CITY

Source: PacFIN FTL table. July 2004

3.7.1.4.3 Pacific Pink Shrimp Fishery

Pacific pink shrimp (*Pandalus jordani*) range from Unalaska in the Aleutian Islands to San Diego, California, at depths of 25 fm to 200 fm (46 m to 366 m). Pink shrimp tend to aggregate in well-defined areas of green mud and muddy-sand bottoms. The states of Washington, Oregon, and California manage the Pacific shrimp fisheries. The Council has no direct management authority. In 1981, the three coastal states established uniform coastwide regulations for the pink shrimp fishery. The season runs from April 1 through October 31. Regulations authorize pink shrimp commercial harvest only by trawl nets or pots. Trawl gear harvests most of these shrimp off the West Coast from Northern Washington to Central California at depths from 60 fm and 100 fm (110 m to 180 m), with the majority taken off Oregon (Table 3-34). The ports with highest landings also occur in Oregon, followed by Washington and Oregon ports (Table 3-35).

Most shrimp trawl gear has a mesh size of one inch to three-eights inches between knots. Shrimp trawl nets are usually constructed with net mesh sizes smaller than the net mesh sizes for legal groundfish trawl gear. Thus, shrimp trawlers commonly catch groundfish, while groundfish trawlers catch little shrimp. In some years the pink shrimp trawl fishery has accounted for a significant share of canary rockfish incidental catch. The Council has discussed methods to control shrimp fishing activities, such as requiring all vessels to use bycatch reduction devices (finfish excluders). In 2002, finfish excluders in the pink shrimp fisheries were mandatory in California, Oregon, and Washington. Many vessels that participate in the shrimp trawl fishery also have groundfish limited entry permits. Vessels participating in the pink shrimp fishery must abide by the same rules as vessels that do not have groundfish limited entry permits. However, all groundfish landed by vessels with limited entry permits are included in the limited entry total.

Table 3-34. Pink Shrimp Landings and Exvessel Revenue by Year and State (LBS and USD)

		YEAR			
State	Data Type	2000	2001	2002	2003
CA	Landed weight (lbs)	2,459,095	3,612,205	4,116,213	2,147,685
	Exvessel revenue ($)	1,049,119	992,644	1,275,023	657,159
OR	Landed weight (lbs)	25,462,479	28,482,140	41,583,534	20,545,976
	Exvessel revenue ($)	10,192,294	7,560,473	11,352,588	5,051,246
WA	Landed weight (lbs)	4,360,914	6,590,344	10,105,043	7,893,802
	Exvessel revenue ($)	1,700,410	1,713,687	2,745,707	1,959,662
Total Landed Weight (lbs)		32,282,488	38,684,689	55,804,790	30,587,463
Total Exvessel Revenue ($)		12,941,823	10,266,804	15,373,317	7,668,068

Source: PacFIN FTL table. July 2004

Table 3-35. Top 15 Ports for Pink Shrimp Landings and Exvessel Revenue (2000–2003)

Rank	Top Ports by Weight	Top Ports by Exvessel Revenue
1	ASTORIA	ASTORIA
2	NEWPORT	NEWPORT
3	CHARLESTON (COOS BAY)	CHARLESTON (COOS BAY)
4	WESTPORT	WESTPORT
5	GARIBALDI (TILLAMOOK)	GARIBALDI (TILLAMOOK)
6	EUREKA	EUREKA
7	CRESCENT CITY	CRESCENT CITY
8	BROOKINGS	BROOKINGS
9	ILWACO	ILWACO
10	SOUTH BEND	SOUTH BEND
11	TOKELAND	MORRO BAY
12	MORRO BAY	TOKELAND
13	AVILA	AVILA
14	FIELDS LANDING	FIELDS LANDING
15	MONTEREY	MONTEREY

Source: PacFIN FTL table. July 2004

3.7.1.4.4 Ridgeback Prawn Fisheries

Ridgeback prawns (*Sicyonia ingentis*) range from south of Monterey, California to Baja California, Mexico, in depths of 145 meters to 525 meters (Sunada et al. 2001). The highest prawn abundance occurs south of Point Conception where they are the most common invertebrate appearing in trawls. They prefer sand, shell, and green mud substrate, and have a relatively sessile lifestyle. Although information about their feeding habits is limited, prawns probably feed on detritus, and in turn fall prey to sea robins, rockfish, and lingcod. Unlike other shrimp species, which carry their eggs during maturation, ridgeback prawns release their eggs into the water column. They spawn seasonally from June to October. Surveys recorded increasing abundance of ridgeback prawns from 1982, when surveys began, to 1985; the population then declined until the 1990s when recent CPUE data suggest increased abundance. Climate phenomena, particularly El Niño events, may cause these changes.

The Ridgeback prawn fishery occurs exclusively in California, centered in the Santa Barbara Channel and off Santa Monica Bay. In 1999, 32 boats participated in the ridgeback prawn fishery. Traditionally, a number of boats fish year-round for both ridgeback and spot prawns, targeting ridgeback prawns during the closed season for spot prawns and vice versa. Most boats typically use single-rig trawl gear. Shrimp gear accounts for nearly all prawn landings, although groundfish trawl and other gears take minor amounts (Table 3-36). The top ports for landed weight and exvessel value occur in the Santa Barbara Channel-Santa Monica Bay region (Table 3-37). The State of California manages the ridgeback prawn fishery. Similar to spot prawn and pink shrimp fisheries, prawns are an “exempted” fishery in the federal open access groundfish fishery, entitling to groundfish trip limits.

Following a 1981 decline in landings, the California Fish and Game Commission adopted a June through September closure to protect spawning female and juvenile ridgeback prawns. Regulations allow an incidental take of 50 pounds of prawns or 15% by weight during the closed period. During the open prawn season, federal regulations limit finfish landings per trip to a maximum of 1,000 pounds, with no more than 300 pounds of groundfish. A vessel operator may land any amount of sea cucumbers with ridgeback prawns as long as the operator possesses a sea cucumber permit. Other regulations include a prohibition on trawling within state waters, a minimum fishing depth of 25 fm, a minimum mesh size of 1.5 inches for single-walled cod ends or 3 inches for double-walled cod ends and maintaining a logbook (required since 1986).

Table 3-36. Ridgeback Prawn Landings and Exvessel Revenue by Year (LBS and USD)

		YEAR			
Gear Group	Data Type	2000	2001	2002	2003
Trawl	Landed weight (lbs)	141,160	16,920	19,735	12,454
	Exvessel revenue ($)	165,345	26,976	31,599	14,641
Shrimp Trawl	Landed weight (lbs)	1,414,844	340,024	422,240	486,890
	Exvessel revenue ($)	1,633,636	508,853	606,064	669,274
Other Gears	Landed weight (lbs)	10,172	0	0	237
	Exvessel revenue ($)	13,201	0	0	641
Total Landed Weight (lbs)		1,566,176	356,944	441,975	499,581
Total Exvessel Revenue ($)		1,812,182	535,829	637,663	684,557

Source: PacFIN FTL table. July 2004

Table 3-37. Rank of All Ports with Ridgeback Prawn Landings and Exvessel Revenue (2000–2003)

Rank	Rank of Ports by Weight	Rank of Ports by Exvessel Revenue
1	SANTA BARBARA	SANTA BARBARA
2	VENTURA	VENTURA
3	OXNARD	OXNARD
4	TERMINAL ISLAND	TERMINAL ISLAND
5	LONG BEACH	LONG BEACH
6	PLAYA DEL REY	PLAYA DEL REY
7	PORT HUENEME	PORT HUENEME
8	SAN PEDRO	SAN PEDRO
9	MORRO BAY	MORRO BAY
10	AVILA	AVILA
11	SAN SIMEON	SAN SIMEON
12	POINT ARENA	POINT ARENA
13	PRINCETON / HALF MOON BAY	PRINCETON / HALF MOON BAY

Source: PacFIN ftl table. August 2004

3.7.1.4.5 Kelp Fishery

The giant kelp forest canopy serves as a nursery, feeding grounds, and/or shelter for a variety of groundfish species and their prey. Kelp plants naturally break free of their holdfasts, and drift with waves and currents along the bottom 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 occurred in California since 1910. However, harvest has declined in recent years to about one-third of that in the early 1990s (Table 3-38). Specially designed ships harvest kelp. The ships cut the surface canopy no lower than 1.2 m below the surface in a strip eight meters wide, much like a lawn mower. Regulations imposed by the State of California 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.

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 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 such as young-of-the-year rockfishes. Extensive or permanent loss of kelp canopy could have adverse impacts on local fish recruitment and abundance.

The following references were used in compiling this description: California Department of Fish and Game (1995), Cross and Allen (1993), Feder et al. (1974), Foster and Schiel (1985), and Vetter (1995).

Table 3-38. Harvest of Kelp off California by Year

Year	Harvested Weight (short tons)
1990	151,439.21
1991	127,504.68
1992	91,246.54
1993	92,940.41
1994	81,006.38
1995	77,753.00
1996	78,461.00
1997	73,165.00
1998	25,313.00
1999	42,211.00
2000	46,200.00
2001	40,298.00
2002	51,868.00

Source: California Department of Fish and Game. As cited at NMFS SWR website Aug 2004. http://swr.nmfs.noaa.gov/fmd/bill/kelp.htm.

3.7.1.4.6 Salmon

The ocean commercial salmon fishery, both non-treaty and treaty, is managed by both the states and the federal government. The Council manages fisheries in the EEZ while the states manage fisheries in their waters. All ocean commercial salmon fisheries off the West Coast states use troll gear, and primarily target chinook and coho. Limited pink salmon landings occur in odd-years. A gillnet/tangle net fishery that does not technically occur in Council-managed waters may have some impact on groundfish that migrate through state waters. Commercial coho landings fell precipitously in the early 1990s and remain very low. In response to the listing of many wild salmon stocks under the ESA, the management regime is largely structured around so-called "no jeopardy standards" developed through the ESA-mandated consultation process. Ocean fisheries are managed according to zones reflecting the distribution of salmon stocks and are structured to allow and encourage capture of hatchery-produced stocks while avoiding depressed natural stocks. The Columbia River, on the Oregon/Washington border; the Klamath River in Southern

Oregon; and the Sacramento River in Central California support the largest runs of returning salmon.

California accounts for most landings and revenues of salmon caught in the coastal management areas, followed by Oregon and Washington (Table 3-39). However, Washington landings in Puget Sound and other non-coastal areas substantially exceed the total coastal landings. Most of the top 10 ports for quantity of landings occur in Washington (Table 3-40), but the top ports in terms of revenues occur more evenly distributed by state.

The salmon troll fishery has a small incidental catch of Pacific halibut and groundfish, including yellowtail rockfish. The historical data show that salmon troll trips that did not land halibut had a higher range of groundfish landings (11-149 mt) than troll trips that landed halibut (1-19 mt). However, looking at groundfish catch frequency, either by vessel or trips, reveals that groundfish are caught more often by vessels or on trips catching halibut. To account for yellowtail rockfish landed incidentally while not promoting targeting on the species, federal managers have allowed salmon trollers to land up to one pound of yellowtail per two pounds of salmon in 2001, not to exceed 300 pounds per month (north of Cape Mendocino).

Table 3-39. Salmon Landings and Exvessel Revenue by Area, State, and Year (LBS and USD)

			YEAR			
Area	State	Data type	2000	2001	2002	2003
Coastal Management Areas	CA	Landed weight (lbs)	5,143,030	2,407,615	4,941,537	6,382,942
		Exvessel revenue ($)	10,325,395	4,772,551	7,643,076	12,166,622
	OR	Landed weight (lbs)	1,563,697	2,960,716	3,501,154	3,667,155
		Exvessel revenue ($)	3,069,828	4,736,557	5,388,352	7,198,494
	WA	Landed weight (lbs)	416,030	1,090,350	1,348,292	1,443,320
		Exvessel revenue ($)	566,873	1,096,778	1,313,661	1,594,448
Other Management Areas	OR	Landed weight (lbs)	1,340,819	1,855,600	2,089,757	2,438,378
		Exvessel revenue ($)	961,419	1,125,372	1,543,793	1,586,972
	WA	Landed weight (lbs)	12,750,614	28,791,819	32,904,386	31,122,453
		Exvessel revenue ($)	9,772,895	11,298,116	12,013,803	11,100,583
Total Landed weight (lbs)			21,214,190	37,106,100	44,785,126	45,054,248
Total Exvessel revenue ($)			24,696,410	23,029,373	27,902,685	33,647,119

Source: PacFIN ftl table. August 2004

Note: "Other management areas" includes inside waters such as Puget Sound and Columbia River

Table 3-40. Top 15 Ports for Salmon Landings and Exvessel Revenue (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	BELLINGHAM BAY	NEWPORT
2	SEATTLE	FORT BRAGG
3	SHELTON	BELLINGHAM BAY
4	COLUMBIA RIVER PORTS - OREGON	CHARLESTON (COOS BAY)
5	TAHOLAH	BODEGA BAY
6	LACONNER	SAN FRANCISCO
7	NEWPORT	COLUMBIA RIVER PORTS - OREGON
8	EVERETT	SHELTON
9	FORT BRAGG	PRINCETON / HALF MOON BAY
10	TACOMA	SEATTLE
11	BLAINE	MOSS LANDING
12	COPALIS BEACH	TACOMA
13	PORT ANGELES	TAHOLAH
14	BODEGA BAY	PORT ANGELES
15	CHARLESTON (COOS BAY)	BLAINE

Source: PacFIN ftl tables. August 2004

3.7.1.4.7 Pacific Halibut

Pacific halibut (*Hippoglossus stenolepis*), in the family Pleuronectidae , range along the continental shelf in the North Pacific and Bering Sea in waters of 40 to 200 m depth. They have flat, diamond-shaped bodies and may migrate long distances. Juvenile halibut, mostly shorter than the legal size limit, tend to migrate from north to south until they reach maturity. Adult halibut migrate from shallow summer feeding grounds to deeper winter spawning grounds. Most adult fish return to the same feeding grounds each summer where most commercial and recreational fishing occurs.

The bilateral (U.S./Canada) IPHC recommends conservation regulations for Pacific halibut, and the governments of Canada and the U.S. implement the regulations in their own waters. The IPHC requires a license to participate in the commercial Pacific halibut fishery in waters off Washington, Oregon, and California (Area 2A). Area 2A licenses, issued for the directed commercial fishery, have decreased from 428 in 1997 to 215 in 2004.The Pacific and North Pacific Fishery Management Councils have responsibility for allocation in Council waters within the IPHC management regime. The Pacific Halibut Catch Sharing Plan (CSP) for Area 2A specifies allocation agreements of the Council, the states of Washington, Oregon, and California, and the Pacific halibut treaty tribes. The CSP specifies recreational and commercial fisheries for Area 2A. The commercial sector has both a treaty and non-treaty components. Regulations limit the directed non-treaty commercial fishery in Area 2A to south of Point Chehalis, Washington, Oregon, and California. Commercial landings have ranged from about 0.5 to 1.0 million pounds (head on dressed weight) and $1.5 to $2.3 million (Table 3-43). Washington accounts for the majority of the highest-producing ports for landed weight and revenue (Table 3-44). In the non-treaty commercial sector, the directed halibut fishery receives an allocation of 85% of the harvest and the salmon troll fishery receives 15% to cover incidental catch. The limited entry primary sablefish fishery north of Point Chehalis, Washington (46º 53' 18" N latitude) may retain halibut when the Area 2A total allowable halibut catch (TAC) is above 900,000 pounds. In 2003, the TAC was above this level, and the allocation was 70,000 pounds. Final landings for this fishery in 2003 were 65,325 pounds; 56% (47,946 pounds) of the allocation was harvested.

Table 3-41. Pacific Halibut Commercial Landings and Exvessel Revenue by Year and Gear (LBS and USD)

		YEAR			
Gear Group	Data Type	2000	2001	2002	2003
Hook and Line	Landed weight (lbs)	519,645	745,500	949,274	807,131
	Exvessel revenue ($)	1,358,462	1,578,914	1,941,603	2,226,318
Troll	Landed weight (lbs)	25,574	37,639	42,811	48,416
	Exvessel revenue ($)	62,210	78,409	81,505	107,640
Total Landed weight (lbs)		545,219	783,139	992,085	855,547
Total Exvessel Revenue ($)		1,420,671	1,657,323	2,023,108	2,333,958

Source: PacFIN ftl table. August 2004

Table 3-42. Top 15 Ports for Pacific Halibut Landings and Exvessel Revenue (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	NEAH BAY	NEAH BAY
2	NEWPORT	NEWPORT
3	PORT ANGELES	PORT ANGELES
4	TAHOLAH	BELLINGHAM BAY
5	BELLINGHAM BAY	TAHOLAH
6	LAPUSH	LAPUSH
7	ASTORIA	ASTORIA
8	WESTPORT	WESTPORT
9	CHARLESTON (COOS BAY)	CHARLESTON (COOS BAY)
10	EVERETT	BLAINE
11	BLAINE	EVERETT
12	FLORENCE	FLORENCE
13	PORT ORFORD	GARIBALDI (TILLAMOOK)
14	GARIBALDI (TILLAMOOK)	CHINOOK
15	CHINOOK	PORT ORFORD

Source: PacFIN ftl table. August 2004

3.7.1.4.8 California Halibut

California halibut (*Paralichthys californicus*), a left-eyed flatfish of the family Bothidae, range from Northern Washington at approximately the Quileute River to southern Baja California, Mexico (Eschmeyer et al. 1983). The center of distribution occurs south of Oregon. They predominantly associate with sand substrates from nearshore areas just beyond the surf line to about 183 m. California halibut feed on fishes and squids and can take their prey well off the bottom.

The commercial California halibut fishery extends from Bodega Bay in northern California to San Diego in Southern California, and across the international border into Mexico. California halibut, a state-managed species, is targeted with hook-and-line, setnets and trawl gear, all of which intercept groundfish. Federal regulations allow fishing with 4.5-inch minimum mesh size trawl in federal waters, but California regulations prohibit trawling within state waters, except in the designated “California halibut trawl grounds,” where a 7.5-inch minimum mesh size must be used during open seasons. Historically, California commercial halibut fishers have preferred setnets because of these restrictions, and predominantly use 8.5-inch mesh and maximum length of 9,000. These nets take most of the landings (Table 3-43). Setnets are prohibited in certain designated areas, including a Marine Resources Protection Zone (MRPZ), covering state waters (to 3 nm) south of Point Conception and waters around the Channel Islands to 70 fm, but extending seaward no more than one mile. In comparison to trawl and setnet landings, commercial hook-and-line catches are historically insignificant. Over the last decade they have ranged from 11% to 23% of total California halibut landings. Most of those landings were made in the San Francisco Bay area by salmon fishers mooching or trolling slowly over the ocean bottom (Kramer et al. 2001). Overall, the ports with highest California halibut landings occur in central and southern California (Table 3-44).

Table 3-43.California Halibut Landings and Exvessel Revenue by Year and Gear (LBS and USD)

		YEAR			
Gear Group	Data type	2000	2001	2002	2003
Hook and Line	Landed weight (lbs)	118,519	124,241	166,307	208,887
	Exvessel revenue ($)	366,478	398,222	523,217	654,537
Misc.	Landed weight (lbs)	C	C	C	C
	Exvessel revenue ($)	C	C	C	C
Net	Landed weight (lbs)	380,105	319,235	255,720	181,439
	Exvessel revenue ($)	1,122,396	981,323	820,973	601,822
Pot	Landed weight (lbs)	463	170	1,501	592
	Exvessel revenue ($)	1,225	531	3,594	2,419
Troll	Landed weight (lbs)	9,163	10,382	8,259	13,735
	Exvessel revenue ($)	21,241	24,687	18,784	29,589
Trawl	Landed weight (lbs)	277,878	377,094	451,186	342,609
	Exvessel revenue ($)	728,537	1,076,334	1,276,334	912,487
Shrimp Trawl	Landed weight (lbs)	63,947	66,634	55,534	77,324
	Exvessel revenue ($)	214,903	226,478	203,011	326,085
Total Landed weight (lbs)		850,075	897,756	938,507	824,586
Total Exvessel revenue ($)		2,454,780	2,707,575	2,845,913	2,526,939

Source: PacFIN ftl table. August 2004
Note: totals exclude confidential data

Table 3-44. Top 15 Ports for California Halibut Landings and Exvessel Revenue (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	SAN FRANCISCO	SAN FRANCISCO
2	PRINCETON / HALF MOON BAY	VENTURA
3	VENTURA	PRINCETON / HALF MOON BAY
4	SANTA BARBARA	SANTA BARBARA
5	SAN PEDRO	TERMINAL ISLAND
6	TERMINAL ISLAND	SAN PEDRO
7	OXNARD	OXNARD
8	MOSS LANDING	PORT HUENEME
9	SANTA CRUZ	OCEANSIDE
10	AVILA	SANTA CRUZ
11	PORT HUENEME	AVILA
12	OCEANSIDE	MOSS LANDING
13	MONTEREY	SAN DIEGO
14	SAN DIEGO	MONTEREY
15	MORRO BAY	MORRO BAY

Source: PacFIN ftl table. August 2004

3.7.1.4.9 Puget Sound Geoduck

The wild stock geoduck fishery (*Panopea abrupta*) in Washington State is jointly managed by the Washington Department of Natural Resources (DNR), the Washington Department of Fish and Wildlife (WDFW), and the Puget Sound Treaty Indian Tribes (Tribes) that have a right to 50% of the harvestable surplus of geoducks. The State and the Tribes are responsible for estimating geoduck population size, determining sustainable yield, and ensuring minimal adverse effects to the environment. DNR has proprietary management interest in the State's half of the harvest and auctions the right to harvest wildstock geoducks to private companies and individuals. Management of the geoduck resource is dynamic due to changes in market demand, resource economics, and new information on geoduck biology and population dynamics. DNR and WDFW conduct civil and criminal enforcement of Washington state laws, regulations and contract conditions that apply to the State's wildstock geoduck fishery (WDNR 2004).

3.7.1.4.10 California Sheephead

California sheephead (*Semicossyphus pulcher*), a large member of the wrasse family Labridae, range from Monterey Bay south to Guadalupe Island in central Baja California and the Gulf of California, in Mexico, but are uncommon north of Point Conception. They are associated with rocky bottom habitats, particularly in kelp beds to 55 m, but more commonly at depths of 3 m to 30 m. They can live to 50 years of age and a maximum length of 91 cm (16 kg). Like some other wrasse species, California sheephead start life as a female, and changing to a male at about 30 cm in length.

Pot fishermen account for well over half of the total catch and revenues of Sheephead (Table 3-45), followed by hook and line gear. Nets and other gears take minimal amounts of Sheephead. The top 15 ports in California have a similar order of landed weight and revenue (Table 3-46)

Table 3-45. Landings and Exvessel Revenue of California Sheephead by State, Gear, and Year (LBS and USD)

			YEAR			
State	Gear	Data type	2000	2001	2002	2003
California	Hook and Line	Landed weight (lbs)	33,211	23,928	22,698	24,587
		Exvessel revenue ($)	93,186	73,996	66,304	82,449
	Other Gears	Landed weight (lbs)	1,506	1,268	1,199	2,677
		Exvessel revenue ($)	4,663	2,860	4,100	10,131
	Net	Landed weight (lbs)	3,067	3,097	1,432	474
		Exvessel revenue ($)	5,897	3,401	1,388	1,317
	Pot	Landed weight (lbs)	136,161	121,941	95,719	79,618
		Exvessel revenue ($)	490,773	437,409	339,741	292,673
Total Landed weight (lbs)			173,945	150,234	121,048	107,356
Total Exvessel revenue ($)			594,519	517,666	411,532	386,570

Source: PacFIN ftl table. August 2004

Table 3-46. Top 15 Ports for Sheephead Landings and Exvessel Revenue (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	OXNARD	OXNARD
2	SAN DIEGO	SAN DIEGO
3	SANTA BARBARA	TERMINAL ISLAND
4	TERMINAL ISLAND	SANTA BARBARA
5	NEWPORT BEACH	NEWPORT BEACH
6	VENTURA	MISSION BAY
7	MISSION BAY	VENTURA
8	OCEANSIDE	OCEANSIDE
9	DANA POINT	DANA POINT
10	SAN PEDRO	SAN PEDRO
11	POINT LOMA	POINT LOMA
12	LONG BEACH	LONG BEACH
13	MORRO BAY	PLAYA DEL REY
14	PLAYA DEL REY	REDONDO BEACH
15	REDONDO BEACH	MORRO BAY

Source: PacFIN ftl table. August 2004

3.7.1.4.11 Coastal Pelagic Species

Coastal pelagic species (CPS) are schooling fish, not associated with the ocean bottom, that migrate in coastal waters. These species include: northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), Pacific (chub) mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and market squid (Decapoda). Until 1999, northern anchovy was managed under the Council's Northern Anchovy FMP. Amendment 8 to the Northern Anchovy

FMP, implemented in December 1999, brought the remaining CPS species under federal management and renamed the FMP the Coastal Pelagic Species FMP.

Sardines inhabit coastal subtropical and temperate waters, and at times, have been the most abundant fish species in the California current. During times of high abundance, Pacific sardine range from the tip of Baja California, Mexico, to southeastern Alaska. During periods of low abundance, Pacific sardine do not occur in large quantities north of Point Conception, California. Pacific mackerel in the northeastern Pacific range from Banderas Bay, Mexico to southeastern Alaska, commonly from Monterey Bay, California to Cabo San Lucas, Baja California, and most abundant south of Point Conception, California. The central subpopulation of northern anchovy ranges from San Francisco, California to Punta Baja, Mexico. Jack mackerel range widely throughout the northeastern Pacific; however, much of their range lies outside the U.S. EEZ. Adult and juvenile market squid are distributed throughout the Alaska and California current systems, but most abundantly between Punta Eugenio, Baja California, Mexico, and Monterey Bay, Central California.

Stock assessments for Pacific sardine and Pacific mackerel from December 1999 and July 1999, respectively, indicate increasing relative abundance for both species. Pacific sardine biomass in U.S. waters was estimated to be 1,581,346 mt in 1999; Pacific mackerel biomass (in U.S. waters) was estimated to be 239,286 mt. Pacific sardine landings for the directed fisheries off California and Baja California, Mexico, reached the highest level in recent history during 1999, with a combined total of 115,051 mt harvested. In 1998, near-record landings of 70,799 mt of Pacific mackerel occurred for the combined directed fisheries off California and Baja California.

Population dynamics for market squid are poorly understood, and annual commercial catch varies from less than 10,000 mt to 90,000 mt. They are thought to have an annual mortality rate approaching 100%, which means the adult population is almost entirely new recruits and successful spawning is crucial to future years' abundance. Amendment 10 to the CPS FMP describes and analyzes several approaches for estimating an MSY proxy for market squid. Council adopted Amendment 10 in June 2002 and NMFS implemented the plan on January 27, 2003 (68 FR 3819).

These fisheries are concentrated in California (Table 3-47), but CPS fishing also occurs in Washington and Oregon. Vessels using round haul gear (purse seines and lampara nets) account for 99% of total CPS landings and revenues per year (Table 3-48). In Washington, the Emerging Commercial Fishery regulations provides for the sardine fishery as a trial commercial fishery. The trial fishery targets sardines, but also lands anchovy, mackerel, and squid. Regulations limit the fishery to vessels using purse seine gear; prohibits fishing inside of three miles, and requires logbooks. Eleven of the 45 permits holders participated in the fishery in 2000, landing 4,791 mt of sardines (Robinson 2000). Three vessels accounted for 88% of the landings. Of these, two fished out of Ilwaco and one out of Westport. Oregon manages the sardine fishery under the Development Fishery Program under annually-issued permits, which have ranged from 15 in 1999 and 2000 to 20 in 2001. Landings, almost all by purse seine vessels, have rapidly increased in Oregon: from 776 mt in 1999 to 12,798 mt in 2001. The number of vessels increased from three to 18 during this period (McCrae 2001; McCrae 2002 personal communication). The Southern California round haul fleet is the most important sector of the CPS fishery in terms of landings, and most of the highest production ports occur in this area (Table 3-49). This fleet is primarily based in Los Angeles Harbor, along with fewer vessels in the Monterey and Ventura areas. The fishery harvests Pacific bonito, market squid, and tunas as well as CPS. The fleet consists of about 40 active purse seiners averaging 20 m in length. Approximately one-third of this fleet are steel-hull boats built during the last 20 years, the remainder are wooden-hulled vessels built from 1930 to 1949, during the boom of the Pacific sardine fleet. Because stock sizes of these species can radically change in response to ocean conditions, the CPS FMP takes a flexible management approach. Pacific mackerel and Pacific sardine are actively managed through annual harvest guidelines based on periodic assessments. Northern anchovy, jack mackerel, and market squid are monitored through commercial catch data. If appropriate, one third of the harvest guideline is allocated to Washington, Oregon, and northern California (north of 35°40' N latitude) and two-thirds is allocated to Southern California (south of 35°40' N latitude). An open access CPS fishery is in place north of 39°N latitude and a limited entry fishery is in place south of 39° N latitude. The Council does not set harvest guidelines for anchovy, jack mackerel, or market squid (PFMC 1998).

Table 3-47. CPS Landings and Exvessel Revenue by Area, State, and Year (LBS and USD)

			YEAR			
Area	State	Data type	2000	2001	2002	2003
Coastal Management Areas	CA	Landed weight (lbs)	465,666,430	376,633,573	316,754,663	182,994,919
		Exvessel revenue ($)	40,179,911	29,373,729	27,852,840	29,261,203
	OR	Landed weight (lbs)	21,629,154	29,337,380	50,396,664	56,500,887
		Exvessel revenue ($)	1,173,218	1,726,387	2,835,693	3,016,660
	WA	Landed weight (lbs)	10,937,156	25,573,818	35,995,417	26,872,582
		Exvessel revenue ($)	716,632	1,394,002	2,044,254	1,546,569
Other Management Areas	OR	Landed weight (lbs)	C	C	C	C
		Exvessel revenue ($)	C	C	C	C
	WA	Landed weight (lbs)	530,364	813,484	1,196,872	1,070,620
		Exvessel revenue ($)	208,419	297,702	529,434	510,373
Total Landed weight (lbs)			498,763,104	432,358,255	404,343,616	267,439,008
Total Exvessel revenue ($)			42,278,180	32,791,820	33,262,222	34,334,805

Source: PacFIN ftl table. August 2004
Note: C represents data restricted due to confidentiality
Totals do not include confidential data
"Other management areas" includes inside waters such as Puget Sound and Columbia River

Table 3-48. CPS Landings and Exvessel Revenue by Year and Gear(LBS and USD)

		YEAR			
Gear Group	Data type	2000	2001	2002	2003
Hook and Line	Landed weight (lbs)	447,269	132,292	46,697	135,851
	Exvessel revenue ($)	64,810	63,396	30,017	53,557
Misc	Landed weight (lbs)	238,310	53,720	90,661	141,291
	Exvessel revenue ($)	82,093	390,882	621,647	463,864
Net	Landed weight (lbs)	496,714,839	430,478,604	404,186,770	266,878,952
	Exvessel revenue ($)	42,035,766	32,142,853	32,605,922	33,761,365
Pot	Landed weight (lbs)	100,375	1,240	347	57,592
	Exvessel revenue ($)	10,194	398	126	15,534
Troll	Landed weight (lbs)	645,533	307,434	558	43,777
	Exvessel revenue ($)	57,140	11,811	666	15,701
Trawl	Landed weight (lbs)	626,541	1,384,594	21,999	181,009
	Exvessel revenue ($)	28,150	182,129	2,734	24,105
Shrimp Trawl	Landed weight (lbs)	1,086	371	1,255	536
	Exvessel revenue ($)	569	351	1,577	678
Total Landed weight (lbs)		498,773,953	432,358,255	404,348,287	267,439,008
Total Exvessel revenue ($)		42,278,722	32,791,820	33,262,689	34,334,805

Source: PacFIN ftl table. August 2004

Table 3-49. Top 15 Ports for CPS Landings and Exvessel Revenue (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	SAN PEDRO	SAN PEDRO
2	PORT HUENEME	PORT HUENEME
3	TERMINAL ISLAND	MOSS LANDING
4	MOSS LANDING	TERMINAL ISLAND
5	ASTORIA	VENTURA
6	VENTURA	ASTORIA
7	ILWACO	SAN FRANCISCO
8	MONTEREY	MONTEREY
9	SAN FRANCISCO	ILWACO
10	WESTPORT	SAUSALITO
11	SAUSALITO	PRINCETON / HALF MOON BAY
12	PRINCETON / HALF MOON BAY	WESTPORT
13	SANTA BARBARA	TACOMA
14	LONG BEACH	MARSHALL
15	MARSHALL	SANTA BARBARA

Source: PacFIN ftl table. August 2004

3.7.1.4.12 Sea Cucumber

Commercial fisheries target two sea cucumber species: the California sea cucumber (*Parastichopus californicus*), also known as the giant red sea cucumber, and the warty sea cucumber (*P. parvimensis*) (Rogers-Bennett and Ono 2001). These species are tube-shaped Echinoderms, a phylum that also includes sea stars and sea urchins. The California sea cucumber occurs as far north as Alaska; the warty sea cucumber is uncommon north of Point Conception and does not occur north of Monterey. Both species live in the intertidal zone to as deep as 300 feet (the California sea cucumber). These bottom-dwelling organisms feed on detritus and small organisms found in the sand and mud. Because sea cucumbers consume bottom sediment and remove food from it, they can alter the substrate in areas where they are concentrated. They can also increase turbidity as they excrete ingested sand or mud particles. Sea stars, crabs, various fishes, and sea otters prey on sea cucumbers. They spawn by releasing gametes into the water column, and spawning occurs simultaneously for different segments of a population. During development, larvae go through several planktonic stages, and settle to the bottom two to three months after fertilization of the egg. Little is known about the population status of these two species; their patchy distribution makes assessment difficult. However, density surveys suggest abundance has declined since the late 1980s. The decline may have resulted from a commercial fishery for these species that began in the late 1970s and expanded substantially after 1990.

California implemented a permit program in 1992. In 1997 the state established separate, limited entry permits for the dive and trawl sectors. Permit rules encourage transfer to the dive sector, and this has lead to growth in this sector, which now accounts for 80% of landings. There are currently 113 sea cucumber dive permittees and 36 sea cucumber trawl permittees. Many commercial sea urchin and/or recreational abalone free-divers also hold sea cucumber permits and began targeting sea cucumbers more heavily beginning in 1997. At up to $20 per pound wholesale for processed sea cucumbers, there is a strong incentive to participate in this fishery. California fishers account for the majority of sea cucumbers by weight and value, followed by Washington fishers (Table 3-50); Oregon has too few participants for public release of data.

Sea cucumbers are managed by the states. Along the West Coast, sea cucumbers are harvested by diving or trawling (Table 3-51). Only the trawl fishery for sea cucumbers lands an incidental catch of groundfish. The warty sea cucumber is fished almost exclusively by divers. The California sea cucumber is caught principally by trawling in Southern California, but is targeted by divers in Northern California. The top ports for landed weight and ex-vessel revenue occur roughly equally in California and Washington (Table 3-52).

Sea cucumber fisheries have expanded worldwide and, on this coast, a dive fishery for warty sea cucumbers occurs in Baja California, Mexico, and dive fisheries for California sea cucumbers occur in Washington, Oregon, Alaska, and British Columbia, Canada (Rogers-Bennett and Ono 2001). In Washington, the sea cucumber fishery only occurs inside Puget Sound and the Straight of Juan de Fuca. Most of the harvest is taken by diving, although the tribes can also trawl for sea cucumbers in these waters.

Table 3-50. Sea Cucumber Landings and Exvessel Revenue by Area, State, and Year (LBS and USD)

			YEAR			
Area	State	Data type	2000	2001	2002	2003
Coastal Management Areas	CA	Landed weight (lbs)	643,310	717,695	946,810	758,569
		Exvessel revenue ($)	606,578	584,970	801,276	687,854
	OR	Landed weight (lbs)	C	C		C
		Exvessel revenue ($)	C	C		C
Other Management Areas	WA	Landed weight (lbs)	605,755	661,657	549,127	438,707
		Exvessel revenue ($)	836,720	903,570	598,820	560,533
Total Landed weight (lbs)			1,249,065	1,379,352	1,495,937	1,197,276
Total Exvessel revenue ($)			1,443,297	1,488,540	1,400,096	1,248,387

Source: PacFIN ftl table. August 2004
Note: C represents data restricted due to confidentiality
"Other management areas" includes inside waters such as Puget Sound and Columbia River

Table 3-51. Sea Cucumber Landings and Exvessel Revenue by Year and Gear (LBS and USD)

		YEAR			
Gear aggregation	Data type	2000	2001	2002	2003
Misc. (including dive gear)	Landed weight (lbs)	574,689	465,804	660,598	466,855
	Exvessel revenue ($)	558,029	419,318	610,742	475,262
Other Gears	Landed weight (lbs)	674,667	913,583	835,339	731,109
	Exvessel revenue ($)	885,777	1,069,291	789,354	774,084
Total Landed weight (lbs)		1,249,065	1,379,352	1,495,937	1,197,276
Total Exvessel revenue ($)		1,443,297	1,488,540	1,400,096	1,248,387

Source: PacFIN ftl table. August 2004
Note: C represents data restricted due to confidentiality
"Other management areas" includes inside waters such as Puget Sound and Columbia River totals are equivalent to previous table to protect confidentiality

Table 3-52. Top 15 Ports for Sea Cucumber Landings and Exvessel Revenue (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	OXNARD	OXNARD
2	SANTA BARBARA	BLAINE
3	BLAINE	ANACORTES
4	ANACORTES	SANTA BARBARA
5	TERMINAL ISLAND	TERMINAL ISLAND
6	POULSBO	BELLINGHAM BAY
7	BELLINGHAM BAY	POULSBO
8	SEATTLE	SEATTLE
9	TACOMA	TACOMA
10	VENTURA	LACONNER
11	LACONNER	VENTURA
12	PUGET ISLAND	PUGET ISLAND
13	FRIDAY HARBOR	FRIDAY HARBOR
14	SAN PEDRO	SAN PEDRO
15	MISSION BAY	PORT TOWNSEND

Source: PacFIN ftl table. August 2004

3.7.1.4.13 Spot Prawn

Spot prawn (*Pandalus platyceros*) are the largest of the pandalid shrimp and range from Baja California, Mexico, north to the Aleutian Islands and west to the Korean Strait (Larson 2001). They inhabit rocky or hard bottoms including coral reefs, glass sponge reefs, and the edges of marine canyons. They have a patchy distribution, which may result from active habitat selection and larval transport. Spot prawns are hermaphroditic, first maturing as males at about three years of age. They enter a transition phase after mating at about four years of age when they metamorphose into females.

Spot prawns are targeted with both trawl and pot gear (Table 3-53). These fisheries are state-managed. For the purposes of managing incidentally-caught groundfish, the trawl fishery is categorized in the open access sector. California has the largest and oldest trawl fishery with about 54 vessels operating from Bodega Bay south to the U.S./Mexico border. California has the top 15 ports for landed weight and ex-vessel revenue (Table 3-54). (Most vessels operate out of Monterey, Morro Bay, Santa Barbara, and Ventura, although some Washington-based vessels participate in this fishery during the fall and winter.) Standard gear is a single-rig shrimp trawl with roller gear, varying in size from eight-inch disks to 28-inch tires. Washington State phased out its trawl fishery by converting its trawl permits to pot/trap permits in 2003. California instituted area and season closures for the trawl fleet in 1984 to protect spot prawns during their peak egg-bearing months of November through January. In 1994, the trawl area and season closure was expanded to include the entire Southern California Bight. As of 2003, the trawl fishery was closed. These closures, along with the development of ridgeback prawn, sea cucumber, and other fisheries, and also greater demand for fresh fish, have kept spot prawn trawl landings low and facilitated growth of the trap fishery. The trap fishery began in 1985 with a live prawn segment developing subsequently. The fleet operates from Monterey Bay, where six boats are based, to Southern California, where a 30 to 40 boat fleet results in higher production. Fishers in both fishing areas set traps at depths of 600 feet to 1,000 feet along submarine canyons or along shelf breaks. Between 1985 and 1991 trapping accounted for 75% of statewide landings; trawling accounted for the remaining 25% (Larson 2001). Landings continued to increase through 1998, when they reached a historic high of 780,000 pounds. Growth in participation and a subsequent drop in landings led to the development of a limited entry program, which is still in the process of being implemented. Other recent regulations include closures, trap limits, bycatch reduction measures for the trawl fishery, and an observer program.

Table 3-53. Spot Prawn Landings and Exvessel Revenue by Year and Gear in California (LBS and USD)

		Year			
Gear	Data type	2000	2001	2002	2003
Pot	Landed weight (lbs)	180,339	218,813	175,497	159,168
	Exvessel revenue ($)	1,646,474	1,993,004	1,607,681	1,505,684
Trawl (all trawl types)	Landed weight (lbs)	266,682	203,346	218,067	6,841
	Exvessel revenue ($)	2,188,968	1,709,452	1,759,197	61,364
Total Landed weight (lbs)		447,021	422,159	393,564	166,009
Total Exvessel Revenue ($)		3,835,442	3,702,456	3,366,877	1,567,049

Source: PacFIN ftl table. August 2004
Note: Spot prawn landings do not show up specifically in landed catch data for WA and OR

Table 3-54. Top 15 Ports for Spot Prawn Landings and Exvessel Revenue in California (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	MORRO BAY	MORRO BAY
2	MONTEREY	MONTEREY
3	OXNARD	OXNARD
4	VENTURA	VENTURA
5	DANA POINT	DANA POINT
6	TERMINAL ISLAND	TERMINAL ISLAND
7	SANTA BARBARA	OCEANSIDE
8	OCEANSIDE	SANTA BARBARA
9	SAN DIEGO	MOSS LANDING
10	RICHMOND	SAN DIEGO
11	MOSS LANDING	RICHMOND
12	SAN FRANCISCO	SAN FRANCISCO
13	FORT BRAGG	FORT BRAGG
14	BODEGA BAY	BODEGA BAY
15	HUNTINGTON BEACH	MISSION BAY

Source: PacFIN ftl table. August 2004

3.7.1.4.14 Sea Urchin

Sea urchins are harvested along the California coast, the Oregon coast, and the Strait of Juan de Fuca region of Washington. Both red and green sea urchins are found along the West Coast. The red sea urchin usually occupies shallow waters, from the mid to low intertidal zones to depths in excess of 164 feet, but occur as deep as 410 feet (McCauley and Carey 1967). Individuals prefer rocky substrates, particularly ledges and crevices, and avoid sand and mud (Kato and Schroeter 1985).

Red sea urchins have life spans of at least 30 years. In southern California, sea urchins feed on the giant kelp (*Macrocystis pyrifera*) (Leighton 1965). In northern California, sea urchin feed on bull and brown kelp (Parker and Kalvass 1992).

The sea urchin fishery first began in the 1970s in response to demand for sea urchin in the Japanese sushi market. Prior to the development of the fishery, sea urchins were regarded as a nuisance by kelp harvesters due to their impact on the kelp resource. Sea urchins are primarily harvested by persons using dive gear, and in California (Table 3-55), landings are prevalent during the winter months in response to peak demand during the Japanese holiday season.

West Coast sea urchins are commercially harvested by divers using hookah diving gear (Table 3-56), consisting of a low-pressure air compressor that feeds air through a hose from the vessel to the divers (University of California Extension 1995). Sea urchins are targeted at depths between 5 and 100 feet, with most dives in the 20 to 60 foot range. Sea urchins are harvested from the ocean bottom with a hand-held rake or hook and put into a hoop net bag or wire basket. The basket is winched onto the boat and emptied into a larger net bag (University of California Extension 1995). In areas far from port, a larger pick-up vessel may take the catch from several harvesting vessels back to port (Parker and Kalvass 1992). Most of the top ports for landing weight and ex-vessel revenue occur in California, with several in Washington (Table 3-57).

Table 3-55. Landings and Exvessel Revenue by Area, State, and Year (LBS and USD)

			YEAR			
Area	State	Data type	2000	2001	2002	2003
Coastal Management Areas	CA	Landed weight (lbs)	15,199,851	13,123,830	13,957,127	10,769,868
		Exvessel revenue ($)	15,057,844	11,686,980	10,218,060	7,699,447
	OR	Landed weight (lbs)	983,556	1,258,957	812,395	143,727
		Exvessel revenue ($)	682,484	802,224	347,879	60,282
Other Management Areas	CA	Landed weight (lbs)	C	C	C	C
		Exvessel revenue ($)	C	C	C	C
	WA	Landed weight (lbs)	940,707	757,465	538,489	387,432
		Exvessel revenue ($)	782,394	559,099	461,781	289,767
Total Landed weight (lbs)			17,124,114	15,140,252	15,309,330	11,301,027
Total Exvessel revenue ($)			16,522,723	13,048,302	11,028,776	8,049,496

Source: PacFIN ftl table. August 2004
Note: "Other management areas" includes inside waters such as Puget Sound and Columbia River

Table 3-56. Sea Urchin Landings and Exvessel Revenue by Area, Gear and Year (LBS and USD)

			YEAR			
Area	Gear Aggregation	Data type	2000	2001	2002	2003
Coastal Management Areas	Other Gears	Landed weight (lbs)	940,707	757,465	538,489	387,432
		Exvessel revenue ($)	782,394	559,099	461,781	289,767
	Misc. (including dive gear)	Landed weight (lbs)	0	0	C	0
		Exvessel revenue ($)	0	0	C	0
Other Management Areas	Other Gears	Landed weight (lbs)	23,635	7,533	8,254	17,859
		Exvessel revenue ($)	21,231	6,824	8,372	13,427
	Misc. (including dive gear)	Landed weight (lbs)	16,159,772	14,375,254	14,761,268	10,895,736
		Exvessel revenue ($)	15,719,098	12,482,380	10,557,567	7,746,301
Total Landed weight (lbs)			17,124,114	15,140,252	15,308,011	11,301,027
Total Exvessel revenue ($)			16,522,723	13,048,302	11,027,720	8,049,496

Source: PacFIN ftl table. August 2004
Note: "Other management areas" includes inside waters such as Puget Sound and Columbia River. Totals exclude confidential data

Table 3-57. Top 15 Ports for Sea Urchin Landings and Exvessel Revenue (2000–2003)

Rank	Top 15 Ports by Weight	Top 15 Ports by Exvessel Revenue
1	SANTA BARBARA	SANTA BARBARA
2	TERMINAL ISLAND	TERMINAL ISLAND
3	OXNARD	OXNARD
4	FORT BRAGG	FORT BRAGG
5	POINT ARENA	SAN PEDRO
6	SAN PEDRO	POINT ARENA
7	ALBION	MISSION BAY
8	MISSION BAY	ALBION
9	BODEGA BAY	BODEGA BAY
10	PORT ORFORD	POINT LOMA
11	POINT LOMA	SEATTLE
12	SEATTLE	PORT ORFORD
13	DEPOE BAY	PORT TOWNSEND
14	PORT TOWNSEND	DEPOE BAY
15	CHARLESTON (COOS BAY)	DANA POINT

Source: PacFIN ftl table. August 2004
N/A indicates data not available

3.7.1.4.15 San Francisco Bay Shrimp

The fishery for San Francisco Bay shrimp began as early as the 1860s. The current commercial fishery for bay shrimp developed in 1965 to supply live bait for sturgeon and striped bass sport fishing with a small percentage of the catch reserved for human consumption. Neither a quota nor season closure is in effect for the commercial fishery, and landings are driven by demand. Bay shrimp may be taken by recreational fishers as well as commercial fishers. Sport regulations allow the use of hand powered shrimp trawls no greater than 18 by 24 inches at the mouth and a daily bag limit of five pounds. Any finfish caught in the sport fishery must be returned to the water. Since 1965, the commercial fishery for bay shrimp has used beam trawls. Live tanks are used on all vessels, and shrimp are transported to local bait shops by truck in either live tanks or iced-down wooden trays with burlap linings (CDFG 2001).

Table 3-58. San Francisco Bay Shrimp Landings and Exvessel Revenue by Year

Year	Exvessel Revenue ($)	Landed weight (lbs)	Vessel Count
1984	$282,110	139,897	N/A
1985	$281,731	130,096	N/A
1986	$277,856	107,474	N/A
1987	$255,002	92,229	N/A
1988	$365,363	132,497	N/A
1989	$360,196	128,859	N/A
1990	$494,017	150,957	N/A
1991	$483,365	140,555	N/A
1992	$401,334	112,238	N/A
1993	$308,509	71,700	13
1994	$419,770	94,134	11
1995	$405,561	92,916	9
1996	$530,999	113,091	10
1997	$322,903	69,124	9
1998	$363,362	89,348	11
1999	$334,016	93,846	11

Source: California Department of Fish and Game. December 2004. Personal Communication

3.7.1.4.16 California Spiny Lobster Fishery

The California spiny lobster is found along the coast of California from the Morro Bay area, south to Rosalia Bay, Baja California, however the majority of the population is found south of Point Conception. This fishery is prosecuted by both commercial and recreational fishers with dive gear and with traps that are set on the ocean bottom and are attached to buoys that float on the surface. Traps are allowed to soak for several hours before being retrieved.

The fishery is managed through the use of restricted access, size limits, escape ports on traps, and seasonal closures. Size limits are used to protect juveniles, and seasonal closures are used to protect egg-bearing females. In addition, marine protected areas implemented around the Channel Islands have reduced the amount of area accessible to fishers targeting spiny lobster.

According to information from the University of Santa Barbara, Donald Bren School of Environmental Science and Management, the annual catch of California spiny lobster in the southern California area is less than 500,000 lbs annually. However, the exvessel price for spiny lobster typically exceeds 6 dollars per pound, meaning the fishery typically generates more than 2 million dollars annually at the vessel level.

Table 3-59. Landings of California Spiny Lobster by Year and Area

Year	Fishing Area	Total
2000	Los Angeles County Coastal	20,763
	Northern Channel Islands	56,756
	Orange County Coastal	57,894
	San Diego County Coastal	87,671
	Santa Barbara County Coastal	20,896
	Southern Channel Islands and Outer Banks	78,044
	Ventura County Coastal	5,011
2000 Total		327,035
2001	Los Angeles County Coastal	39,159
	Northern Channel Islands	66,506
	Orange County Coastal	68,503
	San Diego County Coastal	170,042
	Santa Barbara County Coastal	30,842
	Southern Channel Islands and Outer Banks	89,796
	Ventura County Coastal	7,740
2001 Total		472,588
2002	Los Angeles County Coastal	39,770
	Northern Channel Islands	90,362
	Orange County Coastal	49,602
	San Diego County Coastal	140,188
	Santa Barbara County Coastal	35,289
	Southern Channel Islands and Outer Banks	82,021
	Ventura County Coastal	3,751
2002 Total		440,983
2003	Los Angeles County Coastal	40,822
	Northern Channel Islands	114,114
	Orange County Coastal	58,314
	San Diego County Coastal	117,679
	Santa Barbara County Coastal	37,910
	Southern Channel Islands and Outer Banks	100,671
	Ventura County Coastal	6,158
2003 Total		475,668

Source: University of California Santa Barbara. July 2005. Donald Bren School of Environmental Science and Management. Collaborative Monitoring of the Spiny Lobster in the Channel Islands Marine Protected Areas. http://fiesta.bren.ucsb.edu/~lobster/home/index.html

3.7.2 Tribal Fisheries

West Coast treaty tribes in Washington have formal groundfish allocations for sablefish, black rockfish, and Pacific whiting. Members of four coastal treaty tribes participate in commercial, ceremonial, and subsistence fisheries off the Washington coast. Participants in the tribal commercial fisheries use similar gear to non-tribal fishers. Fish caught in the tribal commercial fishery are distributed through the same markets as non-tribal commercial catch.

Tribal fisheries also take several species for which they have no formal allocations, and some species for which no specific allocation has been determined (Table 3-60). Rather than try to reserve specific allocations of these species, the tribes biennially recommend trip limits for some species to the Council, which tries to accommodate these fisheries. Groundfish fishing by the tribes occurs primarily with hook and line and trawl (Table 3-61).

Thirteen western Washington tribes possess and exercise treaty fishing rights to halibut, including the four tribes that possess treaty fishing rights to groundfish. Tribal halibut allocations are divided into a tribal commercial component and the year-round ceremonial and subsistence component.

In addition, the Makah tribe annually harvests a whiting allocation using mid-water trawl gear and take other groundfish in the process (Table 3-62). Since 1996, a portion of the U.S. whiting OY has been allocated to the West Coast treaty tribes. The tribal allocation is subtracted from the whiting OY before allocation to the non-tribal sectors. Since 1999, the tribal allocation has been based on a sliding scale related to the U.S. whiting OY. To date, only the Makah tribe has fished on the tribal whiting allocation. Makah vessels fit with mid-water trawl gear have also been targeting widow rockfish and yellowtail rockfish in recent years.

All tribes participating in groundfish fisheries have longline vessels in their fleets, but only Makah has trawlers (Table 3-63). Makah has the majority of longline vessels, followed by Quinault, Quileute, and Hoh.

Tribal treaty fisheries are place-oriented—limited to the adjudicated U&A areas. This results in immobile fisheries that cannot move to a new location if the resources or habitat are depleted. In addition, the Tribe and its fishermen have a view of ownership of their fishing grounds rooted in centuries of use and control of these grounds. This sense of ownership influences the fishing practices of the tribes. Because the tribes are limited in the areas they fish, they work to practice good stewardship.

Following this philosophy, the Makah has taken a cautious approach to development of its fisheries. In addition, the Makah is committed to meeting its co-management responsibilities in managing its portion of the in-common resource including working to stay within the harvest limits established by the Council for overfished and abundant stocks.

Currently, the Makah fleet is composed of 43 boats. Twenty-nine of the boats fish for salmon, sablefish, and halibut. These boats primarily fish from March to October. Ten of the boats are small bottom trawlers. The trawl fishery is open from January to December, but primarily the fishing is done from June to October. The mid-water whiting fleet is composed of four boats. Their season is from May to September.

In the Makah bottom trawl fishery, the Tribe adopted the small foot rope restrictions as a means to reduce rockfish bycatch and avoid areas where higher incidences of rockfish occur. In addition, the bottom trawl fishery is limited by overall foot rope length as a means of conducting a more controlled fishery. Harvest is restricted by time and area to focus on harvestable species while avoiding bycatch of other species. If bycatch of rockfish is above a set limit, the fishery is modified to stay within the bycatch limit.

The midwater trawl fishery has similar control measures. A trawl area must first be tested to determine the incidence of overfished rockfish species prior to opening the area to harvest. Vessels are provided guidelines for fishing techniques and operation of their net. Fishing effort is closely monitored by the on-board observer and harvest manager and changes or restrictions are implemented as needed to stay within the bycatch limits.

Managing in this manner is very demanding of both the fisheries management staff and the fishermen, but micro-management allows for efficient harvest of abundant species while minimizing bycatch of overfished species (Joner 2004, personal communication). In developing these trawl fisheries, the Makah have taken a cautious approach that requires testing of gear, area, vessels, and catch composition before the fishery can proceed from one level to the next. In addition, a new or developing fishery must show that it can be conducted in a manner that protects existing fisheries.

Another example of the Tribe's commitment to good stewardship of its resources includes the bycatch reduction efforts in the Makah whiting fishery. Full retention of rockfish bycatch is required (as is the case in all Makah groundfish fisheries); the bycatch is processed for human consumption and forfeited to the Tribe for distribution to food banks and similar programs. This program avoided wastage and discards of bycatch species, created a disincentive to both the catcher vessels and processor and provides full accounting of bycatch in the fishery. This in turn has reduced bycatch levels of nearly all species.

These examples illustrate the Tribes commitment to sustainable harvest of its marine resources. Management and protection of EFH and HAPC will occur as the Tribes continue to respond to resource needs in their fisheries.

Table 3-60. Tribal Shoreside Landings and Exvessel Revenue by Species Group and Year

		Year				
Species Group	Data Type	2000	2001	2002	2003	2004
CPS	Landed weight (lbs)				C	
	Exvessel revenue ($)				C	
Crab	Landed weight (lbs)	922,909	665,443	1,804,399	1,420,102	2,672,525
	Exvessel revenue ($)	1,957,757	1,292,271	3,240,886	2,660,939	5,704,007
Groundfish	Landed weight (lbs)	1,152,546	1,274,750	1,675,078	11,808,437	18,689,384
	Exvessel revenue ($)	2,625,809	2,589,479	2,034,776	3,639,098	4,082,579
HMS	Landed weight (lbs)		15,110	21,664	37,950	15,301
	Exvessel revenue ($)		11,876	11,645	33,456	11,162
Other	Landed weight (lbs)	281,820	418,480	480,185	485,509	537,583
	Exvessel revenue ($)	747,950	840,983	949,711	1,271,393	1,506,766
Salmon	Landed weight (lbs)	236,966	735,977	573,684	513,772	1,090,256
	Exvessel revenue ($)	282,162	631,997	444,341	512,614	1,648,124
Shellfish	Landed weight (lbs)	C			C	C
	Exvessel revenue ($)	C			C	C
Sum of weight (lbs)		2,594,241	3,109,760	4,555,010	14,265,770	23,005,049
Sum of revenue (lbs)		5,613,678	5,366,607	6,681,358	8,117,501	12,952,638

Source: PacFIN FTL table. September 2005
Note: Totals do not include confidential data

Table 3-61. Tribal Shoreside Landings by Gear Type and Year

		Year				
Gear Type	Data	2000	2001	2002	2003	2004
Hook and Line	Landed weight (lbs)	1,317,524	1,406,585	1,125,842	1,362,733	1,623,791
	Exvessel revenue ($)	3,264,578	3,296,352	2,470,980	3,423,539	3,942,738
Misc.	Landed weight (lbs)	C			C	C
	Exvessel revenue ($)	C			C	C
Net	Landed weight (lbs)	55,731	119,043	11,810	5,412	4,597
	Exvessel revenue ($)	66,020	84,960	8,185	4,950	4,720
Pot	Landed weight (lbs)	943,559	665,443	1,804,399	1,420,102	2,672,525
	Exvessel revenue ($)	2,022,219	1,292,271	3,240,886	2,660,939	5,704,007
Troll	Landed weight (lbs)	198,984	656,317	600,689	567,302	1,143,716
	Exvessel revenue ($)	226,440	569,236	457,477	553,069	1,696,708
Trawl	Landed weight (lbs)	78,443	262,372	1,012,270	10,910,311	17,560,420
	Exvessel revenue ($)	34,420	123,789	503,830	1,475,040	1,604,465
Total Sum of weight (lbs)		2,594,241	3,109,760	4,555,010	14,265,860	23,005,049
Total Sum of revenue ($)		5,613,678	5,366,607	6,681,358	8,117,538	12,952,638

Source: PacFIN FTL table. July 2004
Note: Totals do not include confidential data
* for crab only

Table 3-62. Tribal At-Sea Catch by Year (Units are in Pounds)

	YEAR			
Species Aggregation	2000	2001	2002	2003
Other Fish	483,822	1,529,540	2,987,067	3,145,036
Pacific Whiting	13,781,245	13,404,002	48,045,527	51,706,192
Total	14,265,068	14,933,542	51,032,594	54,851,228

Source: PacFIN NPAC4900 table. September 2005

Table 3-63 Distribution of Vessels Engaged in Tribal Groundfish Fisheries

Treaty Tribe	Number of Vessels in Groundfish Fishery			Port
	Longline (length in ft)	Trawl (length in ft)	Total	
Makah	35 (33'-62')	10 (49'-62')	41 a/	Neah Bay
Hoh	1	-	1	La Push
Quileute	7	-	7	La Push
Quinault	10	-	10	West Port
a/ Four Makah vessels participate in both longline and trawl fisheries.				

Source: NMFS. 2004. Groundfish Bycatch Final Programmatic Environmental Impact Statement

3.7.3 Recreational Fisheries

Recreational fishing is an important economic contributor to the west coast in general, and to some communities specifically. The recreational fishing sector can be divided into two groups; the charter fleet and the private fleet. The private fleet is typically made up of vessels owned by residents living in or near areas where they fish. The charter fleet is a for-hire fleet that plays a large role in the tourism sector of many west coast communities, and opportunities to fish on a charter vessel can be a substantial draw for tourists considering a visit to the coast.

The distribution of resident and non-resident ocean anglers among the West Coast states in 2000, 2001, and 2002 demonstrates the importance of recreational fishing, especially in Southern California (Table 3-64). Southern California has more than twice the number of resident recreational marine anglers than the next most numerous region, Washington State. While most of the recreational anglers were residents of those states where they fished, a significant share were non-residents. Oregon had the largest share of non-resident ocean anglers in all three years.

Table 3-64. Estimated number of West Coast marine anglers: 2000 - 2002 (thousands)

Year/State	Total	State Residents	Non-Residents	% Non-Residents
2000				
Washington	497	450	47	9.50%
Oregon	365	285	80	21.90%
Northern California	-	388	-	
Southern California	-	1,097	-	
Total California	1,705	1,485	220	12.90%
2001				
Washington	915	861	54	5.90%
Oregon	601	505	97	16.10%
Northern California	-	961	-	
Southern California	-	1,838	-	
Total California	3,084	2,799	285	9.20%
2002				
Washington	1,493	1,399	94	6.30%
Oregon	1,056	845	211	20.00%
Northern California	-	2,022	-	
Southern California	-	3,709	-	
Total California	6,406	5,731	675	10.50%

source: Pacific Fishery Management Council. 2004. Proposed Acceptable Biological Catch and Optimum Yield Specifications and Management Measures for the 2005-2006 West Coast Groundfish Fishery. Draft Environmental Impact Statement.

Fishing effort is related to weather, with relatively more effort occurring in the milder months of summer, and relatively less in winter (Table 3-65). As might be expected, this effect is more pronounced in higher latitudes, although the reasons include opportunity as well as climate. Salmon seasons are longer in California than in Oregon, which in turn are longer than in Washington. Until recently, groundfish seasons were also more restrictive in Washington, with the lingcod season being closed from November through March.

Table 3-65. Total estimated West Coast recreational marine angler boat trips in 2003 by mode and region (thousands of angler trips)

State/Region	Boat Mode	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Annual Total
WA	Charter	0.0	1.2	16.0	37.8	6.1	0.0	61.1
	Private	22.0	19.5	57.2	32.9	5.0	0.0	136.5
	Total	22.0	20.6	73.2	70.7	11.1	0.0	197.6
OR	Charter	0.8	4.4	27.0	34.2	7.7	0.7	74.8
	Private	31.4	31.2	123.6	108.4	19.4	1.3	315.3
	Total	32.2	35.7	150.6	142.5	27.1	2.0	390.1
N. CA	Charter	3.4	11.3	24.1	73.3	33.0	3.3	148.4
	Private	75.9	83.9	332.5	502.8	211.5	278.2	1,485.0
	Total	79.4	95.2	356.7	576.1	244.6	281.5	1,633.4
S. CA	Charter	32.7	42.0	113.0	256.2	87.3	42.4	573.6
	Private	136.9	192.8	348.2	400.8	331.3	222.5	1,632.5
	Total	169.5	234.8	461.1	657.0	418.6	264.9	2,206.1
Total All States	Charter	36.9	58.9	180.1	401.5	134.1	46.4	857.9
	Private	266.2	327.4	861.5	1,044.9	567.2	502.0	3,569.3
	Total	303.1	386.2	1,041.6	1,446.4	701.3	548.4	4,427.2

source: Pacific Fishery Management Council. 2004. Proposed Acceptable Biological Catch and Optimum Yield Specifications and Management Measures for the 2005-2006 West Coast Groundfish Fishery. Draft Environmental Impact Statement.

Recreational fishing in the open ocean has generally been declining slightly since 1996 (Table 3-66); however, charter effort has decreased while private effort increased during that period. Part of this increase likely resulted from longer salmon seasons associated with increased abundance. Some effort shift from salmon to groundfish for example likely occurred prior to 1996 when salmon seasons were shortened.

Table 3-66. Trends in effort for recreational ocean fisheries in thousands of angler trips

Area	1996	1997	1998	1999	2000	2001a/	2002a/	2003b/
Total Angler Trips								
Washington	51	50	44	49	40	61	56	61
Oregon	54	65	57	60	87	70	62	75
North and Central CA	90	139	158	162	206	221	142	148
Southern CA	982	812	674	609	876	577	438	574
Total	1,177	1,066	933	880	1,218	927	843	858

source: Pacific Fishery Management Council. 2004. Proposed Acceptable Biological Catch and Optimum Yield Specifications and Management Measures for the 2005-2006 West Coast Groundfish Fishery. Draft Environmental Impact Statement.
a) The 2001 and 2002 estimates are not directly comparable to previous years due to differences in estimation methodology
b) Preliminary

3.7.3.1 Recreational Charter Industry

Table 3-65 shows the distribution of trips by boat mode and region in 2003. More than half of the charter vessel trips operated from California ports, demonstrating the importance of recreational fishing industry in that state.

3.7.3.2 Private Vessels and the Recreational Fishing Experience Market

Demand for recreational trips and estimates of the economic impacts resulting from recreational fishing are related to numbers of anglers. Reliable data are not available on the number of West Coast anglers targeting specific species. However, data are available on the total number of saltwater anglers, and it is evident the presence of opportunities to catch species other than directly targeted ones increases the propensity of anglers to fish and the value of the overall recreational fishing experience. In the U.S., over nine million anglers took part in 76 million marine recreational fishing trips in 2000. The West Coast accounted for about 22% of these participants and 12% of trips. 70% of West Coast trips were made off California, 19% off Washington, and 11% from Oregon (Gentner 2001).

3.8 *Buyers and Processors*

Excluding Pacific whiting delivered to at-sea processors, vessels participating in Pacific groundfish fisheries deliver to shore-based processors within Washington, Oregon, and California. Buyers are located along the entire coast; however, processing capacity has been consolidating in recent years. Several companies have left the West Coast or have chosen to quit the business entirely. Remaining companies have purchased some former plants (Research Group 2003), but other plants have remained inactive. This has led to trucking groundfish from certain ports to another community for processing. Therefore, landings do not necessarily indicate processing activity in those communities. However, examination of the species composition of landed catch by state can lead to inferences of some processor characteristics.

According to PacFIN data, in 2002 Oregon had the largest amount of groundfish landings (56%), followed by Washington (28%), and California (16%). In contrast, Oregon has the largest amount of exvessel revenue (40%), followed by California (32%) and Washington (22%), respectively. Oregon accounts for the majority of Pacific whiting landings, which creates a large difference between the percentage of landed catch and exvessel revenue because Pacific whiting has a relatively low price per pound. The relatively high amount of Pacific whiting being landed in Oregon may create a case where many processors must generate capacity to handle large quantities at a time. Groundfish processors in Washington may receive landings from Alaska fisheries. Depending on the amount of catch Washington processors can draw from Alaska fisheries, some groundfish processors may require the capacity to process large amounts of product. California processors concentrating on West Coast fisheries may focus on relatively smaller throughput of groundfish.

The seafood distribution chain begins with deliveries by the harvesters (exvessel landings) to the shoreside networks of buyers and processors, and includes the linkage between buyers and processors and seafood markets. In addition to shoreside activities, processing of certain species (e.g., Pacific whiting) also occurs offshore on factory ships. Several thousand entities have permits to buy fish on the West Coast (Table 3.66). Of these, 1,780 purchased fish caught in the ocean area and landed on Washington, Oregon, or California state fishtickets in the year 2000 (excluding tribal catch) and 732 purchased groundfish (PFMC 2004).[5]

According to PacFIN data, the number of unique companies buying groundfish along the West Coast has declined in recent years. This trend coincides with recent regulatory restrictions and diminished landings of higher valued species such as rockfish (Table 3-67). The number of buyers purchasing other species such as crab and salmon has been stable or increasing in recent years.

Table 3-67. Count of Fish Buyers by Year, Species Type, and State (not unique records)

		Year			
State	Species Group	2000	2001	2002	2003
CA	CPS	174	126	118	112
	Crab	298	306	291	351
	Groundfish	412	385	324	310
	HMS	233	241	222	199
	Other	558	515	510	505
	Salmon	277	225	269	273
	Shellfish	6	10	2	2
	Shrimp	154	126	129	107
OR	CPS	14	15	16	16
	Crab	67	77	81	83
	Groundfish	84	74	79	81
	HMS	96	112	125	138
	Other	90	91	103	94
	Salmon	104	134	143	150
	Shellfish	19	14	46	27
	Shrimp	36	36	30	26
WA	CPS	12	17	16	15
	Crab	125	125	158	168
	Groundfish	43	42	40	45
	HMS	37	39	55	53
	Other	109	102	98	106
	Salmon	189	218	219	213
	Shellfish	167	178	177	171
	Shrimp	75	72	72	80

Source: PacFIN ftl and ft tables. July 2004
Note: records are not unique buyers and should not be summed

3.9 *Fishing Communities*

Fishing communities, as defined in the MSA, include not only the people who catch the fish, but also those who share a common dependency on directly related fisheries-dependent services and

[5]/ A "buyer" was defined here by a unique combination of PacFIN port code and state buyer code on the fishticket. For California, a single company may have several buying codes that vary only by the last two digits. In PacFIN, these last two digits are truncated, and so were treated as separate buying units only if they appear for different ports.

industries. Commercial fishing communities may include boatyards, fish handlers, processors, and ice suppliers. Similarly, entities that depend on recreational fishing may include tackle shops, small marinas, lodging facilities catering to out-of-town anglers, and tourism bureaus advertising charter fishing opportunities. People employed in fishery management and enforcement makes up another component of fishing communities.

Fishing communities on the West Coast depend on commercial and/or recreational fisheries for many species. Participants in these fisheries employ a variety of fishing gears and combinations of gears. Community patterns of fishery participation vary coastwide and seasonally, based on species availability, the regulatory environment, and oceanographic and weather conditions. Communities are characterized by the mix of fishery operations, fishing areas, habitat types, seasonal patterns, and target species. Although unique, communities share many similarities. For example, all face danger, safety issues, dwindling resources, and a multitude of state and federal regulations.

Individuals in unique communities have differing cultural heritages and economic characteristics. Examples include a Vietnamese fishing community of San Francisco Bay and an Italian fishing community in Southern California. Native U.S. communities with an interest in the groundfish fisheries are also considered. In spite of a variety of ethnic backgrounds, fishers in many areas come together to form the fishing communities, drawn together by their common interests in economic and physical survival in an uncertain and changing ocean and regulatory environment.

This section provides an overview of West Coast fishing communities organized around regions comprising port groups and ports consistent with the organization of fish landings data in the PacFIN database. Ports are coded in PacFIN using a two- or three-letter code, or PCID; landings data from several sites may be combined under one of these ports. The ports have been further aggregated into 18 port groups. These port groups are designed to reduce issues surrounding the disclosure of confidential information (which could be a problem with disaggregated data). Because ports and port groups are also units of analysis when evaluating socioeconomic and demographic characteristics, their boundaries are consistent with major civil boundaries, such as county and state lines.

The discussion here further aggregates these geographic entities into seven larger regions, each comprising one or more port groups: Puget Sound, the Washington coast, the northern Oregon coast, the southern Oregon coast, Northern California, Central California, and Southern California. Each subsection first describes the constituent port groups and ports and associated fleet characteristics. Socioeconomic and demographic characteristics are then summarized.

Demographic characteristics at the state, port group, county, and port levels are derived from U.S. census data. Port- and port group-level data are derived in two ways: census places and census block groups. The U.S. Census Bureau defines consolidated cities and incorporated places as census designated places (CDPs).[6]/ However, the following ports are not identified as census places: La Push, Grays Harbor, and Willapa Bay in Washington; Salmon River in Oregon; and Albion, Princeton, Avila Beach, Ventura, San Pedro, Wilmington, and Terminal Island in California. Furthermore, dispersed populations in rural areas may make the census places less representative of population involved in the local economy. For these two reasons, ports have also been characterized by deriving data at the census block group level. Census block groups

6/ In some cases more than one census place corresponds to a port. These are: Port Angeles and Port Angeles East; Crescent City, Bertsch Oceanview, and Crescent City North; and Newport Beach and Newport Coast CDP. Demographics are reported separately for these places in the tables.

comprise several census blocks and contains between 600 and 3,000 people, with an optimum of 1,500.[7]/ Block groups never cross county or state lines. A geographic information system (GIS) was used to select block groups covering an area coincident with the corresponding census place in urban areas and a somewhat larger area in rural areas. For the ports without corresponding census places, Zip Code Tabulation Areas were used in all cases, except Salmon River, Oregon that used a point designating the location of a boat landing. Demographic data are only reported for the "block group equivalent area" in these cases. The block groups comprising the block group equivalent areas were further filtered by choosing only those within 10 miles of the coast. Block group equivalent areas have a larger population for ports in rural areas. In urban areas there is typically little or no population difference between the block group area and the census place. In a few cases, such as San Diego, the population of the block group equivalent area may actually be smaller because part of the census place lies further than 10 miles from the coast.

Rankings given in

Table 3-68 through Table 3-74 are comparisons of port groups within the context of other ports in Washington, Oregon and California.

Washington State

3.9.1.1 Puget Sound

3.9.1.1.1 Port and Fleet Characteristics

The Seattle metropolitan area dominates the Puget Sound area as a regional population and economic center. Seattle has traditionally served as an important entry port for Alaska, and many of the large catcher-processors participating in Alaskan fisheries are based there. Blaine and Bellingham, both north of Seattle, are important ports for groundfish vessels.

In 2002, fishers landed 3,794 mt of groundfish in the Puget Sound port group, a smaller amount than most other port groups in Washington and Oregon. Puget Sound landings had relatively high exvessel revenue in 2002, at $3.3 million, comparable to other port groups in Washington. The large amounts of high-value sablefish landed in this region partly explain the higher revenue; flatfish also make up a larger component of landings than in other port groups.

About one-third of the Puget Sound port group's fishing vessels were home ported in Bellingham in 2001. A vessel buyback program permanently retired 91 groundfish limited entry trawl vessels and associated permits. Thus the current number of limited entry trawl vessels is less than what is reported here. A recent report (NMFS 2004) provides information on the home ports of retired vessels. Where appropriate, changes in vessel numbers are noted. Bellingham and Blaine—on Puget Sound near the Canadian border—hosted all nine of the region's groundfish limited entry trawl vessels and almost all the limited entry fixed gear vessels. However, the aforementioned

[7] Because block groups are delineated to limit the variation in population size between block groups, the geographic size of block groups can vary substantially. In urban areas, with high population density, block groups are smaller than in rural areas where population density is lower. This explains why block groups representing ports in rural areas cover large geographic areas in comparison to the census place.

report shows that four vessels were retired in Bellingham and one in Blaine. Seattle is a distant second in terms of the number of vessels participating in West Coast fisheries, with 93, and only two limited entry fixed gear vessels port there. But many of the vessels listed as at-sea only—which participate in the Pacific whiting fishery—are likely part of the fleet based in Seattle and also fishing in Alaska. Otherwise, Puget Sound is less important as a center for West Coast groundfish vessels; with 36 vessels it ranks near the bottom among the port groups. In terms of the distribution of different sized vessels, Puget Sound is consistent with the West Coast as a whole, with about two-thirds of the vessels under 40 feet; one of the two vessels over 150 feet participating in West Coast fisheries is based in Seattle, however.

The Puget Sound is a major population center on the West Coast and is largely urban (Table 3-68). Washington and Oregon, and the more rural coastal areas in particular, are less racially and ethnically diverse than coastal California, especially Southern California. The Puget Sound region has the fifth-largest percent non-white population of the port groups, or about a quarter of the population. All the other port groups with larger percent non-white populations are in Central and Southern California. Hawaiian and Pacific Islanders represent largest non-white racial group with 10% of the population for the port group and 13% of Seattle's population. (As might be expected, Seattle and Tacoma are the most ethnically diverse census places in this port group.) Puget Sound ranks eleventh among the port groups for the percentage of the population that is Hispanic, fourteenth if looking at census places, suggesting that the Hispanic population is more rural. Comparing communities within the Puget Sound port group, Skagit County, and the La Conner environs in particular, and also Shelton have a proportionately large Hispanic population, although the absolute numbers in these more rural communities are small.

Table 3-68 Puget Sound Demographics at a Glance

	Value	Rank
Total population:	749,916	3
Urban population	97.2%	5
Non-white population:	25%	5
Hispanic population:	5.5%	11
Working age population (17-64):	69.4%	4
High school graduate and higher*:	88.1%	4
Natural resource-related employment**:	0.4%	15
Average household income:	$58,327	7
Poverty rate:	11.6%	12

(Values for block group equivalent areas. Census data, 2000. *Some college, bachelor and graduate. **Population employed in private sector natural resource-related occupation.)

Employment- and income-related statistics reflect the area's urbanism and economic activity. A large proportion of the population is of working age (defined as between 17 to 64 year olds). The 2000 census, representing income in 1999, showed relatively high incomes; however, these data do not reflect a subsequent economic down-turn. As has been widely reported, Washington and Oregon had the highest unemployment rates in the nation in subsequent years; employment in Oregon especially has been slow to rebound. Median income values reported in the census cannot be aggregated and are thus not available for the port area, although data are available for states, counties and census places. (Median income better represents economic well being of the population at large than average income, because it is not skewed by a relative few "outlier" high income earners.) Of census places, Seattle has the highest median income in this port group, $45,736, very close to the value for Washington State as a whole. The counties impinging on the port areas (which, as defined by census place or block group equivalent generally exclude inland areas of counties) generally show higher median and average incomes, probably reflecting greater wealth in surrounding suburbs.

According to economic modeling estimates of income and employment derived from fisheries (for November 2002 to October 2001), Puget Sound ranks at the bottom in terms of the share of personal income and employment derived from all commercial fishing activities. The relative unimportance of fisheries as a share of total income and employment in the region reflects its economic dynamism, with many industries—notably computer software and commercial aircraft manufacture—providing substantial income and employment. However, groundfish-fishery-related activities represent 61% of total fishery activities, more than in any of the other port areas. Thus, groundfish fisheries play an important role in a sector that makes up a small proportion of the total regional economy.

3.9.1.2 Washington Coast (North Washington Coast and Central and South Washington Coast)

3.9.1.2.1 Port and Fleet Characteristics

Ports in the Straits of Juan de Fuca, along the north coast of the Olympic Peninsula, and West Coast of the peninsula make up the North Washington Coast port group. The Central and South Washington Coast port group continues south to the Columbia River border with Oregon. The South and Central Washington Coast shows the largest groundfish landings of the three Washington port groups in 2002, with 13,247 mt, mostly low-value Pacific whiting delivered to shore-based processing plants. As a result, the North Washington Coast, with greater landings of higher value species such as sablefish, shows more ex-vessel revenue in 2002—$3.4 million versus $2.6 million. However, these landings do not reflect the treaty Indian tribes participating in West Coast groundfish fisheries, located in these two port groups. Because of the Pacific whiting landings, the Central and South Washington Coast ranks third among the port groups for total groundfish landings in 2002. In terms of landings value, however, these two port areas are similar to other port groups in southern Oregon and Washington—northern Oregon ports have notably higher exvessel revenue while Southern California ports have significantly less. The South Washington Coast ports receive landings from several nongroundfish fisheries, and had the highest exvessel revenue, $34.4 million in 2002, of all port areas on the West Coast. High-value Dungeness crab contributes to this total.

The South Coast has almost twice as many vessels involved in the groundfish fishery as the North Coast port group—97 versus and 52. Only Port Angeles, Neah Bay, and La Push of the North Coast ports hosted groundfish vessels; La Push had no limited entry trawl vessels listed. Neah Bay is home to the Makah Tribe, while La Push is near the Quileute Indian reservation and it is likely that some of the five vessels ported there are involved in the tribal fishery sector. Port Angeles is the delivery port for the bulk of limited entry fixed gear and open access groundfish vessels in the North Coast region. Westport and Ilwaco are the dominant ports for groundfish in the Central and South Coast port group. Ilwaco has relatively few groundfish limited entry vessels, but has a total number of groundfish vessels, 42, similar to that of Westport, 51. Most of the larger vessels, in excess of 60 feet, are ported in Westport and Ilwaco. Some of these are likely participants in groundfish fisheries, particularly the industrial fishery for Pacific whiting.

3.9.1.2.2 Community Demographics

These two port groups are sparsely populated, more rural areas (Table 3-70). Both are less ethnically diverse than most of the other port groups; lower ranked port groups for this statistic are on the Oregon coast. However, these regions have large Native U.S. populations, at least proportionately, and rank third and seventh for this statistic. Both port groups also have a comparatively lower proportion of working age population. The North Coast port group includes some communities with a large number of retirees. 46% of the population in Sequim, for example, is 65 and older. The Central and South Coast port group is noticeably worse off in terms of other socioeconomic indicators of education and income. But Neah Bay, in the North Coast group, has the lowest median income, at $21,635 in 1999, of any of the ports that are also census places.

Table 3-69 Washington Coast Demographics at a Glance

	North Coast		Central/South Coast	
	Value	Rank	Value	Rank
Total population:	58,855	7	39,574	11
Urban population	63.1%	12	60.5%	13
Non-white population:	9.8%	13	9.6%	14
Hispanic population:	2.3%	18	5.0%	14
Working age population (17-64):	58.1%	16	58.5	15
High school graduate and higher*:	87.7%	5	78.8%	15
Natural resource-related employment**:	1.92%	13	3.72%	3
Average household income:	$45,252	11	$40,188	15
Poverty rate:	12.6%	7	15.0%	4

(Values for block group equivalent areas. Census data, 2000. *Some college, bachelor and graduate º. **Population employed in private sector natural resource-related occupation.)

Earnings from and employment in fishing-related activities is important in the Washington Coast port groups. The South Coast ranked first for the proportion of total personal income derived from fishing activities at 4.8%, with the Central and North Coast regions ranking fifth and ninth in 2001. This is consistent with the employment-related census data discussed above. Groundfish-related revenues are a less important component of fisheries-related income and employment on the South Coast, however, in comparison to the Central and North Coast regions. 59% of 2001 fisheries income was derived from groundfish-related activities on the North Coast, as compared to only 7.4% on the South Coast.

3.9.2 Oregon

3.9.2.1 North Oregon Coast (Astoria, Tillamook, and Newport)

3.9.2.1.1 Port and Fleet Characteristics

The port groups of the north Oregon coast, the most important groundfish region on the West Coast, accounted for $12.3 million in exvessel groundfish revenue in 2002, almost a quarter of the $51.5 million coastwide total. The bulk of the at-sea deliveries—which are Pacific whiting delivered to floating processors—is attributable to these port groups. The Astoria-Tillamook port group and Newport rank at or near the top of all the groundfish species categories, largely because of the high-volume whiting fishery landings in this region. However, other groundfish surpass whiting in terms of exvessel revenue, in part because these two port areas rank second and third behind the North Washington Coast for sablefish landings.

Astoria and Newport are home to a large fraction of the limited entry groundfish trawl fleet with 57 of the 243 total vessels in the fleet in 2002. The vessel buyback program retired 13 limited entry trawl vessels in Astoria and six trawlers in Newport in 2003 (NMFS 2004a). These port areas have a relatively large number of vessels in the 60 foot and above length classes, also reflecting the larger limited entry trawlers fishing out of these ports.

3.9.2.1.2 Community Demographics

These port groups are demographically quite similar (Table 3-71). Tillamook is much more rural, ranking lowest for urban population of all the port groups. (Even looking at the value for census places, Tillamook ranks fourteenth in terms of urban population, with 70%.) It is also the least racially diverse port group and has the highest proportion of the population involved in natural resource-related occupations (farming, forestry, fishing, and hunting). Of these three areas, Newport has the highest percent non-white population, and Native U.S.s represent the largest share of this population with 3.2% of the total population. These port groups rank in the middle in terms of educational attainment. Although average income is comparatively modest, relatively low poverty rates suggest less wealth disparity in these areas. However, looking at rates for individual census places suggests pockets of poverty in some areas. The rate for Astoria is 15.2% while Siletz Bay in the Newport port group has a 15.7% poverty rate. Siletz Bay also has a large percentage (19.3% of the population) of Native U.S.s. Median incomes range from a low of $31,074 for Seaside in the Astoria port group to a high of $40,250 in Nehalem Bay in the Tillamook port group, which has the lowest average income of the three.

Table 3-70 North Oregon Coast Demographics at a Glance

	Astoria		Tillamook		Newport	
	Value	Rank	Value	Rank	Value	Rank
Total population:	39,957	12	19,876	17	24,335	14
Urban population	71.51%	11	28.51%	18	61.21%	13
Non-white population:	7.4%	16	5.47%	18	10.4	11
Hispanic population:	5.1%	13	5.1%	12	4.8%	15
Working age population (17-64):	62.9%	11	59.8%	14	60.87	13
High school graduate and higher*:	85.0%	7	85.0%	8	85.3%	6
Natural resource-related employment**:	2.07%	11	7.31%	1	2.5%	9
Average household income:	$45,399	10	$42,730	13	$44,715	12
Poverty rate:	12.3%	10	11.4%	13	10.9%	14

(Values for block group equivalent areas. Census data, 2000. *Some college, bachelor and graduate º. **Population employed in private sector natural resource-related occupation.)

Fishery-related income and employment are important in these port groups. Newport ranked second while Astoria-Tillamook ranked fourth in terms of contribution fisheries activities made to these economic indicators in 2001. About half of all fisheries income in these port groups was derived from groundfish-fishery-related activities in that year, reflecting the significance of these ports to the West Coast groundfish fishery, discussed above.

3.9.2.2 South Oregon Coast (Coos Bay and Brookings)

3.9.2.2.1 Port and Fleet Characteristics

The Pacific whiting fishery diminishes in importance, measured by landings and exvessel revenue in southern Oregon. Whiting appears as a component of the Coos Bay port group landings, but not in the Brookings region. The Brooking port group had the lowest groundfish landings north of San Francisco for 2002, at 881 mt. However, Brookings ranks near the other port groups with $2.3 million in exvessel revenue from groundfish in 2002. The rockfish category contributes most to revenues in Brookings. Those sold as live fish command higher prices, which earned the

Brookings ports more revenue from fewer landed fish in comparison to the neighboring Coos Bay port group. Live fish deliveries are an important component of California groundfish fisheries, and increasingly in southern Oregon as well. Also, as a proportion of revenue from all fisheries, groundfish are especially important in the Brooking region: the $2.3 million value amounts to just over half the $4.3 million in landings from all fisheries.

There are some notable differences in fleet characteristics between these two port groups. Coos Bay had 29 limited entry groundfish trawlers in 2001 but Brookings had only four. The vessel buyback program retired eight limited entry trawl vessels in Coos Bay. Five retired vessels are reported for Brookings out of a total of nine (NMFS 2004a), more than the 2001 count. This discrepancy is likely due to differences in the way vessel homeports are determined. Port Orford in the Brookings port group had a fleet of limited entry fixed vessels numbering 14 in 2001. The table also shows a large number of vessels in the open access. Some of these vessels are likely participating in the live fish fishery and contributing to high-value rockfish landings.

3.9.2.2.2 Community Demographics

The fairly rural port groups of Brookings and Coos Bay are generally similar to northern Oregon ports in terms of race and ethnicity. Both have a comparatively small percentage of non-white and Hispanic population (Table 3-70). Native U.S.s are the largest minority group at a little over 2% in both port groups. These two port groups rank at the bottom for the percent of the population between ages 17 and 64; Coos Bay ranks first for population 65 years old and up, Brookings third. This reflects the popularity of this part of the Oregon coast as a retirement destination. The two ports also rank at the bottom in terms of average household income and have fairly high poverty rates. Median incomes in constituent census places, however, are higher than in some Northern California communities (see Table 3-72), ranging from $31,656 in Brookings to $29,492 in Bandon, or about two-thirds the statewide value of $40,916. Fisheries made a modest contribution to income and employment in 2001, with Brookings ranking somewhat higher than Coos Bay for the percent share coming from fisheries.

Table 3-71 South Oregon Coast Demographics at a Glance

	Coos Bay		Brookings	
	Value	Rank	Value	Rank
Total population:	59,901	8	20,137	16
Urban population	80.44%	9	49.2%	15
Non-white population:	7.8%	15	6.7%	17
Hispanic population:	3.1%	17	3.4%	16
Working age population (17-64):	57.6%	17	55.5%	18
High school graduate and higher*:	83.0%	11	81.3%	13
Natural resource-related employment**:	2.52%	8	3.0%	5
Average household income:	$39,553	18	$39,563	17
Poverty rate:	14.8%	5	13.3%	6

(Values for block group equivalent areas. Census data, 2000. *Some college, bachelor and graduate º. **Population employed in private sector natural resource-related occupation.)

3.9.3 California

3.9.3.1 Northern California (Crescent City, Eureka, and Fort Bragg)

3.9.3.1.1 Port and Fleet Characteristics

In 2002, groundfish landings accounted for 29% of total exvessel revenues in the three port groups of Crescent City, Eureka, and Fort Bragg, compared to 34% in Oregon and 18% in Washington. During this year these port groups also accounted for a little over half of the value of all groundfish landed in California but only about a quarter of all fishery landings in California. Fishers landed less groundfish in these three port groups, 8,303 mt in 2002, is less than in any one of three port groups in Washington and Oregon (South and Central Washington, Astoria-Tillamook, and Newport) and less than the sum of any three port groups in those two states. The high value relative to landings likely reflects the importance of high-value live fish deliveries. Rockfish and lingcod are an important component of landings, measured by exvessel revenue. In Fort Bragg rockfish were the largest component of groundfish landings. Eureka represents the southern terminus of the Pacific whiting fishery in terms of landings ports with 2,775 mt landed there in 2002, a small amount in comparison to landings in southern Washington and northern Oregon.

The total number of groundfish vessels in each of these three port groups is less than in Oregon port groups, although greater than port groups in Washington. However, the largest number of limited entry trawl vessels was retired during the vessel buyback program in this region. According to the buyback report (NMFS 2004a), fishers retired 14 vessels in both Crescent City and Eureka, and another four vessels in Fort Bragg. The open access sector also plays a larger role in these ports. In Eureka, for example, of the 98 vessels making groundfish landings in 2001, 68 were in the open access sector with groundfish accounting for more than 5% of their revenue for the year. Smaller vessels are more prevalent in the fishing fleets in these port groups; only 7% of the vessels are in the 60 feet and above size groups, half or less of the comparable percentage in Oregon port groups such as Astoria-Tillamook and Newport.

3.9.3.1.2 Community Demographics

Hispanics comprise the largest minority group in these three port groups (Table 3-72), although they make up a lower share of the population than in most of the other port groups in California. The next largest minority groups after Hispanics is Native Americans, which make up 5.4% of the population in the Crescent City area, 4.0% in Eureka, and 2.9% in Fort Bragg, ranking them first, third, and fifth among the port groups, respectively, for this statistic. Crescent City and Eureka rank low in terms of average household income and have the highest poverty rates among all the port groups. Median incomes in constituent census places are also comparatively low; the median income for Crescent City—$20,133—is less than half the value for California as a whole. Fort Bragg has a comparatively high percentage of the population employed in natural resource related jobs. Estimated employment in fisheries in 2001 was relatively high in Crescent City but more modest in the other two port groups. Groundfish fisheries played a more prominent role in Eureka than the other two port groups in this region, likely because of the shore-based processing of Pacific whiting at this port.

Table 3-72 Northern California Coast Demographics at a Glance

	Crescent City		Eureka		Fort Bragg	
	Value	Rank	Value	Rank	Value	Rank
Total population:	24,472	13	52,460	9	21,237	15
Urban population	76.3%	10	82.5%	8	43.9%	17
Non-white population:	20.9	6	14.5	9	14.7	8
Hispanic population:	13.0%	7	6.2%	9	14.1%	6
Working age population (17-64):	64.8%	6	64.6%	7	73.9%	8
High school graduate and higher*:	71.4%	18	84.8	9	84.0	10
Natural resource-related employment**:	2.6%	12	2.0%	12	5.1%	2
Average household income:	$39,654	16	$41,482	14	$49,781	9
Poverty rate:	18.5%	1	17.3%	2	12.5%	8

(Values for block group equivalent areas. Census data, 2000. *Some college, bachelor and graduate º. **Population employed in private sector natural resource-related occupation.)

3.9.3.2 Central California (Bodega Bay, San Francisco, Monterey, and Morro Bay)

3.9.3.2.1 Port and Fleet Characteristics

In Central California and especially Southern California, groundfish diminish as a significant component of commercial landings, but the landings represent high value. In 2002 San Francisco ranked below Eureka and Fort Bragg port groups in terms of the amount of groundfish landings, but second only to Eureka in California measured by exvessel value. (Note that in the fishery-related tables, as opposed to the demographic tables, Bodega Bay ports are included in the San Francisco port group.) Rockfish were an important component of landings in all three port groups in 2002, but in Morro Bay especially they provided a large portion of exvessel revenue. The importance of the live fish fishery contributes to the high value relative to landings. Flatfish are also an important contributor to landings in all three port groups, while sablefish are significant in the Monterey port group.

As in Northern California, open access vessels were an important part of the fleet in these port groups, based on landings at member ports. The limited entry trawl vessel buyback program retired 11 vessels in this region (NMFS 2004a), further reducing the importance of that sector.

Taking the three port groups together, the open access sector made up 86% of vessels making groundfish landings. Many of these likely targeted groundfish on some trips, as groundfish accounted for more than 5% of total landings value for a substantial number of these vessels. In Morro Bay almost all of these vessels made landings of nearshore species, suggesting the importance of the live fish fishery—which targets fish in relatively shallow water—in this port group. These port groups have smaller vessels—97.5% are less than 60 feet—in comparison to the coastwide value of 92%.

3.9.3.2.2 Community Demographics

This region is more ethnically diverse, better educated and wealthier than port groups to the north (Table 3-73). Like Seattle in Puget Sound, San Francisco and the Bay Area metropolitan area dominate this region in terms of population and economic activity. The sparsely populated Bodega Bay port group includes affluent Sausalito, just across the Golden Gate Bridge from San Francisco. Its median income of $87,469 places it above all other communities except for the Newport Coast CDP in Southern California. Yet all of these port groups compare positively in terms of the statistics measuring income and education, with Morro Bay somewhat behind in comparison to the other three port groups. As might be expected, natural resource related employment is insignificant in the San Francisco port group and modest in the other three. These ports rank near the bottom of the West Coast port groups in estimates of 2001share of total income and employment from fisheries. Groundfish-related activities were also a less important share of fisheries income and employment in the Central California port groups, outranking only Southern California.

Table 3-73 Central California Coast Demographics at a Glance

	Bodega Bay		San Francisco		Monterey		Morro Bay	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Total population:	15,592	18	1,484,046	1	112,344	6	40,812	10
Urban population	49.1%	16	99.7%	2	92.5%	6	87.7%	7
Non-white population:	11.0%	10	55.0%	1	20.1%	7	10.3%	12
Hispanic population:	9.2%	9	16.7%	4	16.0%	5	10.9%	8
Working age population (17-64):	73.9%	1	70.0%	3	72.2%	2	61.6%	12
High school graduate and higher*:	93.9%	1	80.1%	14	89.3%	3	91.2%	2
Natural resource-related employment**:	2.8%	6	0.1%	18	1.0%	14	2.4%	10
Average household income:	$108,183	1	$72,203	2	$67,623	3	$56,804	8
Poverty rate:	6.3%	18	12.3%	9	10.3%	15	9.9%	17

(Values for block group equivalent areas. Census data, 2000. *Some college, bachelor and graduate º. **Population employed in private sector natural resource-related occupation.)

3.9.3.3 Southern California (Santa Barbara, Los Angeles, and San Diego)

3.9.3.3.1 Port and Fleet Characteristics

Commercial groundfish fisheries are relatively unimportant in Southern California; these port groups show groundfish exvessel revenue in 2002 somewhat greater than a half a million dollars in each group. Half of that revenue, or better, came from rockfish. In contrast, Los Angeles ranked second (behind the South Washington Coast) for exvessel revenue from all fisheries on the West Coast, and Santa Barbara ranked fourth in 2002. Recreational fisheries dominate groundfish value in this region, and generated an estimated $37.2 million in income in 2001. (This statistic cannot be directly compared to exvessel revenue figures because income includes a wider range of economic activity than what is reflected in exvessel revenue. Nonetheless, it suggests that recreational groundfish fisheries play a greater role in the regional economy than commercial groundfish fisheries.)

Open access vessels dominate the commercial groundfish fisheries. No groundfish limited entry trawlers operate out of these ports and only a modest number of limited entry fixed gear vessels do. Of the 258 vessels making groundfish landings at these ports in 2001, 236 were in the open access sector.

3.9.3.3.2 Community Demographics

Coastal Southern California is overwhelmingly urban and the most racially and ethnically diverse region on the West Coast (Table3-74). Los Angeles is the preeminent urban center on the West Coast. These port groups rank at the top for the percent of the population that is Hispanic. The population value for the Los Angeles port group is somewhat misleading because it includes a small subset of the cities and communities in the Los Angeles area (Los Angeles and Orange counties have a combined population of 7.7 million). The Los Angeles ports in particular show significant disparities in economic well-being. The Newport Coast CDP, for example, has the highest median income of the West Coast port areas—$164,653—and an average income of $264,648. This is more than four times the average income for the port group as a whole. To a lesser degree, there are these types of disparities in the Santa Barbara port group. Santa Barbara itself is a quite affluent city while the coastal areas in Ventura County to the south, also part of the port group, have fewer wealthy residents. Comparison of the median and average income values for Santa Barbara and the other ports in the port group reflect the differences in income distribution. There is a much greater difference between median income and average income in Santa Barbara compared to the other ports. For example, median household income in Santa Barbara is less than in Oxnard while average household income is greater.

Table 3-74 Southern California Coast Demographics at a Glance

	Santa Barbara		Los Angeles		San Diego	
	Value	Rank	Value	Rank	Value	Rank
Total population:	400,353	5	703,511	4	1,336,350	2
Urban population	99.2%	3	100.0%	1	99.6%	3
Non-white population:	39.2%	3	46.9%	2	38.8%	4
Hispanic population:	45.8%	1	35.8%	2	26.0%	3
Working age population (17-64):	63.8%	10	63.8%	9	66.2%	5
High school graduate and higher*:	73.8%	17	75.1%	16	82.5%	12
Natural resource-related employment**:	3.4%	4	0.1%	17	0.2%	16
Average household income:	$63,423	5	$64,901	4	$61,947	6
Poverty rate:	9.9%	16	15.6%	3	11.9%	11

(Values for block group equivalent areas. Census data, 2000. *Some college, bachelor and graduate °.
**Population employed in private sector natural resource-related occupation.)

The estimates of income and employment derived from fisheries are comparatively small for these port groups; Santa Barbara ranks higher than the other two but still in the bottom half of all West Coast port groups. These port groups rank at the bottom of the port groups in terms of the share groundfish contributes to fishery-related income.

3.9.4 Coastwide Summary

3.9.4.1 Dependence on and Engagement in Fishing and Fishing-Related Activities

By examining the rankings of port groups (as explained in Section 3.9) we get an idea of how engaged each port area is in commercial fishing relative to other opportunities in the regional economy. Both the income and employment measures show that the south Washington coast is the area most heavily invested in commercial fishing relative to its economy. Newport and Astoria-Tillamook in Oregon, and Crescent City, California, are the next most engaged. Brookings and Central Washington coast alternate for fifth and sixth place, depending on whether the income or employment measure is used. By this measure the least engaged port areas are the large, relatively urbanized centers of Puget Sound, San Diego, San Francisco, and Los Angeles.

While these areas certainly include local pockets that are heavily engaged in fishing activities, the size and diversity of the surrounding economies tend to mask the significance of locally important factors.

The socioeconomic reference tables show how much of the total fishery-related income and employment in each region is generated by groundfish activity. This measure shows Puget Sound, North Washington Coast, Astoria-Tillamook, and Eureka all depend on groundfish for at least 50% of fishery-related income and employment. All but four of the port groups generate at least 14% of fishery-related income from groundfish.

The second set of socioeconomic reference tables splits the groundfish totals into limited entry trawl and other gear components. From this information we see that of the regions highly involved in groundfish, Astoria-Tillamook, Puget Sound, Newport, and Eureka-derive more than 40% of groundfish income from the limited entry trawl fishery. Only the North Washington coast derives more than one-third of groundfish income from nontrawl sources.

Estimated personal income generated in 2001 by the West Coast ocean recreational fishery was also generated using the Fisheries Economic Assessment Model (or FEAM, see Jensen 1996). The ocean recreational fishery accounted for $254 million in personal income and almost 10,000 jobs in 2001. Of this, groundfish trips accounted for $71 million and 2,800 jobs, respectively, or about 28% of the total. The proportion of income associated with groundfish trips ranged from 17% in Washington to 45% in Oregon. The ratio of charter angler trips to private vessel participation was much greater in Northern and Southern California than in Washington and Oregon, probably reflecting differences in species opportunities, season length and weather along the coast.

3.9.4.2 County Economic Indicators

The socioeconomic reference tables (Appendix E) display the most recent (2001) information on the components of total personal income in counties along the West Coast, Puget Sound, and Lower Columbia River by county. The counties are ranked on the basis of several different average or per capita income measures. In terms of total per capita personal income, the urban Northern California counties are on top, with Marin county ranked number one, followed by two other Bay Area counties, San Mateo and San Francisco. San Mateo and San Francisco also rank first and second in terms of average annual wage, a measure of the strength of these economies as centers of high wage employment, with King County Washington at number three. Marin, San Mateo, and San Francisco counties are ranked first, second, and third in terms of per capita non-labor income (dividends, interest and rent). The status of Marin County as a top bedroom community for San Francisco-bound commuters is betrayed by its ranking as number one in terms of residence adjustment, a net measure of income brought home by resident commuters minus the income carried out by non-residents. The number two and three spots in this category are held by Contra Costa, California, and Columbia County, Oregon, respectively. The four poorest counties in the region, measured by per capita income, are Del Norte County in California, and Klickitat, Pacific, and Grays Harbor counties in Washington.

Transfer payments include welfare and Social Security benefits received from federal, state, and local governments. As such, it can be both a measure of how dependent an area is on public assistance or an indicator of how attractive an area is as a retirement destination. By this measure, Pacific County, Washington, is number one, followed by Curry County, Oregon and Clallam County in Washington. Looking at dividends, interest, and rent (a measure of wealth) expands this picture. By this measure, Curry and Clallam counties rank relatively high (7th and 11th respectively), but Pacific County is well down the list at thirty-third, indicating that Pacific is probably the poorer of the three counties.

According to 2002 unemployment rates in coastal counties (the latest available county-level data) counties with relatively high unemployment rates are arrayed along the lower Washington coast, Columbia River, and southern Oregon coast. Monterey and Del Norte were the only counties in California with unemployment rates among the highest ten. Three of the four counties with highest unemployment rates in 2002 were located in southwestern Washington.

According to national average unemployment rate and the state averages for the three coastal states, unemployment rates for all three states were significantly above the national average in 2002. In Washington, 11 of the 15 counties displayed higher unemployment rates than the state average. In Oregon, 7 of 11 counties had higher than state-average unemployment. In California, 7 of 19 counties had unemployment rates higher than the state average.

3.9.4.3 Social Structure: Networks, Values, Identity

The fishing community on the West Coast is composed of many separate communities based on fishery, gear type, targeted species, geography, and, to some degree, cultural background and ethnicity. For example, Astoria, Oregon, has Finnish roots that are celebrated in community festivals, and Native U.S. communities have ties to the fishery that date back thousands of years.

Commercial fishing enterprises that operate in waters of Washington, Oregon, and California are socially and culturally diverse. However, most tend to be family-run businesses. While most fishers are male, women are often involved in the shoreside aspects of the fishing business and provide an important support and communications network for the fishing community. Few fishing families own multiple boats, and few boats are owned by large corporations. In many communities, families can trace several generations of involvement in the fishing industry.

Recreational fishing is also an important part of many communities' identities. The recreational fishing industry includes charter boats, guides, marinas; and gear, bait, and other suppliers. Families and individuals own and operate many of these businesses. In addition to their direct impact on the local community, the recreational fishing industry supports a broad-based community of thousands of individual boat owners and shore fishers participating in ocean and inland recreational fisheries.

The commercial fishing industry generally places a high value on independence. Fishing necessarily occurs at sea, and frequently attracts people who enjoy solitude and self-direction. This sense of independence and self-reliance contrasts sharply with the increasingly stringent controls being placed on the industry.

Fishing has a high level of danger and consistently rates among the most dangerous professions in the United States. Despite this danger, people in the industry have few safety nets. Crew members are not technically employees and do not qualify for unemployment insurance, workers compensation, and other benefits normally associated with workers in other demanding and dangerous occupations. Vagaries of weather, market conditions and regulations demand high levels of flexibility. Many crew members are itinerant, moving from port to port and job to job (Gilden 1999).

The challenges of pursuing and maintaining fishing-based livelihoods have caused fishers to form organizations to represent common interests. Examples include the Coos Bay Trawlers

Association, the Newport Fishermen's Wives Association, the Pacific City Dorymen's Association, the Fishermen's Marketing Association, the Pacific Marine Conservation Council, the West Coast Fishermen's Alliance, the Western Fishboat Owner's Association, and the Women's Coalition for Pacific Fisheries (Gilden 1999). These organizations help the multiple facets of the fishing community represent their interests to policy makers and the general public.

3.9.4.4 Impact on the Built Environment in Fishing Communities

While few coastal communities depend exclusively on fishing, harvesting, processing and related support industries (fuel, docks, ice, gear repair, etc.) are part of a complex web of interaction with other economic activities such as sport fishing, whale watching, tourism, and other recreational activities. Commercial and recreational fishers coexist, and both contribute financially to the businesses and infrastructure that serve and support them. Communities such as Newport, Oregon, celebrate their fishing industry, and have turned the port waterfront into a major tourist attraction. This is also true for many other historic ports in Washington, Oregon, and California. Maintenance of port facilities for the fishing fleet provides access for other user groups, such as recreational fishers and boaters, and draws tourists attracted to the sights and smells of a working fishing port.

The presence of a viable commercial fleet helps provide the funding and incentive to dredge harbor entrances and to maintain jetties and port facilities. These in turn assist the recreational industry and private users to operate safely and efficiently from coastal ports. Seafood processors and shoreside support businesses pay property taxes and license fees to the port cities and surrounding jurisdictions, thereby contributing to the maintenance of the local infrastructure for all area residents.

In ports such as Brookings and Garibaldi in Oregon, reduction in fishing fleets has coincided with the silting of harbor entrances due to reduced dredging. This has restricted access for larger vessels, including trawlers, and made it more difficult for a fleet to become established in the future (Gilden 1999). In another example, the Port of Astoria recently added a new breakwater to provide additional moorage for larger vessels involved in the new sardine fishery (Oregon Coastal Zone Management Association 2002).

3.9.4.5 Identification of Minority and Low Income Communities and Addressing Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires federal agencies to identify and address disproportionately high adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations in the United States. Fishery management actions promulgated by the Pacific Council and implemented by NMFS can have environmental and socioeconomic impacts over a very wide area; the affected area of many actions covers all West Coast waters and adjacent coastal communities involved in fishing. This makes it difficult to identify minority and low-income populations that may be disproportionately affected.

The same population units described above and used to characterize the demographics of ports and port groups were used to evaluate what ports might qualify as low income and minority. These are census places and block group equivalent areas. Five criteria were used: percent non-white population, percent Native U.S. population, percent Hispanic population, average income, and poverty rate. Statistics for the ports need to be compared to a reference community to determine if they are sufficiently different from a more general, but comparable, population for consideration as a minority or low-income community. Three reference communities were identified: north, central, and south. (A single coastwide reference community was not used because of the substantial variation in population characteristics along the coast.) To begin developing the reference communities, census block groups within 10 miles of the coast were selected and coded using GIS. (Some manual editing was necessary to include smaller census blocks, which, although more than 10 miles from the coast, were surrounded by large block groups that qualified. This is because the selection rule was based on the boundary of the block group, not its centroid. A small number of block groups qualifying, but not in coastal counties, were also manually excluded.) The three regions are based on port groups; coastal block groups were further coded according to these regions. The northern region includes port groups in Washington, Oregon, and the Crescent City, Eureka, and Fort Bragg port groups in California. The central region includes the Bodega Bay, San Francisco, Monterey, and Morro Bay port groups. The southern region includes the Santa Barbara, Los Angeles, and San Diego port groups.

Once reference communities were identified, a threshold value for each of the five statistics used in the evaluation was determined. The block groups in each reference community were ranked and the value constituting the minimum of the highest quintile (twentieth percentile) was identified for percent non-white, percent Native U.S., percent Hispanic, and percent households below the poverty line, and the value constituting the maximum of the bottom quintile for average household income.

Using the quintile value, the ports were evaluated to see if they met the threshold for each of these statistics. Tables in Appendix E titled "Summary of Qualifying Communities" summarize the results. Providing results for both block group equivalents (the column headed "B") and census places (the column headed "P") allows comparison to note how they differ. The result shows that there are multiple communities found along the Pacific coast that could be described as having a large proportion of low income or minority residents.

Table 3-75. Location and Composition of Port Groups.

State	Port Group Area	County	PCID	Name
Washington	Puget Sound	Whatcom	BLN	Blaine
		Whatcom	BLL	Bellingham Bay
		San Juan	FRI	Friday Harbor
		Skagit	ANA	Anacortes
		Skagit	LAC	La Conner
		Snohomish	ONP	Other North Puget Sound Ports
		Snohomish	EVR	Everett
		King	SEA	Seattle
		Pierce	TAC	Tacoma
		Thurston	OLY	Olympia
		Mason	SHL	Shelton
		Unknown	OSP	Other South Puget Sound Ports
	North Washington Coast	Jefferson	TNS	Port Townsend
		Clallam	SEQ	Sequim
		Clallam	PAG	Port Angeles
		Clallam	NEA	Neah Bay
		Clallam	LAP	La Push
	South & Central WA Coast	Grays Harbor	CPL	Copalis Beach
		Grays Harbor	GRH	Grays Harbor
		Grays Harbor	WPT	Westport
		Pacific	WLB	Willapa Bay
		Pacific	LWC	Ilwaco/chinook
		Klickitat	OCR	Other Columbia River Ports
	Unidentified WA	Pacific	OWC	Other Washington Coastal Ports
		Unknown	OWA	Unknown WA Ports
Oregon	Astoria	Multnomah	CRV	Psuedo Port Code for Columbia R.
		Clatsop	AST	Astoria
		Clatsop	GSS	Gearhart - Seaside
		Clatsop	CNB	Cannon Beach
		Unknown	WAL	Landed in WA; Transp. to OR
	Tillamook	Tillamook	NHL	Nehalem Bay
		Tillamook	TLL	Tillamook / Garibaldi
		Tillamook	NTR	Netarts Bay
		Tillamook	PCC	Pacific City
	Newport	Lincoln	SRV	Salmon River
		Lincoln	SLZ	Siletz Bay
		Lincoln	DPO	Depoe Bay
		Lincoln	NEW	Newport
		Lincoln	WLD	Waldport
		Lincoln	YAC	Yachats
	Coos Bay	Lane	FLR	Florence
		Douglas	WIN	Winchester Bay
		Coos	COS	Coos Bay
		Coos	BDN	Bandon
	Brookings	Curry	ORF	Port Orford
		Curry	GLD	Gold Beach
		Curry	BRK	Brookings
California	Crescent City	Del Norte	CRS	Crescent City
		Del Norte	ODN	Other Del Norte County Ports
	Eureka	Humboldt	ERK	Eureka (Includes Fields Landing)
		Humboldt	FLN	Fields Landing
		Humboldt	TRN	Trinidad
		Humboldt	OHB	Other Humboldt County Ports
	Fort Bragg	Mendocino	BRG	Fort Bragg
		Mendocino	ALB	Albion
		Mendocino	ARE	Arena
		Mendocino	OMD	Other Mendocino County Ports
	Bodega Bay	Sonoma	BDG	Bodega Bay
		Marin	TML	Tomales Bay
		Marin	RYS	Point Reyes
		Marin	OSM	Other Son. and Mar. Co. Outer Coast Ports

Table 3-75. Location and Composition of Port Groups.

State	Port Group Area	County	PCID	Name
		Marin	SLT	Sausalito
	San Francisco	Alameda	OAK	Oakland
		Alameda	ALM	Alameda
		Alameda	BKL	Berkely
		Contra Costa	RCH	Richmond
		San Francisco	SF	San Francisco
		San Mateo	PRN	Princeton
		San Francisco	SFA	San Francisco Area
		San Francisco	OSF	Other S.F. Bay and S.M. Co. Ports
	Monterey	Santa Cruz	CRZ	Santa Cruz
		Monterey	MOS	Moss Landing
		Monterey	MNT	Monterey
		Monterey	OCM	Other S.C. and Mon. Co. Ports
	Morro Bay	San Luis Obispo	MRO	Morro Bay
		San Luis Obispo	AVL	Avila
		San Luis Obispo	OSL	Other S.L..O. Co. Ports
	Santa Barbara	Santa Barbara	SB	Santa Barbara
		Santa Barbara	SBA	Santa Barbara Area
		Ventura	HNM	Port Hueneme
		Ventura	OXN	Oxnard
		Ventura	VEN	Ventura
		Ventura	OBV	Other S.B. and Ven. Co. Ports
	Los Angeles	Los Angeles	TRM	Terminal Island
		Los Angeles	SPA	San Pedro Area
		Los Angeles	SP	San Pedro
		Los Angeles	WLM	Wilmington
		Los Angeles	LGB	Longbeach
		Orange	NWB	Newport Beach
		Orange	DNA	Dana Point
		Orange	OLA	Other LA and Orange Co. Ports
	San Diego	San Diego	SD	San Diego
		San Diego	OCN	Oceanside
		San Diego	SDA	San Diego Area
		San Diego	OSD	Other S.D. Co. Ports
	Unidentified CA	Unknown	OCA	Unknown CA Ports

3.10 *Non-Fishing Values*

This section discusses the value of the marine environment to members of the general public who are not involved in consumptive use of coastal and marine resources. The sectors benefiting from a resource can generally be placed into one of three groups: consumptive users (e.g., recreational fishers who keep their catch, commercial harvesters, and processors), non-consumptive users (e.g., wildlife viewers), and non-consumptive non-users (e.g., members of the general public who derive value from knowing that a species or habitat is being maintained at a healthy level). Table 3-76 displays the general relationship between use/non-use and consumptive/non-consumptive types of activities.

Table 3-76 Relationship between Use/Non-use and Consumptive/Non-consumptive Activities

	Consumptive	Non-Consumptive
Use	Commercial and Recreational Fishing	Wildlife Viewing
Non-use	N/A	Existence Value, Bequest Value, Social and Cultural Value

This section discusses use and non-use non-consumptive activities within the marine environment. Non-consumptive activities include marine wildlife viewing (whale watching, recreational diving, marine eco-tours, etc). Wildlife viewing can be either market based or non-market based. Non-use non-consumptive value, often called passive use value, can result from the value placed on future access to the resource for oneself, others or future generations, biodiversity, cultural heritage and social significance of the coastal and marine resource.

3.10.1 Non-Consumptive Use Value

Marine wildlife viewing along the West Coast includes onshore and at-sea activities, such as SCUBA and skin diving, whale watching, eco-tours, tide pool viewing, etc. Wildlife viewing likely contributes to the tourism economy of many local communities by providing revenue and employment through companies providing these services to the public. Restaurants and hotels likely receive some indirect value from these activities. Complete information about the prevalence, distribution and economic contribution of entities providing whale watching and eco-tour services are not currently available on a coastwide basis. However, a survey completed by PSMFC in 2001 of charter boats operating in the Pacific Region showed that 31 of 82 charter boats surveyed made at least one nature watching trip in 2000. Each charter vessel mad an average of 14 trips. Two of 82 surveyed charter vessels indicated that they conducted at least one non-fishing SCUBA diving trip with an average of 11 in the year (PSMFC 2001).

Some area-specific information is available about particularly popular whale watching destinations such as the San Juan Islands and Channel Islands. In all, approximately 40 U.S. companies provided whale watching services in the Pacific Northwest (Personal communication

2004, Richard Osborne). Entities chartering trips in the San Juan Islands rely largely on revenues from whale watching of three resident killer whale pods in the Haro Strait region (located between the San Juan Islands and Vancouver Island). Charter participants also viewed other wildlife, such as transient Orcas, Minke whales, Gray whales, Dall's and Harbor porpoises, seals, sea lions, bald eagles, many kinds of seabirds, and blacktail deer. Several of the U.S. entities (17 companies) belong to an organization called Whalewatch Operators Northwest (along with several Canadian operations) and adhere to voluntary whale watching guidelines, sanctioned by the organization, that aim to be safe, professional and respectful of wildlife. U.S. boats have increased from zero in 1976 to about 28 vessels in 2003 in Haro Strait. The number of both whale watch boat passengers and land-based whale watching visitors to Lime Kiln State Park in Friday Harbor on San Juan Island tallied at about 30,000 and 65,000 respectively in 2003 (The Whale Museum 2003). These statistics indicate the growth of the whale watching industry over the past three decades.

NMFS social scientists at the Northwest Fisheries Science Center have begun a project that evaluates non-consumptive use of killer whales as an unregulated common pool resource by whale watch operators in the Puget Sound (Lazrus and Norman 2004).

The Channel Islands National Marine Sanctuary (CINMS) DEIS provides some information about non-consumptive recreational activities in that area from commercial entities. In 1999, the popular wildlife viewing destination tallied an estimated 42,008 person-days as non-consumptive recreation from "for hire" operations in the CINMS, where a "person-day" is one person undertaking an activity for any part of a day or a whole day (CINMS 2000). They were not able to estimate amounts of non-consumptive recreation from private household boats. Whale watching was the most prevalent non-consumptive recreational activity with about 26,000 person-days (62% of those surveyed for non-consumptive activities). Non-consumptive diving was about 26% of all activity while sailing and kayaking/Island sightseeing accounted for the remaining 13% of non-consumptive recreational activity. In all, these non-consumptive recreational activities contributed an estimated $82,837 in total profit in 1999 (CINMS 2000).

The Diving Equipment and Marketing Association tallies 159 specialty diving retail entities in California, 25 in Oregon, and 49 in Washington. Popular areas for diving include the Channel Islands and Monterey Bay. However, divers also highly value the Northwest states. Readers of SCUBA Diving magazine (January 2004) recently voted Washington State as one of the best places to dive in North America. The Channel Islands and Washington State were voted the second and eighth best places to dive in North America. Kelp forests are often the primary destination for viewing wildlife. Dive shop owners indicate that wolf eels, octopi, sharks, anemones and rockfish are highlights of diving excursions.

3.10.1.1 Value of Protected or Preserved Marine Resources

Offsite non-consumptive uses of resources protected or preserved by management are public in nature, and do not exclude anyone from deriving the identified benefits. Total value placed on offsite non-consumptive use of the stock or component of the ecosystem set aside will also depend on:

1. The size of the human population
2. The level of income
3. Education levels
4. Environmental perceptions and preferences

(Spurgeon 1992).

The above relationships imply that as human populations and the welfare of those populations increase, and as the fish stocks and their ecosystems remaining in good condition decreases, the non-consumptive values associated with maintaining ocean resources are likely to increase. The relationships also imply that once preservation of the basic integrity of ecosystem processes and marine fisheries components occurs, the incremental benefit from additional preservation will likely decrease.

3.10.1.2 Estimation of Value

Non-consumptive use of the marine environment includes use of both market and non-market consumer goods. In the market for recreational charter trips that involve non-consumptive use of the marine environment (e.g. whale watching trips, eco-tours, etc.) individuals pay fees to a company or individual providing the service. When individuals participate in marine wildlife viewing on their own (e.g. tidal pool viewing, beachcombing, etc.) they often pay for transportation, lodging and other services as part of a recreational excursion. However, this bundle of services is not marketed in a traditional market and is therefore referred to as a non-market consumer good.

For goods exchanged in markets where a consumer price can be determined (e.g. seafood), price and quantity information can be used to estimate the benefits consumers derive from consumption activities. In the market for recreational experiences (e.g. charter boats offering marine wildlife viewing excursions), price and quantity information from these trips might allow estimation of the benefits participants derive from this type recreational activity. However, charter trips may often be purchased as part of a bundle of goods and services that include other recreational activities. Therefore, the estimation of benefits from recreational charter activities is less straightforward than for traditionally marketed consumer goods.

For other consumer goods, especially bundles of goods and services, such as a recreational fishing trip taken on a private vessel, the prices and quantities associated with each transaction are much more difficult to determine. For the private recreationalists, the amount spent on gear and other goods necessary to carry out a particular marine wildlife viewing trip is difficult to isolate. The term “private” is used here to designate an individual using the marine environment from a private vessel, the shore, bank or a public pier, as opposed to using a charter vessel.

Although these values are not possible to quantify at this time due to a lack of data, there are indications that the use and value of certain aspects of the marine environment are increasing. However, cumulative value is uncertain with respect to the Pacific marine environment.

3.10.2 Non-Consumptive Non-Use Values

3.10.2.1 Passive Use Values

Passive use values are often related to biodiversity, cultural heritage, social significance of the fishery or ecosystem, existence value, and bequest value.

3.10.2.2 Biological Diversity

The value of biological diversity may be part of the value placed on a site by non-consumptive users (onsite or offsite). Three levels of biological diversity have been identified, (1) genetic diversity within a species, (2) species diversity (richness, abundance, and taxonomic diversity) and (3) ecosystem diversity. Ecosystem diversity encompasses the variety of habitats, biotic communities and ecological processes (Caribbean Fishery Management Council 1998). Healthy ecosystems characterized by high biological diversity are generally able to provide a wider range of ecosystem services than are available from damaged or less diverse ecological communities. Examples of such ecosystem services include the nutrient recycling and filtering capabilities of wetlands and the carbon sequestration function provided by growing forests.

3.10.2.3 Social and Cultural Value

The existence of coastal fishing communities may have intrinsic social and cultural value. For example, the Newport Beach dory fishing fleet, founded in 1891, is a historical landmark designated by the Newport Beach Historical Society. The city grants the dory fleet use of the public beach in return for the business and tourism this unique fishery generates.

3.10.2.4 Existence Value

Existence value is often used to describe the willingness to pay for a good even though one makes no direct use of it, may not benefit from it individually, and may not plan any future use for self or others. Benefits may accrue to passive users of coastal and marine resources from the preservation of fish stocks at higher levels of abundance.

3.10.2.5 Bequest Value

If value is placed on conservation for future generations, this is called bequest value. Bequest value is defined by willingness to pay in order to ensure the continued supply of ecosystem services, the availability of which would otherwise be uncertain.

3.10.2.6 Estimation of Value

Lack of data about individuals' value of the U.S. West Coast marine environment precludes at this time adequate quantification of passive use value under each of these categories.

3.10.3 Non-fishing Activities

This section discusses the value of the marine environment to entities involved in use of the coastal and marine environment resulting from non-fishing activities. Several industries benefit from direct use of the coastal and marine environment that do not involve fishing. The following subsections describe the major non-fishing activities that occur on the coast and provide the location of such activities where data is available.

Several non-fishing industries are likely economically important to particular coastal communities. Providing a description of each of these industries in the Pacific region requires economic information about the portion of economic value and employment that each industry creates related specifically to use of the West Coastal and marine environment. This information is not readily available at this time. Current socioeconomic research by social scientists at the NWFSC and AKFSC will describe some of these industries and their economic, social and cultural importance to specific coastal communities. However, many non-fishing activities may take place further inland and the community profiles research may not contain information adequate for evaluation of impacts to the coastal and marine environment.

3.10.3.1 Wildlife Viewing

Marine wildlife viewing along the West Coast includes on-shore and at-sea activities like SCUBA and skin diving, whale watching, eco-tours, tide pool viewing, etc. Wildlife viewing likely contributes to the tourism economy of several local communities by providing revenue and employment through companies providing these services to the public. Restaurants and hotels will likely receive some indirect value from these activities. However, information about the prevalence, distribution and economic contribution of entities providing whale watching and eco-tour services are not currently readily available. Current projects focusing on community profiling may provide some information about the significance of these industries to specific local economies.

Some information is available about the distribution of entities providing diving trip services. The Diving Equipment and Marketing Association tallies 159 specialty diving retail entities in CA, 25 in Oregon and 49 in Washington. Popular areas for diving include the Channel Islands and Monterey Bay. However, the Northwest states are also valued highly by divers. The Pacific Northwest was just voted the best place to dive in the U.S. (SCUBA diving magazine, June 2004). Kelp forests are often the primary destination for viewing wildlife. Dive shop owners indicate that wolf eels, octopi, sharks, anemones and rockfish are highlights of diving excursions.

3.10.3.2 Dredging, Disposal of Dredge Material and Fill Material

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 navigational access for ships and boats to docking facilities (ports and marinas). Dredging creates deepwater navigable channels or maintains existing channels that periodically fill with sediments that flow into these channels from rivers or move by wind, wave, and tidal dynamics. Dredging removes, disturbs, and re-suspends quantities and associated qualities of the sea floor and may cause turbidity plumes. 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.) provide legal mandates for dredging.

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 is 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, and other sensitive habitats, such as emergent marshes and sub-aquatic vegetation, including eelgrass beds and kelp beds. Dredging may also modify current patterns and water circulation in 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.

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.

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.

Dredging, disposal of dredged material and filling are known to occur in all estuarine and some marine areas of the West Coast. However, there is currently no centralized location for spatial data delineating dredge and fill sites. Generally, the information about these areas resides with the U.S. Army Corps of Engineers as written reports. However, some state agencies, ports, as well as private entities have limited GIS information about dredging and filling occurring within their jurisdiction. For this EIS, we were able to acquire GIS data for disposal areas within and offshore from Gray's Harbor, Washington (Figure 3-31).

3.10.3.3 Oil/Gas Exploration/Production

Offshore exploration and production of natural gas and oil reserves have been and will continue to be important aspects 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 and physical disruption 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.

The impacts of oil exploration-related seismic energy release may 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 re-suspension 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 thus primary productivity 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 dislodged 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.

The habitat value of a number of platforms on the Pacific OCS was determined under OCS Study MMS 99-0015, *The Ecological Role of Natural Reefs and Oil and Gas Production Platforms on Rocky Reef Fishes in Southern California.* Dr. Milton Love and co-researchers from the Marine Science Institute (MSI) at the University of California at Santa Barbara compared fish assemblages from eight platforms and eight natural outcrops at similar depth. The observations were top to bottom on both platforms and natural reefs over a six-year period including 2001. All surveys and videotapes are archived at UCSB. The analyses were based on at least 40 submersible and hundreds of SCUBA dives on platforms and on 133 submersible and hundreds of SCUBA dives on natural outcrops located throughout southern California, the Santa Barbara Channel, and off Pt. Conception and Pt. Arguello.

The MSI researchers found that platform fish assemblages are somewhat different from those of natural reefs. However, these differences were due almost entirely to the greater numbers of more species of fishes around platforms, rather than differences in species composition between platforms and natural outcrops. At least 85 species of fish were observed at platforms and 94 species at the outcrops. Rockfishes dominated both habitats, comprising 89.7% of all fishes at platforms and 92.5% at outcrops. Almost all of the more abundant species that the researchers observed were more common around platforms. Species that were more common at one or more platforms than at natural reefs included cowcod and bocaccio (young-of-the-year (YOY), juvenile, and adult), copper, greenspotted, greenstriped, YOY widow, vermilion, canary and flag rockfishes and YOY juvenile and adult lingcod.

Those few species that appeared to be more characteristic of natural outcrops than platforms (more were found at natural reefs than at platforms) e.g., bank, pygmy, speckled, squarespot, and swordspine rockfishes, were primarily small or dwarf species. During the surveys, the researchers found that on many southern California outcrops these diminutive forms dominate heavily fished natural reefs. Of the dwarf rockfish species, only the halfbanded rockfish was abundant at platforms and was, in fact, more abundant at platforms than at natural outcrops.

The preclusionary effects that platforms provide to fisheries by providing species such as rockfish protection from fishing was also clearly shown by the researchers. The scientists compared densities of all rockfishes (of all sizes), all rockfishes greater than or equal to 30 cm, and adult bocaccio and cowcod that they observed at platforms and at natural outcrops. In most cases, fishes 30 cm or larger were less abundant, or sometimes absent, from many natural reefs compared to most platforms. Platform Gail, in particular, held (including 2001 observations) some of the highest densities of the important but severely depleted cowcod and bocaccio that were seen anywhere during the observations. The researchers believe that for some rockfish species such as bocaccio and cowcod and perhaps others, and for lingcod, some platforms in the Santa Barbara Channel and Santa Maria Basin are major nursery grounds and harbor relatively high densities of both juveniles and adults. Given the very low populations of a number of these important species, it is quite possible that platforms are important fish habitat on a regional level.

One way to determine the ecological performance and relative importance of a platform as fish habitat is to compare the amount of potential larvae created by rockfish at a platform with that of rockfish on natural outcrops in the same general area. When compared to the potential larval production from rockfish on natural reefs, adults at platforms may be producing a significant amount of the rockfish larvae potentially entering the local fishery stocks.

The MSI researchers found that a number of platforms harbored higher densities of YOY rockfishes than did natural outcrops. Thirteen of the 20 highest YOY rockfish densities over the period of research were observed at platforms (Grace, Harvest, Hermosa, Hidalgo, Holly, and Irene), primarily in the platform midwaters. The highest YOY rockfish densities over natural outcrops tended to be at high relief sites (pinnacles) that were influenced by the California Current, well away from the mainland. The researchers found that the midwaters of many platforms bear a striking resemblance to some of the pinnacles that dot the outer continental shelf of southern California. At both the platforms and at relatively shallow and steep-sided pinnacles (such as those on Hidden Reef), the assemblages are dominated by young rockfishes and larger fish predators are relatively uncommon.

In a 1999 pilot study, Dr. Love and his staff collected YOY blue rockfish and bocaccio from several platforms and adjacent natural reefs. These samples are archived at UCSB. A few samples were examined and the growth rates determined for YOY blue rockfish from Platform Gilda and from Naples Reef by examining the daily growth marks laid down on otoliths. On average, the fish from Platform Gilda grew faster than those from Naples Reef. Thus, for this pilot study and at least blue rockfish at these two sites, Platform Gilda provided at least as beneficial a habitat as did the natural reef.

The MSI researchers found evidence to demonstrate that, in general, platforms harbored higher densities of young rockfish than did nearby natural outcrops or, indeed, most other outcrops surveyed in central and southern California. The researchers point out that platforms occupy more of the water column than do most natural outcrops and presettlement pelagic juvenile rockfishes are much more likely to encounter these tall structures than the relatively low-lying natural structures. It is interesting to note that most of the natural outcrops that the researchers surveyed that harbored high densities of YOY rockfishes (e.g. Hidden Reef and outcrops around islands) were also very high relief pinnacles that thrust their way well into the water column. The researchers observed that many of the major predators of young rockfishes are species that live and stay close to the bottom, such as lingcod, copper and vermilion rockfishes, cowcod and large bocaccio. The researchers found that in general, these species do not ascend the platform jacket up into the water column, and thus are absent from the platform midwaters. In this respect, the researchers conclude that platforms resemble some of the pinnacles that dot southern California continental shelf. Larger species, such as cowcod, lingcod, and greenblotched rockfishes are not abundant around the steep, smooth sides of offshore pinnacles.

The Minerals Management Service provided data delineating active federal oil and gas leases, as well as platforms and pipelines. All oil and gas activity is occurring off southern California. Currently, there are 85 active lease areas, encompassing 165,212 hectares, 23 platforms, and 30 pipeline sections with a total length of 300 km (Figure 3-31).

3.10.3.4 Water Intake Structures

The withdrawal of ocean water by offshore water intakes structures is a common coastwide occurrence. Water may be withdrawn to provide 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 also occur.

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 caught 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.

GIS data locating water intake structures were extracted from NOAA's ESI data for California. Similar data are not available for Oregon and Washington. There are six water intake structures in northern California, 15 water intake structures in central California, and eight water intake structures in southern California (Figure 3-31).

3.10.3.5 Utility Line/Cables/Pipeline Installation

The existing GIS data for underwater cables depicts approximately 25 cables. These data were provided by NMFS, Alaska Fisheries Science Center and from Pacific States Marine Fisheries Commission. Most likely, these data underestimate the number of existing submarine cables within the Pacific EEZ (Figure 3-32).

3.10.3.6 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.

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 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. Shading effects may inhibit growth of submerged aquatic vegetation, which may provide shelter and nursery habitat for a number of fish species and their prey.

There is very little GIS data depicting existing use of aquatic habitat for aquaculture purposes. NOAA, NOS, Special Projects Office developed a data set which delineates shellfish classification as determined from the 1995 National Shellfish Register. These classifications indicate whether the area is approved for shellfish harvest based on a number of characteristics including water quality and pollution, however they do not indicate whether the area is actively being used for aquaculture or not. These data cover the entire West Coast, but very few areas in California are delineated by the classification (Figure 3-31).

3.10.3.7 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/storm water 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, and health and abundance may result due to these discharges. Many of these changes can be long lasting.

Wastewater effluent and non-point source/storm water 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.

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 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 National Pollutant Discharge Elimination System (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, seagrasses, 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 may reduce light penetration and lower the rate of photosynthesis (e.g., in 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, which has 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 this technology is fairly new, 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.

3.10.3.8 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 use of hazardous materials from both facilities and vessels.

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 affect the egg and larval stages of most groundfish species.

3.10.3.9 Fish Enhancement Structures

Construction of fish enhancement structures, commonly called artificial reefs, is 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 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.

The use of artificial reefs can adversely impact the aquatic environment in at least two ways. First, habitat upon which the reef material is placed is lost. 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 prevent mobile forms (e.g., benthic-oriented fish species) from using 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, which 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.

3.10.3.10 Coastal Development and Agriculture 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 groundwater 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.

Development activities within watersheds and in coastal marine areas often impact groundfish habitat and other fish species on both long-term and short-term scales. Toxic runoff from development sites reduces the quality and quantity of suitable fish habitat by the introduction of pesticides, fertilizers, petrochemicals, and construction chemicals (e.g., concrete products, seals and paints). Sediment runoff can also restrict tidal flows 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, thereby harming 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.

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.

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; nutrients such as nitrogen and phosphorous, organic solids, microorganisms like bacteria and viruses, and salts. These pollutants and wastes may make habitat unsuitable for shelter, feeding, spawning; and if conditions are extreme, they result in fish kills.

9% of Washington, Oregon, and California coastal watershed areas in 1990 were agriculture– potentially causing impacts from runoff and pesticide application

60% of Washington, Oregon, and California coastal watershed areas in 1990 were forested. Some portion of this area is used for Silviculture/Timber Harvest.

12% of Washington, Oregon, and California coastal watershed areas were urban or built-up land. The most heavily urbanized areas are the Puget Sound Trough in Washington, Portland in Oregon, and San Francisco Bay Area, Central California coast, and Los Angeles to San Diego, California. 16% of Washington, Oregon, and California coastal watershed areas were rangeland (Figure 3-32).

We expect that the urbanized areas have increased in area over the last 15 years.

3.10.3.11 Marinas

Data for boating facilities in Washington were acquired from the Washington Office of the Interagency Committee (IAC). There are 426 boating facilities in Washington State that are classified by the IAC as "Large Boat Facilities". 293 of these facilities are in the Puget Sound area, 30 are located on the Straits of Juan de Fuca and the outer coast or coastal estuaries of Washington.

Locations of marinas in California were extracted from the Environmental Sensitivity Index (ESI) data from NOAA, NOS, Office of Ocean Resources Conservation and Assessment. There are 49 marinas along coastal California, although no marinas are indicated in San Francisco, so this is an underestimate of the total number of facilities. 14 marinas are located in northern California (north of San Francisco Bay), 8 marinas are located in central California (south of San Francisco Bay to Santa Barbara), and 27 marinas, a little over half of the marinas, are located in southern California (Santa Barbara to the Mexican border) (Figure 3-32).

3.10.3.12 Shoreline Protection

Data depicting shoreline hardening in Washington was extracted from the ShoreZone Inventory provided by Washington Department of Natural Resources (DNR), Nearshore Habitat Program. According to Washington DNR, Nearly one-third of Washington's marine and estuarine coastline has some shoreline protection structures. Most of the structures occur within Puget Sound, with some hardening within the coastal estuaries of Gray's Harbor and Willapa Bay. The ocean coastline of Washington is relatively unmodified.

For California, GIS data delineating hardened shoreline sections was extracted from NOAA's ESI data. Shoreline sections that were classified as man-made structures or riprap were included in these data. In northern California, approximately 5% of the shoreline has been hardened. In central California, approximately 4% of the shoreline has been hardened. Southern California has the greatest proportion of shoreline hardening with approximately 31% of the shoreline being hardened (Figure 3-32).

No GIS data are available for Oregon, but according to the Surfrider, State of the Beach 2004 for Oregon, more than 18 miles of the Oregon coastline have some sort of shoreline armoring, which is approximately 5% of the coastline.

3.10.3.13 Riverine Activities

Very little spatial data were available to locate and delineate impacts within and from the riverine systems. One data set that was available was the location of dams for all the West Coast states. These dam locations are from National Inventory of Dams, downloaded from: http://crunch.tec.army.mil/nid/webpages/nid.cfm.

There are 673 dams in Washington, 812 dams in Oregon, and 1485 dams in California. In Washington and Oregon, the dams are spread throughout the state, with some concentrations in the Puget Sound trough and around Portland, OR and the Oregon coastal range. In California, the dams appear to be concentrated in northern California, especially San Francisco Bay area and the Sierra Nevada mountains, as well as around the greater Los Angeles area in Southern California (Figure 3-32).

3.10.3.14 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).

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.

3.10.3.15 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 coastal waters. This timber or woody debris plays a significant role in salt marsh ecology.

For a variety of reasons—including dam operations, aesthetics and commercial use of the wood—woody debris is often removed before reaching estuarine and coastal waters. 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 woodborers convert the wood to fecal matter, supplying carbon from terrestrial sources to the ocean food chain. The dwindling supply of wood may jeopardize the ecological link between the forest and the sea.