3.0 The Affected Environment

3.1 Introduction

Groundfish *BYCATCH* and its characteristics (e.g., species, extent of harm, quantity, distribution in time and space) result from the dynamic and complex interaction of attributes of the species, the fisheries, and the affected *ENVIRONMENT*, both physical and biological. Life history strategies can influence vulnerability to bycatch at the level of an individual, a population, or group of species. For example, fish morphology (e.g., size, shape, presence of spines, large gill cover), distribution (e.g., preferred temperature, in deepwater, along cliffs) and behavior (e.g., schooling, inhabiting crevices, fast-swimming) affect how vulnerable a fish or species is to capture or harm by a particular gear. Fishers continuously adjust their gears, fishing practices and areas, to the extent allowed by regulation, to take advantage of these attributes in order to efficiently maximize the harvest of targeted species, as well as to reduce the harvest of unwanted species. The physical and biological environment also influences the distribution and abundance of species, largely through the availability and abundance of suitable habitat, prey, predators, competitors, and reproductive opportunities.

Chapter 3 describes various components of the coastal marine *ECOSYSTEM* and how people and communities use and rely on the groundfish resources of this region. The groundfish FMP and management regime covers groundfish stocks off Cape Flattery, Washington to the California border with Mexico. Hundreds of plant and animal species occur along the West Coast and groundfish-related bycatch may affect many of them. To make this chapter easier to read and understand, much of the detail on the biology of species and associated literature citations, have been placed in an appendix (See Appendix B).

This chapter describes the affected environment as it is today, which is the baseline environmental condition. The baseline represents the status of environmental attributes at a time before the proposed action is implemented, and in Chapter 4 serves as a point of comparison to evaluate possible significant impacts. The status quo environmental condition is the result of millions of years of natural events and changes, and at least 150 years of human-caused events and changes. Humans have affected the downstream sediment transport from freshwater streams, which has affected the amount and characteristics of sediment entering the marine environment. Tree harvesting, on the other hand, sometimes results in increased erosion and sediment transport, especially in watersheds with few or no dams. Oil and mineral exploration and extraction have undoubtedly affected the ocean physical environment, at least in the immediate vicinity of those activities. Fishing activities have also contributed to changes in the physical environment.

The biological environment has also been directly affected by fishing and other marine harvesting activities. For example, several recent studies have suggested that historical (and pre-historical) removal of whales and other marine mammals has created cascading effects[1/] throughout marine *FOOD WEBS*. More recently, fishing has contributed to reduced abundance of several groundfish species, resulting in NOAA Fisheries designating nine species as overfished.

3.1.1 How Chapter 3 Is Organized

Chapter 3 describes the human environment as it exists today. To help set the context for the analysis of impacts, Section 3.2 provides a brief description of the physical environment, including marine geology, climate and currents. Section 3.3 describes the biological environment, including the biology of selected species: important groundfish species, protected species, and other relevant fish and shellfish species. Several species or species groups are given special emphasis in this chapter because of concerns regarding their population status and relevancy to bycatch issues. These include eight *OVERFISHED* groundfish species and protected marine species including Pacific salmon, marine birds, marine mammals and sea turtles. Other important species include those with substantive bycatch of groundfish in a non-groundfish fishery such as for pink shrimp; with substantive bycatch of the species in a groundfish fishery, such as Pacific halibut; especially vulnerable species such as Dungeness crab in softshell condition and long-lived and slowly reproducing species such as sharks and rays. Known *TROPHIC* relationships are identified, as are species that may be directly affected by groundfish fishing operations (for example, accidentally captured and/or killed by groundfish operations). This section summarizes the information in Appendix B and arranges it within the context of bycatch issues. Citations for Section 3.3 discussion appear within the more comprehensive Appendix B.

Section 3.4 describes the social and economic environment; that is, the human uses of West Coast groundfish stocks, and how these activities relate to other fishing activities in the region. Section 3.4.1 identifies incentives and disincentives relating to bycatch. Sections 3.4.2-3.4.8 describe the commercial, recreational and tribal fisheries, commercial fish buyers and processors, and coastal communities where groundfish-related activities occur are described. Section 3.8 discusses vessel safety issues, and Section 3.9 describes management

1. For example, some species may be considered keystones because they are the primary predator on another species. Reducing or eliminating such a keystone predator could result in a population explosion of the prey species, which would in turn affect the populations of other species that occupy that trophic level. Likewise, a keystone prey species' population can be reduced, resulting in a crash of species that rely on that prey for reproduction or survival. In either case, removal of a keystone species can cause significant (and unpredictable) changes in other populations.

and enforcement activities and costs. Section 3.10 describes other fisheries that take groundfish incidentally (open access, non-groundfish fisheries) to provide a broader view of catch and bycatch on the West Coast.

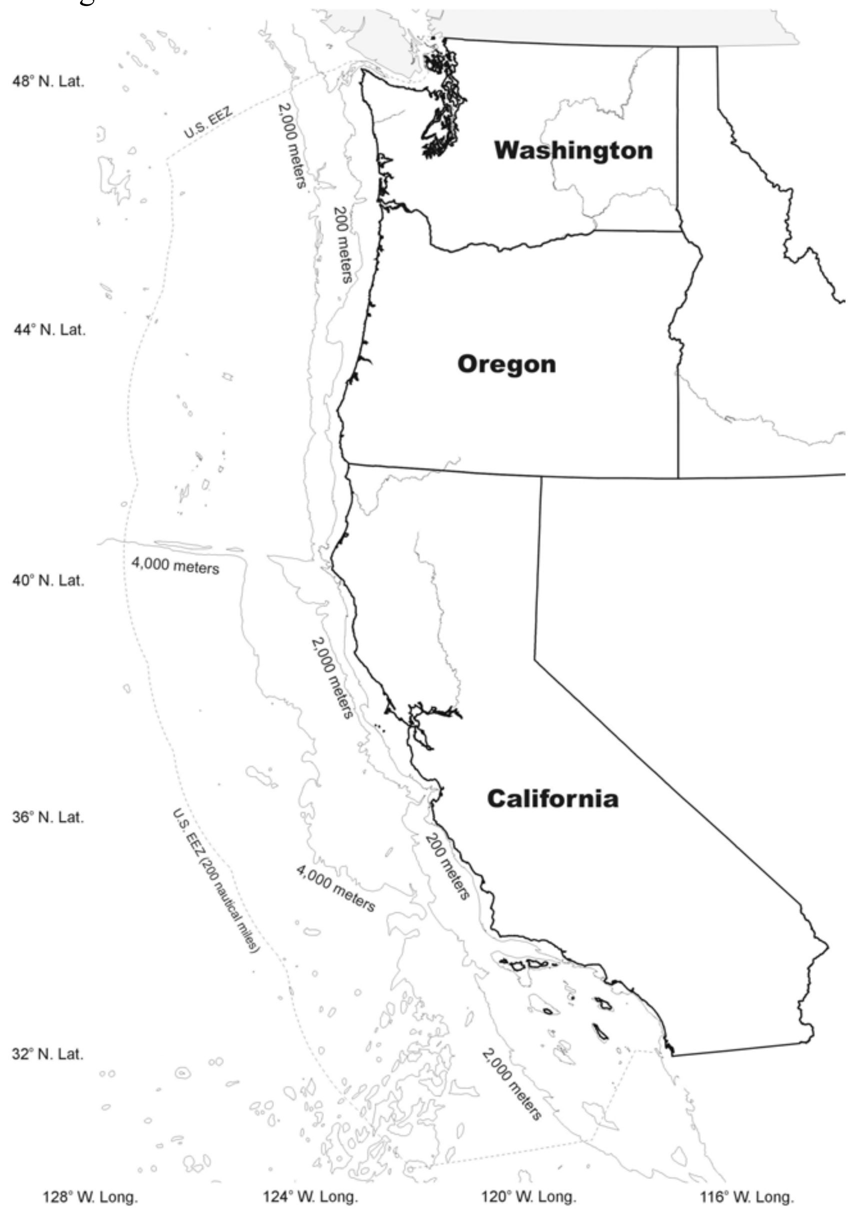
3.2 The Physical Environment

Essential Fish Habitat (EFH) for groundfish is defined as the aquatic *HABITAT* necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and for groundfish contributions to a healthy ecosystem. This approach focuses on ecological relationships among groundfish species and between the species and their habitat. These habitat types are described primarily by physical features with the caveat that EFH also includes the associated biological communities. EFH for groundfish is identified by seven major habitat types: rocky *SHELF*, non-rocky shelf, continental slope/basin, canyon, *NERITIC* zone, oceanic zone and *ESTUARINE*. EFH descriptions have been incorporated in the FMP in both section 11.10 and in a detailed appendix (available online at http://www.nwr.noaa.gov/1sustfsh/efhappendix/page1.html. Groundfish EFH is currently being re-evaluated in a separate EIS.

3.2.1 Geology Bathymetry and physical topography help determine habitat by influencing its physical structure and also the *CO-OCCURRENCE* of other species. Groundfish species are harvested in the *PELAGIC* zone, close to the bottom, or on the bottom, mostly within 50 miles of the shoreline where maturing and adult stages are found. Mud, sand, gravel, and exposed rocky areas, along with associated biological *COMMUNITIES*, make up the varied benthic habitats for groundfish on the continental margin.

The continental margin and waters out to 200 miles, the seaward boundary of the EEZ, are important habitat for groundfish and other marine species affected by groundfish fishing. The continental margin is composed of the *CONTINENTAL SHELF* and *CONTINENTAL SLOPE* - the steeper, deeper part of the continental margin (Figure 3.1). The U.S. West Coast is characterized by a relatively narrow continental shelf. The 200 m depth contour shows a shelf break closest to the shoreline off Cape Mendocino, Point Sur, and in the Southern California Bight; and widest from central Oregon north to the Canadian border, as well as off Monterey Bay. Deep submarine canyons pocket the EEZ, with depths greater than 4,000 m south of Cape Mendocino. Major estuaries along the coast include San Francisco Bay, Columbia River, Willapa Bay, Grays Harbor, and the Strait of Juan de Fuca. A number of small estuaries occur all along the West Coast.

Table 3.4.4 Bathymetry of the West Coast groundfish fishery management area.



3.2.2 California Current System Biological characteristics of species, combined with physiographic features, are important determinants of changes in distribution. More mobile and schooling species, such as Pacific whiting, may vary in location *en masse* as they move in response to environmental conditions and prey availability. Current regimes may also control the distribution of larvae, helping to determine the location of adult populations. As mentioned earlier, fish distribution is an influential factor in determining bycatch, and thus, currents and their variability can affect bycatch.

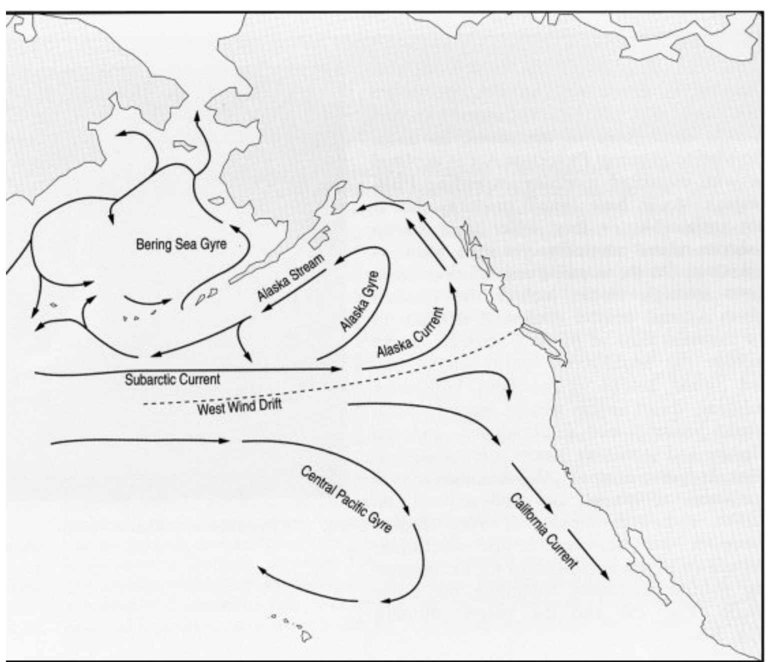
The West Coast marine environment is part of the California Current ecosystem (Figure 3.2). Large scale ocean currents, the North Pacific and Alaska gyres in particular, create a dynamic coastal environment. The North Pacific Current crosses the Pacific Ocean from Japan to Canada where it encounters the continental margin near Vancouver Island. The current splits into a northward flowing current carrying water into the Gulf of Alaska and a southward flowing current carrying water along the coast from Washington to California. This broad, shallow surface current which flows southward is called the California Current. It is strongest during the summer and is opposed by a weaker northward flowing and deeper California Undercurrent.

The California Current system changes significantly during the winter. The California Current moves farther offshore and the continental shelf is dominated by a strong northward flowing Davidson Current associated with winter storms.

Influenced by the California Current system and coastal winds, waters off the U.S. West Coast are subject to major nutrient upwelling as deep, nutrient-rich water is upwelled against the coastline. During periods of strong upwelling, primary ocean productivity is enhanced, increasing overall ocean production throughout many different trophic levels including those occupied by groundfish species.

Shoreline topographic features such as Cape Blanco and Point Conception, and bathymetric features such as banks, canyons, and other submerged features, often create large-scale current patterns such as eddies, jets, and squirts. For example, a current jet off Cape Blanco drives surface water offshore, which is replaced by upwelling sub-surface water. One of the better known current eddies off the West Coast occurs in the Southern California Bight between Point Conception and Baja, California, wherein the current circles back on itself by moving in a northward and counterclockwise motion just within the Bight.

Table 3.4.4Major ocean currents off the West Coast of North America.



3.2.3 Climate Climate can influence the distribution and abundance of marine species, which in turn, can be reflected in bycatch type and amount. Population data on some groundfish species seem to show a linkage between climate and recruitment. The effect of *EL NIÑO-SOUTHERN OSCILLATION* (*ENSO*) events on climate and ocean productivity in the northeast Pacific is relatively well-known. For example, Pacific whiting tends to have stronger year classes following an El Niño event than in other years. Also, some localized larval rockfish populations have shown lower survival rates in years when coastal upwelling and plankton production was reduced by El Niño events.

Periods of warmer or cooler ocean conditions and the event of shifting from warm to cool or vice versa can all have a wide array of effects on marine species abundance. Ocean circulation varies during these different climate events, affecting the degree to which nutrients from the ocean floor mix with surface waters. Periods of higher nutrient mixing tend to have higher phytoplankton (primary) productivity, which can have ripple effects throughout the *FOOD WEB*. In addition to changes in primary production, climate shifts may affect zooplankton (secondary) production in terms of increasing or decreasing abundance of the zooplankton biomass as a whole or of particular zooplankton species. Again, these changes in secondary production ripple in effect through the food web. Upper trophic level species depend on different lower order species for their diets, so a shift in abundance of one type of prey species will often result in a similar shift in an associated predator species. This shifting interdependency affects higher order species like groundfish in different ways at different life stages. Some climate conditions may be beneficial to the survival of larvae of a particular species but may have no effect on an adult of that same species.

EL NIÑO and *LA NIÑA* events are examples of short-scale climate change, six-month to two-year disruptions in oceanic and atmospheric conditions in the Pacific region. An El Niño is a climate event with trends such as a slowing in Pacific Ocean equatorial circulation, resulting in warmer sea surface conditions and decreased coastal upwelling. Conversely, a La Niña is a short-scale climate events characterized by cooler ocean temperatures. In years of poor upwelling or when El Niño warms the waters off the West Coast, ocean productivity is reduced. Under severe El Niño conditions, species distributions can change radically.

Recently, scientists have concluded that large scale regime shifts overlay shorter term El Niño and La Niña events, creating longer term changes in productivity associated with decades-long warm or cold periods. In the past decade, a still longer period cycle, termed the *PACIFIC DECADAL OSCILLATION* or *PDO*, has been identified. Although similar in effect, instead of the 1 year to 2 year periodicity of ENSO, PDO events affect ocean conditions for 15 years to 25 years. The PDO shifts between warm and cool phases. The warm phase is characterized by warmer temperatures in the northeast Pacific (including the West Coast) and cooler-than-average sea surface temperatures and lower-than-average sea level air pressure in the central North Pacific; opposite conditions prevail during cool phases. Because the effects are similar, in-phase ENSO events (that is, an El Niño during a PDO warm phase) can be intensified.

3.3 The Biological Environment

Detailed descriptions of the life history and status of groundfish, other fish and shellfish, marine mammals, sea turtles and seabirds are provided in Appendix B. For ease of readability, these descriptions are summarized below and the associated information sources are only cited in the appendix. Section 3.3.5 describes biological associations, that is, the geographic and trophic relationships of various species.

Primary production (phytoplankton abundance) and secondary production (zooplankton abundance) influence the abundance of higher trophic level organisms, including fish populations targeted by fishers. Changes in production in terms of increasing or decreasing abundance of the zooplankton biomass as a whole or of particular *ZOOPLANKTON* species ripple through the food web.

Upwelling zones are generally considered the most productive in the ocean. Upwelling occurs in the spring and early summer off central California. Submarine canyons along the Washington coast are sites of increased upwelling.

Brown, red, and green algae and coralline algae are abundant in the intertidal areas of rocky shorelines. These algae provide rich food supplies and provide cover for diverse communities of animal species. Eel grasses are also important spawning and nursery areas in estuaries.

The vegetation zone extends to from shore to depths where light penetration becomes insufficient for substantial plant growth. Kelp forests provide cover for many groundfish species, especially rockfishes, and they attract other species that may be prey, predators, or competitors with groundfish. Kelp forests of the Washington, Oregon and northern California coasts are dominated by bull kelp (*Nereocystis*), which is an annual species, dying each winter. Kelp forests off central and southern California are comprised of giant kelp (*Macrocystis*), which is a perennial species. It can live for several years in deeper water, but can be removed by storms on exposed coasts.

3.3.1 Groundfish

The Pacific Coast groundfish FMP manages more than 80 species. These species occur throughout the EEZ and occupy diverse habitats at all stages in their life history. While a few species have been intensively studied, there is relatively little information on the life history, habitat, and stock status of most groundfish species.

The life history, distribution, and stock status of each important groundfish species are summarized in Appendix B. More detailed information on the status of each of the groundfish species or species groups is available in the stock assessments associated with the annual SAFE report, as well as in the EIS for ABC and OY Specifications and Management Measures for the 2004 Pacific Coast Groundfish Fishery.

More detailed information about groundfish and other species may be found in Appendix B.

In addition to the individual species descriptions in Appendix B, generalized descriptions are provided below for the following groundfish species groups: rockfishes, thornyheads, gadids, flatfishes, sharks, and skates. These generalized descriptions are followed by information on the stock status for each *OVERFISHED* species and *EMPHASIS SPECIES*. The term overfished describes a groundfish stock whose abundance is below its overfished/rebuilding threshold. Eight groundfish species are below the overfished threshold in 2004: bocaccio, canary rockfish, cowcod (south of Point Conception), darkblotched rockfish, lingcod, Pacific ocean perch, widow rockfish, and yelloweye rockfish. We are using the term “emphasis species” to describe a groundfish stock (other than an overfished stock) that is particularly relevant to bycatch issues and specifically incorporated in analyses of the alternatives in this EIS. Our groundfish emphasis species are black, yellowtail and chilipepper rockfish, shortspine and longspine thornyhead, sablefish, cabezon, English, Dover, and Petrale sole and arrowtooth flounder. The impacts of the alternatives described in Chapter 4 on these species should be representative of the impacts on species with similar life histories and distributions.

3.3.1.1 Generalized Rockfish (Sebastes spp.) Biology.

Rockfishes are a very diverse group of over 60 species that occur along the West Coast. Adults of many species are most common in nearshore areas, whereas others (e.g., yellowtail rockfish) inhabit deeper waters on the shelf. Most rockfishes are demersal, often solitary, and associated with rocky areas or other structure. Adults of these species tend to remain in localized areas and do not undertake significant migrations or movements. A few others (e.g, widow rockfish) are considered pelagic, schooling species. All bear live young. Most species mate in the fall and larvae are released in spring, often in rocky or reef habitats. Larvae are carried inshore to rear during the summer and fall. Typically young-of-the-year are associated with vegetated and/or rocky areas and may occur in groups or larger schools. As they grow older, they adapt the adult lifestyle. Most rockfishes are slow-growing, long-lived and produce relatively few young each year. For most species, average age of maturity is reached between five and ten years. Some species are estimated to have a life span well over 50 years, perhaps 100 years, and the longevity of many species is 20 years or more. More detailed life histories for many rockfish species are provided in Appendix B.

3.3.1.2 Generalized Thornyhead Biology.

Two species of thornyheads occur off the West Coast, shortspine thornyhead (*Sebastolobus alascanus*) and longspine thornyhead (*S. altivelis*). They are found from Baja California to the Bering Sea and occasionally to Japan. They are common from southern California northward. Thornyheads are demersal and occupy soft bottoms in deep water. Their distributions overlap considerably although longspines also inhabit somewhat deeper waters. Off Oregon and California, shortspine thornyhead mainly occur approximately 100 -1,400 m, most commonly from approximately 100 -1,000 m, and longspine thornyhead mainly occur at depths of approximately 400 -1,400+m, most often between about 600 -1,000 m in the oxygen minimum zone. Off California, spawning occurs in February and March in deep water. Eggs rise to the surface to develop and hatch. Floating egg masses can be seen at the surface in March, April, and May. Larvae are pelagic for about 12-15 months. During January to June, juveniles settle onto the continental shelf and then move into deeper water as they become adults. Off California, shortspines begin to mature at 5 years; 50% are mature by 12-13 years; and all are mature by 28 years. Although it is difficult to determine the age of older individuals, they may live to over 100 years of age. Thornyheads eat a variety of invertebrates such as shrimps, crabs, and amphipods, as well as fishes and worms. Longspine thornyhead are a common item found in the stomachs of shortspine thornyhead and cannibalism of newly settled juveniles is important in the life history of thornyheads. Sablefish commonly prey on longspine thornyhead.

3.3.1.3 Generalized Flatfish Biology

Twelve species of *FLATFISHES* are classified as West Coast groundfish: arrowtooth flounder, butter sole, curlfin sole, Dover sole, English sole, flathead sole, Pacific sanddab, Petrale sole, rex sole, rock sole, sand sole, and starry flounder. (Although they are flatfish, Pacific halibut and California halibut are not classified as West Coast groundfish, and are considered in Section 3.2.4 below.) Flatfish are demersal, inhabiting sandy, muddy, or gravelly bottoms from estuarine areas seaward over the shelf and onto the continental shelf. Starry flounder is common in estuarine areas and shallow nearshore areas and Dover sole and arrowtooth flounder are common on the outer shelf and slope. Others are most common nearshore and on the shelf. Individuals of the same species often occur together in large, non-random associations. Some may make extensive migrations, especially between feeding and spawning grounds. Spawning is most common during late winter and early spring. Except for rock sole, flatfish spawn many pelagic eggs, from hundreds of thousands to a few million, depending on species and size of the fish. Rock sole reportedly spawn over a variety of substrates, from rocky banks to sand and mud; their eggs are demersal and adhesive. For many species, eggs rise in the water column and are carried shoreward with the currents as they develop, and the young settle in relatively shallow waters. However, rex sole settle mainly on the outer continental shelf. As they age and grow, most flatfish move from shallow nursery areas into deeper waters. Age of maturity varies from 2 to 10 years, depending on species and sex. Longevity varies from 10 to 20 years with Dover sole living potentially twice as long. Juveniles and adults are carnivorous.

3.3.1.4 Generalized Gadid Biology

Two species of GADIDS are classified as groundfish off the West Coast: Pacific whiting (*Merluccius productus*) and Pacific cod (*Gadus macrocephalus*). (Another gadid, walleye pollock, is not classified as a West Coast groundfish under the FMP, but its biology is described in Section 3.2.4 below.) Pacific Whiting, also known as Pacific hake, range from Sanak Island in the western Gulf of Alaska to Magdalena Bay, Baja California Sur. Off the West Coast, Pacific cod are at the southern end of their range, which extends from northern China along the Pacific rim to the Bering Sea and southward to Santa Monica, California. Smaller populations of cod and whiting occur in several of the larger semi-enclosed inlets, such as the Strait of Georgia and Puget Sound. Whiting are semi-pelagic. The highest densities of Pacific whiting are usually between 50 and 500 m, but adults occur as deep as 920 m and as far offshore as 400 km. Whiting school at depth during the day, then move to the surface and disband at night for feeding. Coastal stocks spawn off Baja California in the winter, then the mature adults begin moving northward and inshore, as far north as southern British Columbia by fall. They then begin the southern migration to spawning grounds and further offshore. Spawning occurs from December through March, peaking in late January. Their eggs are neritic and float to neutral buoyancy. Age of maturity for males and females is three years and longevity is about 25 years. All life stages feed near the surface late at night and early in the morning. Juveniles and small adults feed chiefly on euphausiids. Large adults also eat amphipods, squid, herring, smelt, crabs, and sometimes juvenile whiting. Eggs and larvae of Pacific whiting are eaten by pollock, herring, invertebrates, and sometimes whiting. Juveniles are eaten by lingcod, Pacific cod and rockfish species. Adults are preyed on by sablefish, albacore, pollock, Pacific cod, marine mammals, soupfin sharks and spiny dogfish. The life history of Pacific cod off the West Coast differs in some aspects from the life history of Pacific whiting. Adult Pacific cod occur as deep as 875 m, but the vast majority occurs between 50 and 300 m. They are not considered to be highly migratory, but individuals can move long distances. Eggs are demersal, and eggs and larvae can be found over the continental shelf between Washington and central California from winter through summer. Most mature by 3 years of age, and longevity is about 15 years. Juveniles and adults are carnivorous and feed at night.

3.3.1.5 Generalized Shark Biology

On the West Coast, three species of sharks are classified as groundfish: spiny dogfish, soupfin shark and leopard shark. (Other sharks off the West Coast are more oceanic and as an example, the biology of the common thresher shark is considered in Section 3.2.4 below.) Leopard shark inhabit nearshore waters, including shallow bays and estuaries in California; soupfin shark occur near bottom in nearshore areas and over the shelf; and spiny dogfish occur near bottom and at times, higher in the water column from inshore areas to the outer shelf. They are schooling species and may make long migrations. They bear live young, primarily during the spring. Leopard sharks can produce up to 36 pups; soupfin sharks average 35 pups and spiny dogfish produce up to 20 pups, although litters of 4-7 are common. The gestation period lasts for 10-12 months for leopard shark, but two years for spiny dogfish. Age at maturity also varies by species and sex, but is about 10 to 20 years for females. These sharks are long-lived, from 30 to 70 years, depending on species and sex.

3.3.1.6 Generalized Skate Biology

Three species of skates are classified as West Coast groundfish: big skate, California skate, and longnose skate. Adults inhabit mud or sand bottom on the shelf, although California skate is more common in shallower areas, especially off California. They are OVIPAROUS, with fertilization occurring internally, and eggs are deposited on the bottom in egg cases. Young hatch and inhabit level, sandy or muddy bottoms. Age of maturity ranges from six to12 years and adults live for 20-30 years.

3.3.1.7 Lingcod Biology

Lingcod (*Ophiodon elongatus*), a top order predator of the family Hexagrammidae, ranges from Baja California to Kodiak Island in the Gulf of Alaska. Lingcod is DEMERSAL at all life stages. Adult lingcod prefer two main habitat types: slopes of submerged banks 10-70 m below the surface with seaweed, kelp and eelgrass beds and channels with swift currents that flow around rocky reefs. Juveniles prefer sandy substrates in estuaries and shallow subtidal zones. As the juveniles grow they move to deeper waters. Adult lingcod are considered a relatively sedentary species, but there are reports of migrations of greater than 100 km by sexually immature fish. Mature females live in deeper water than males and move from deep water to shallow water in the winter to spawn. Mature males may live their whole lives associated with a single rock reef, possibly out of fidelity to a prime spawning or feeding area. Spawning generally occurs over rocky reefs in areas of swift current. After the females leave the spawning grounds, the males remain in nearshore areas to guard the nests until the eggs hatch. Hatching occurs in April off Washington but as early as January and as late as June at the geographic extremes of the lingcod range. Males begin maturing at about 2 years (50 cm), whereas females mature at 3+ years (76 cm). In the northern extent of their range, fish mature at an older age and larger size. The maximum age for lingcod is about 20 years. Lingcod are a visual predator, feeding primarily by day. Larvae are zooplanktivores. Small demersal juveniles prey upon copepods, shrimps and other small crustaceans. Larger juveniles shift to clupeids and other small fishes. Adults feed primarily on demersal fishes (including smaller lingcod), squids, octopuses and crabs. Lingcod eggs are eaten by gastropods, crabs, echinoderms, spiny dogfish, and cabezon. Juveniles and adults are eaten by marine mammals, sharks, and larger lingcod.

3.3.1.8 Sablefish Biology

Sablefish (*Anoplopoma fimbria*) are abundant in the north Pacific, from Honshu Island, Japan, north to the Bering Sea, and southeast to Cedros Island, Baja California. There are at least three genetically distinct populations off the West Coast of North America: one south of Monterey characterized by slower growth rates and smaller average size, one that ranges from Monterey to the U.S./Canada border that is characterized by moderate growth rates and size, and one ranging off British Columbia and Alaska characterized by fast growth rates and large size. Large adults are uncommon south of Point Conception. Adults are found as deep as 1,000 fm (1,900 m), but are most abundant between 200 and 1,000 m. Off southern California, sablefish were abundant to depths of 1,500 m. Adults and large juveniles commonly occur over sand and mud in deep marine waters. They were also reported on hard-packed mud and clay bottoms in the vicinity of submarine canyons. Spawning occurs annually in the late fall through winter in waters greater than 300 m. Sablefish are oviparous with external fertilization. Eggs hatch in about 15 days and are demersal until the yolk sac is absorbed. After yolk sac is absorbed, the age-0 juveniles become pelagic. Older juveniles and adults are benthopelagic. Larvae and small juveniles move inshore after spawning and may rear for up to four years. Older juveniles and adults inhabit progressively deeper waters. The best estimates indicate that 50% of females are mature at 5-6 years (24 inches), and 50% of males are mature at 5 years (20 inches). Sablefish larvae prey on copepods and copepod nauplii. Pelagic juveniles feed on small fishes and cephalopods, mainly squids. Demersal juveniles eat small demersal fishes, amphipods and krill. Adult sablefish feed on fishes like rockfishes and octopus. Larvae and pelagic juvenile sablefish are heavily preyed upon by sea birds and pelagic fishes. Juveniles are eaten by Pacific cod, Pacific halibut, lingcod, spiny dogfish, and marine mammals, such as Orca whales. Sablefish compete with many other co-occurring species for food, mainly Pacific cod and spiny dogfish.

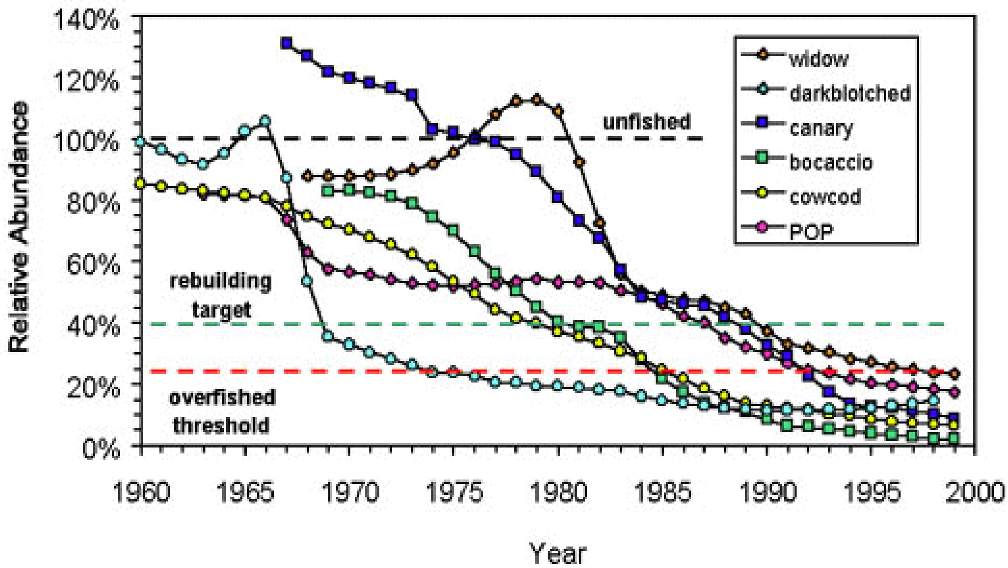
3.3.1.9 Cabezon Biology

Cabezon (*Scorpaenichthys marmoratus*) are found from central Baja California north to southeast Alaska. This species inhabits inshore waters from the intertidal out to depths of about 42 fm (76 m). It is most common at depths of 2.5 fm to 30 fm (5-59 m). Cabezon are found on rocky, sandy and muddy bottoms, and in kelp beds. They inhabit restricted home ranges. Age of maturity ranges from 3 to 6 years. Spawning takes place from late October to March in California, and from November through September in Washington. Fecundity ranges from 50,000 to 150,000 eggs, depending on size of the female. Eggs are deposited in clusters in shallow waters or in the low intertidal on bedrock, or in crevices. Males guard the nest after spawning and nest sites may be re-used from year to year. Eggs hatch two to three weeks after spawning. Small juveniles spend three to four months in the water column feeding on small crustaceans and other zooplankton. At about 1.5 inches (approximately 4 cm) they take up a demersal lifestyle. Adult cabezon primarily eat crustaceans (crabs, small lobster) but also mollusks (squid, octopus, abalone), smaller fishes, and fish eggs. Small cabezon are eaten by larger fishes including rockfishes, lingcod, adult cabezon, and other sculpins. Adults are eaten by pinnipeds.

3.3.1.10 Status of Overfished Groundfish Species

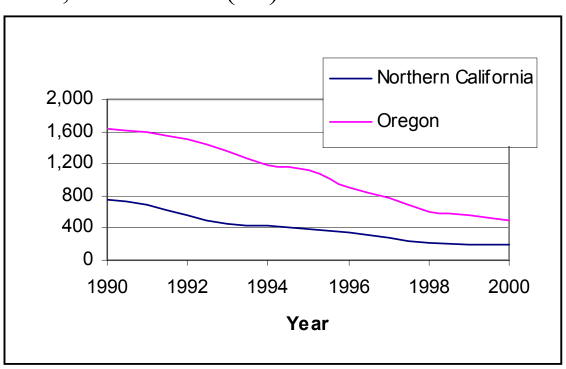
Eight groundfish species on the West Coast have been designated as overfished, based on estimates of their population abundance. A species is designated as overfished if its abundance has been estimated at less than 25% of its unfished population size. The rebuilding target for overfished species is 40% of its unfished population level. Historical estimates of relative abundance for six rockfish species are shown in the Figure 3.3 (adapted from S. Ralston, personal communication). Trends in relative abundance of darkblotched rockfish, bocaccio and cowcod show relatively long, steady declines during the 1970s and 1980s to very low levels in1990s. Trends in relative abundance for Pacific ocean perch, widow rockfish and canary rockfish are more variable, but abundance generally declined during the late 1980s and through the1990s. More detailed information about the status of these species, including biomass estimates, is provided in Appendix B.

Table 3.4.4Relative abundance trends of six overfished rockfish stocks.



Adopted from Steve Ralston; NOAA/NMFS/SW Fisheries Science Center

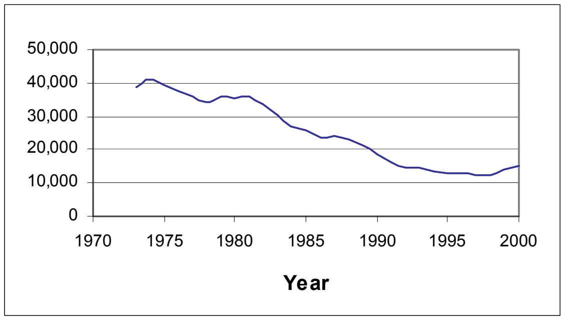
Table 3.4.4Yelloweye rockfish biomass trend, 1990-2000 (mt).



Yelloweye rockfish and lingcod have also been designated as overfished. The population status of these two species is presented below. (Pacific whiting is no longer classified as overfished.)

Yelloweye rockfish biomass shows a steady decline during the 1990s (Figure 3.4). The population was considerably below the unfished level when assessed in 2001, although there is relatively little information about yelloweye rockfish and uncertainties remain in the assessment. Regulations have severely restricted landings of yelloweye rockfish in recent years.

Table 3.4.4Lingcod population biomass (mt, age 2+).



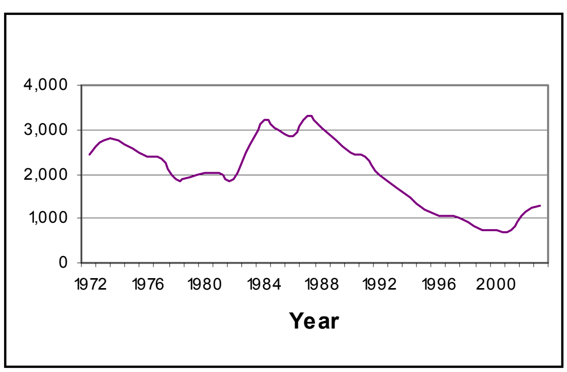
In 1997, lingcod was estimated to be at about 9% of its estimated unfished spawning potential (Figure 3.5). The estimated biomass of lingcod shows a decline from approximately 40,000 mt of fish, age 2 years and older, in the mid-1970s to a low of approximately 12,000 mt during the late 1990s.

3.3.1.11 Status of Emphasis Groundfish Species

In addition to the eight overfished species, the following 12 groundfish species are identified as emphasis species. These stocks are particularly relevant to bycatch issues and are highlighted in this EIS: Pacific whiting, sablefish, Dover sole, English sole, Petrale sole, arrowtooth flounder, chilipepper rockfish, yellowtail rockfish, shortspine thornyhead, longspine thornyhead, black rockfish and cabezon. Information about their population status is summarized below. More detailed information about their life histories and population status is provided in Appendix B.

The coastal population of Pacific whiting (Figure 3.6) was previously classified as overfished, but the 2004 assessment indicated the stock is now above the B40% level and may be classified as rebuilt. The whiting biomass fluctuates dramatically due to periodic fluctuations in recruitment strength. Stock biomass increased to a historical high in 1987 due to exceptionally large 1980 and 1984 year classes, then declined as these year classes passed through the population and were replaced by more moderate year classes. Stock size stabilized briefly between 1995-1997, but then declined continuously to its lowest point in 2001. The 2002 stock assessment indicated the population had fallen into the overfished category, based on an assumption about the size of the 1999 year class. Since 2001, stock biomass has increased substantially, and it now appears the 1999 year class was larger than anticipated. Based on this improved understanding of the large 1999 year class and a new acoustic survey,

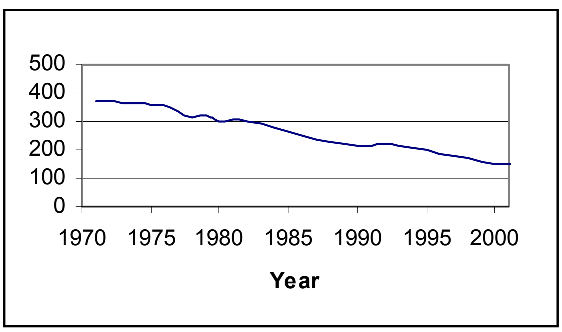
Table 3.4.4Pacific whiting female spawning biomass trend, 1972 - 2003.



the whiting stock in 2003 was estimated to range from 2.6 to 4.0 million mt (age 3+ biomass). The mature female biomass in 2003 was estimated to range from 47% to 49% of an unfished stock. Thus the stock is considered to be rebuilt to the target level of abundance only 3 years after reaching a low level that resulted in the overfished determination. It now appears the 2001 biomass had remained slightly above the overfished threshold. However, as the 1999 year class passes through its age of peak abundance, the stock is projected to decline again after 2004. By 2006, the spawning stock biomass is projected to again decline to near the overfished threshold.

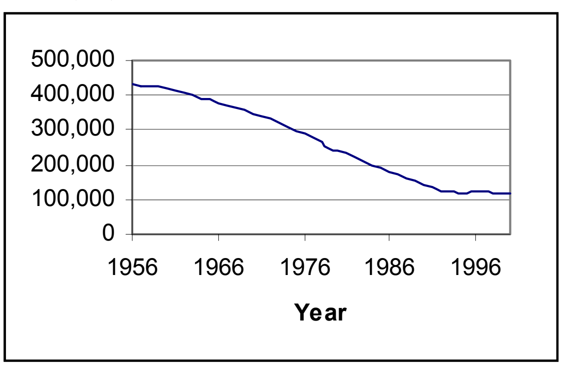
The coastwide ABC and OY for 2004 are estimated to be 514,441 mt and 250,000 mt, respectively. The ABC is based on the F40% harvest rate and the OY has been reduced from the ABC to protect widow rockfish, which is caught in common with whiting. At this time there is no evidence of sufficiently large recruitments after 1999 to maintain the stock at a high abundance level. However, as evidenced in the past, rapid increases and subsequent decreases in stock abundance and potential yield are typical for a stock with such extreme fluctuations in recruitment.

Table 3.4.4Sablefish biomass trend, 1970-2000 (1,000 mt)



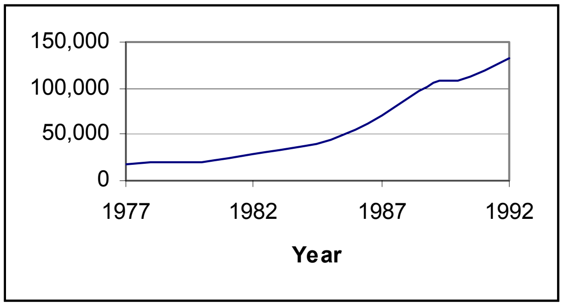
The estimated biomass of sablefish shows a slow, steady decline since the early 1970s (Figure 3.7). The stock is currently estimated to be between 27% and 38% of its unfished biomass and consequently, falls under the FMP's precautionary management principles.

Table 3.4.4Dover sole biomass trend, 1956-1996 (mt).



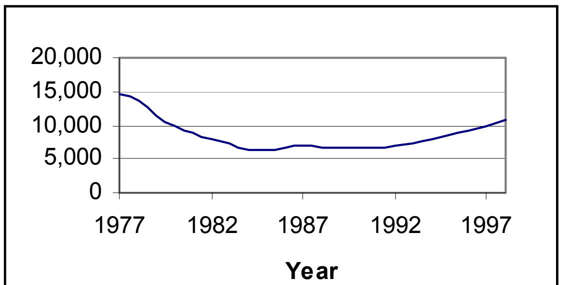
The most recent stock assessment for Dover sole completed in 2001 indicates that the current spawning stock size is about 29% of its unexploited biomass (Figure 3.8). Recent abundances appear to be without trend, but they have been preceded by a steady decline since the late 1950s.

Table 3.4.4English sole biomass trend (mt).



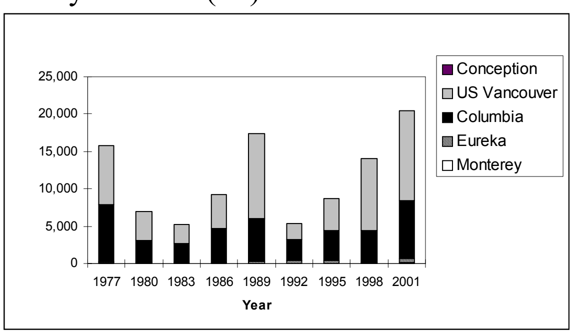
English sole has not been assessed since 1993. This assessment addressed English sole in northern areas (US Vancouver and Columbia) and indicated a nearly 7-fold increase in biomass since the 1970s to about 133,000 mt (Figure 3.9).

Table 3.4.4Petrale sole biomass trend, 1977-1997.



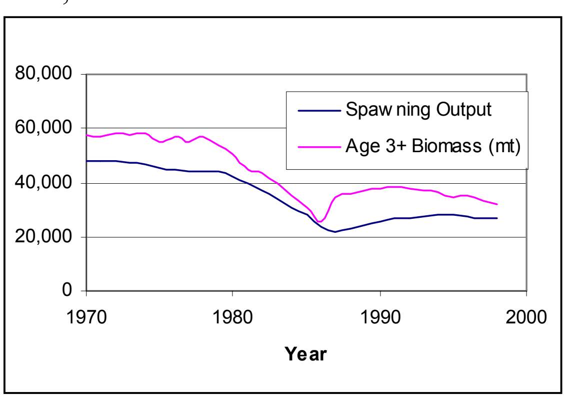
Petrale sole is currently estimated to be in excess of 39% of its unfished spawning biomass (Figure 3.10). The most recent assessment addressed the northern stock (US Vancouver and Columbia areas). Biomass appears to be stable or increasing after an initial fishing down process.

Table 3.4.4Arrowtooth flounder triennial survey biomass (mt).



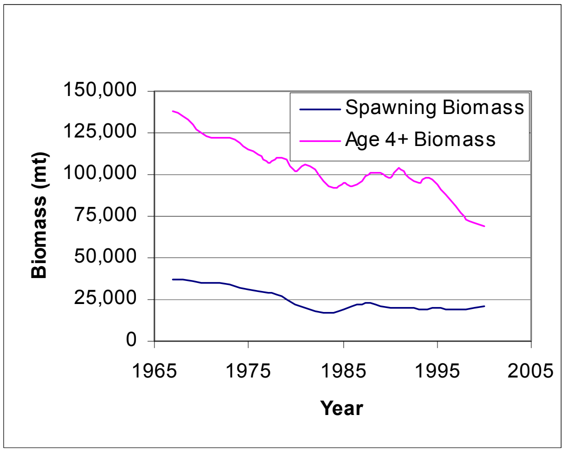
Arrowtooth flounder is at the southern end of its range in the Pacific region, and biomass off the West Coast appears to be highly variable, based on triennial trawl survey results (Figure 3.11). Most of the biomass occurs in the US Vancouver and Columbia areas, and a joint US/Canada assessment is recommended.

Table 3.4.4Chilipepper rockfish biomass trend, 1970 - 2000.



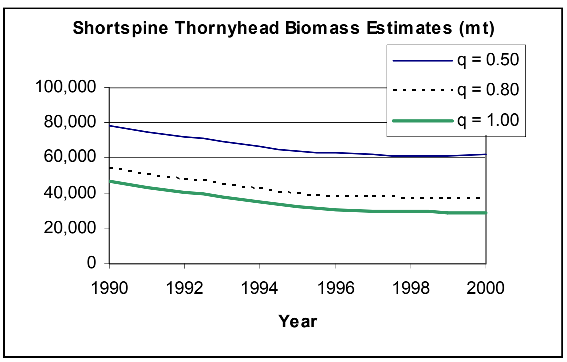
The most recent assessment of chilipepper rockfish in 1998 indicated a decline in biomass, but the stock remains above the target level (Figure 3.12). Chilipepper is managed as part of a complex, and regulations to protect bocaccio rockfish have reduced catches of chilipepper rockfish.

Table 3.4.4Yellowtail rockfish biomass trend, 1967-1997.



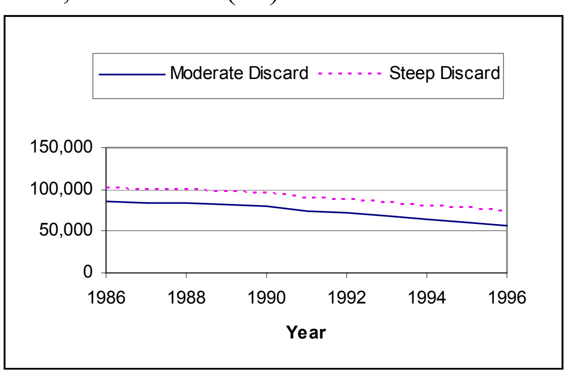
The most recent assessment for yellowtail rockfish in 2000 indicated that there has been a long-term decline in biomass, but the stock remains above the target level (Figure 3.13). Considerable uncertainty remains in the assessment, particularly over the relationship of yellowtail rockfish off the West Coast to those off Canada.

Table 3.4.4Shortspine thornyhead biomass trend, 1990-2000 (mt).



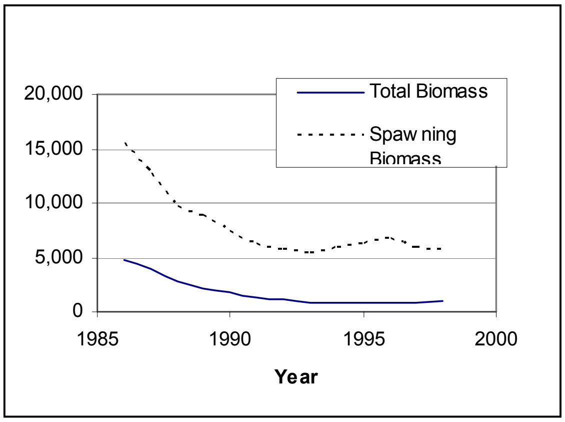
The most recent assessment for shortspine thornyhead in 2001 shows that the stock remains above the overfished level, between 24% and 48% of its unfished biomass (Figure 3.14). Considerable uncertainties remain in the assessments, particularly on the estimates of "q", the survey catchability coefficient.

Table 3.4.4Longspine thornyhead biomass trend, 1990-2000 (mt).



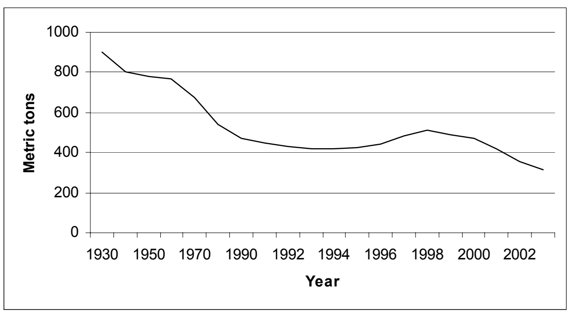
Longspine thornyhead (Figure 3.15) is estimated to be above 40% of its unfished biomass, according to the most recent assessment completed in 1997. One of the uncertainties in the assessment is the level of discard. The biomass trend is similar for both levels of discard, although estimated biomass is lower when a moderate level of discarding is assumed.

Table 3.4.4Black rockfish biomass trend, 1985-2000 (mt).



The black rockfish stock off Washington and Oregon is above the target biomass level (Figure 3.16). Estimated spawning biomass and total biomass declined during the 1980s , but appear to have remained relatively stable during the 1990s. However, uncertainties remain in the assessment.

Table 3.4.4Spawning biomass trend for cabezon in California.



The first West Coast cabezon assessment was prepared in 2004. Very little is currently known about cabezon life history, and even less is known about its population status. There is little direct information on the structure of cabezon stocks; however, the abundance trends for California and Washington are substantially different and the growth curves differ markedly. In addition, the historical fishing patterns are very different in the three states. For these reasons, the assessment treated the cabezon population as two stocks divided at the Oregon-California border. Due to data limitations, only the California stock was assessed (Figure 3.17). The assessment estimated the reproductive output of the California cabezon resource in 2003 to be 34.7% of its virgin level. The current reproductive output is estimated to be 313 mt.

Although the population in Oregon-Washington was not assessed, the available data indicate the population may be dropping rapidly.

3.3.2 Other Relevant Fish, Shellfish and Squid

We have selected twelve non-groundfish species (excluding protected species described in Section 3.3.3 below), identified as emphasis species, to capture the impacts of the alternatives. These twelve species are Pacific halibut, California halibut, pink shrimp, spot prawn, ridgeback prawn, Dungeness crab, jack mackerel, Pacific mackerel, walleye pollock, common thresher shark, and eulachon. These species represent the range of impacts likely experienced by a broader range of species, but with similar life histories, distributions, and vulnerabilities to bycatch impacts. Life histories of emphasis species are summarized below and more detailed descriptions, including available information on stock status, are given in Appendix B. Similar descriptions are also provided in Appendix B for additional species that would likely experience similar impacts under the alternatives. These additional species are blue shark, shortfin Mako shark, Pacific angel shark, Pacific herring, longfin smelt, night smelt, and surf smelt.

> The following non-groundfish have been selected to represent other fish species in order to illustrate the impacts of the alternatives on non-groundfish species that may occur with groundfish.

3.3.2.1 Pacific Halibut

Pacific halibut (*Hippoglossus stenolepis*) ranges from California to the Bering Sea and extends into waters off Russia and Japan. The International Pacific Halibut Commission (IPHC) is responsible for management of Pacific halibut in the Northeast Pacific ocean. Pacific halibut are demersal and inhabit sand and gravel bottoms, especially banks, on the continental shelf. Halibut from California through the Bering Sea are considered to form one homogeneous population. Halibut off the West Coast are at the extreme southern end of their range and those that inhabit West Coast waters result from the southerly migration of juveniles. Halibut spawn during the winter in deep water (1,000 feet or 300 m). Their eggs and larvae rise and drift great distances with the ocean currents in a counter-clockwise direction around the northeast Pacific Ocean. Young fish settle to the bottom in shallow feeding areas. After two or three years, young halibut tend to counter-migrate to more southerly and easterly waters. 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 the winter. Pacific halibut grow to about 500 pounds (227 kg). Females typically grow faster and live longer than males; nearly all halibut over 100 pounds (45 kg) are females. Age of maturity for females is approximately 12 years. Most halibut are less than 25 years old. Halibut are carnivorous. Adults prey upon cod, sablefish, pollock, rockfishes, sculpins, turbot, and other flatfish. They also leave the bottom to feed on sand lance and herring in the water column. Octopus, crabs, clams, and occasionally small halibut are also eaten. Large juvenile and adult halibut are occasionally eaten by marine mammals but are rarely prey for other fish.

3.3.2.2 California Halibut

California halibut (*Paralichthys californicus*) range from the Quillayute River, Washington to Almejas, Baja California, but their abundance and commercial fishery in U.S. waters are concentrated from Bodega Bay to San Diego, California. The State of California manages the California halibut resource off its coast; little fishing or catch occurs off Oregon and Washington. Adults live on soft bottom habitats in coastal water generally less than 300 feet (91 m) deep, with greatest abundance at depths less than 100 feet (30 m). California halibut live up to 30 years and reach 60 inches (153 cm). Male halibut mature at one to three years of age and eight to twelve inches (20 - 30 cm), whereas females mature at four to five years and 15 to 17 inches (38 - 43 cm). Adults spawn throughout the year with peak spawning in winter and spring. Pelagic eggs and larvae drift over the shelf but are in greatest densities within four miles of shore. Newly settled and larger juvenile halibut are usually found in unvegetated shallow-water bays. Juveniles emigrate from the bays to the coast at about one year of age and 6.9 to 8.7 inches (17.5 - 22 cm). Adult California halibut primarily prey upon Pacific sardine, northern anchovies, squid, and white croaker. Small juvenile halibut eat primarily crustaceans.

3.3.2.3 Pink shrimp

Pink shrimp(*Pandalus jordani*), also called ocean shrimp, occur from the Aleutian Islands to San Diego, California. State agencies plus the Washington treaty tribes manage the pink shrimp resource and fisheries off their respective coasts. Pink shrimp occur at depths from 150 to 1,200 feet (46 - 366 m) but are generally found at depths from 240 to 750 feet (73 - 229 m). Concentrations of shrimp remain in well-defined areas or beds from year to year. These areas are associated with green mud and muddy-sand bottoms. Most pink shrimp spend the first year and a half of life as males, then pass through a transitional phase to become females. Pink shrimp adjust their sex ratio to fluctuating age distributions. Mating takes place during September and October. Fertilization takes place when the females begin extruding eggs in October. Females usually carry between 1,000 and 2,000 eggs until the larvae hatch in March and April. The larval period lasts 2½ to three months. Developing juvenile shrimp occupy successively deeper depths, and often begin to show in commercial catches by late summer. Pink shrimp grow in steps by molting or shedding their shells and growth rates vary by region, season, sex and year class. Pink shrimp feed mainly at night on planktonic animals, such as euphausiids and copepods. Many species of fish prey on pink shrimp, including Pacific whiting, arrowtooth flounder, sablefish, petrale sole and several species of rockfish. Predation by whiting may affect the abundance of pink shrimp.

3.3.2.4 Spot Prawn

Spot prawn (*Pandalus platyceros*) ranges from the Aleutian Islands to San Diego, California, and extends to the Sea of Japan and the Korea Strait. Spot prawns are typically found at depths between 653 and 772 feet (198-234 m). Juvenile shrimp concentrate in shallower, inshore areas (<297 feet or 90m) and migrate offshore as they mature. Spot prawn distribution is very patchy and related to water temperature, salinity and physical habitat. Spot prawns typically inhabit rocky or hard bottoms, including reefs, coral or glass-sponge beds, and the edges of marine canyons. Spot prawns can live up to six years off California but longevity decreases in more northerly areas; the average age off Canada is only four years. Spot prawns change sex in midlife. They mature first as males, mate, and then change to females after a transition phase. Sexual maturity is reached during the third year (about 1.5 inches or 38 mm carapace length). By the fourth year (about 1.75 inches or 44 mm carapace length), many males begin to change sex to the transitional stage. By the end of the fourth year, the transitionals become females. Each individual mates once as a male and once or twice as a female. Spawning occurs once each year, typically in late summer or early autumn. Spawning takes place at depths of 500 to 700 feet (151-212 m). Females carry eggs for a period of four to five months before they hatch. Spot prawns produce a few thousand eggs. Eggs hatch over a 10-day period and is completed by April. The larvae spend up to three months in the water column and then begin to settle out at shallow depths. Spot prawns typically feed on other shrimp, plankton, small mollusks, worms, sponges and fish carcasses. They usually forage on the bottom throughout the day and night.

3.3.2.5 Ridgeback Prawn

Ridgeback prawn (*Sicyonia ingentis*) occurs from Monterey, California, to Cedros Island, Baja California. They inhabit depths ranging from less than 145 feet to 525 feet (44 - 160 m). Major concentrations occur in the Ventura-Santa Barbara Channel area, Santa Monica Bay, and off Oceanside. Other pockets of abundance occur off Baja California. Ridgeback prawns inhabit substrates of sand, shell and green mud. Because they are relatively sessile, little or no intermixing occurs. Their maximum life span is five years and sexes are separate. Females reach a maximum carapace length of 1.8 inches (46 mm) and males 1.5 inches (38 mm). Ridgeback prawns are free spawners, in contrast to other shrimps which carry eggs. Both sexes spawn as early as the first year, but most spawn during the second year at a size of 1.2 inches (30 mm). On average, females produce 86,000 eggs. Following spawning, both sexes undergo molting. The food habits of the ridgeback prawn are unknown, but it may feed on detritus like closely related species. Likely predators include rockfish, lingcod, octopus, sharks, halibut, and bat rays.

3.3.2.6 Dungeness Crab

Dungeness crab (*Cancer magister*) and their respective fisheries are managed by the West Coast states and Washington treaty tribes. Dungeness occur in coastal waters along North America from Unalaska Island to Magdalena Bay, Mexico. They are widely distributed over sandy or muddy bottom, generally in waters shallower than 90 feet (27.4 m), but they have been found as deep as 600 feet (183 m). Crabs grow each time they molt. Juveniles molt 11 or 12 times prior to sexual maturity, which may be reached at three years. At four to five years, a Dungeness crab can be over 6.5 inches (16.5 cm) in carapace width and weigh between 2 and 3 pounds (0.9 - 1.4 kg). The estimated maximum life span is between 8 and 13 years. Males mate only with female crabs that have just molted, from spring through fall. A large female crab can carry 2.5 million eggs under her abdomen until hatching. Young planktonic crabs go through six developmental stages before they molt into their first juvenile stage. After molting, the juveniles inhabit shallow coastal waters and estuaries with large numbers living among eelgrass or other habitats with aquatic vegetation. Shell hash is also important habitat for young Dungeness crabs. Dungeness crabs scavenge along the sea floor and their diet includes shrimp, mussels, small crabs, clams, and worms. Cannibalism is common. Young planktonic crabs are important prey for salmon and other fishes. Juveniles are eaten by a variety of fishes in the nearshore area, especially starry flounder, English sole, rock sole, lingcod, cabezon, skates and wolf eels. Octopus may also be an important predator.

3.3.2.7 Market Squid

Market squid (*Loligo opalescens*) is a coastal pelagic species (CPS) managed by the Council. They occur throughout the California and Alaska current systems from the southern tip of Baja California, Mexico, to southeastern Alaska. Market squid are most abundant from Punta Eugenio, Baja California and Monterey Bay, California. Although generally considered pelagic, they are found over the continental shelf from the surface to depths of at least 2,625 feet (800 m). Adults and juveniles are most abundant between temperatures of 10 °C and 16° C. Market squid are small, short-lived molluscs reaching a maximum size of 12 inches (30 cm) total length, including arms. Most mature and spawn when about one year old, then die. Spawning along the West Coast occurs year-round. Spawning squid concentrate in dense schools. Known major spawning areas are shallow semi-protected nearshore areas with sandy or mud bottoms adjacent to submarine canyons. In these locations, egg deposition occurs between 1.5 and 17 feet (5-55 m). Females produce 20 to 30 capsules and each capsule contains 200 to 300 eggs. Females attach each egg capsule individually to the substrate. As spawning continues, mounds of egg capsules covering more than 100 square meters (1076 sq. ft.) may be formed. Hatchlings are dispersed by currents, and their distribution after leaving the spawning areas is largely unknown. Market squid are important forage to a long list of fish, birds, and mammals. Some of the more important squid predators are chinook salmon, coho salmon, lingcod, rockfish, harbor seals, California sea lions, sea otters, elephant seals, Dall's porpoise, sooty shearwater, Brandt's cormorant, rhinoceros auklet and common murre.

3.3.2.8 Jack Mackerel

Jack mackerel (*Trachurus symmetricus*) is a coastal pelagic species (CPS) managed by the Council. It is a widely distributed, schooling fish throughout the northeastern Pacific Ocean and much of their range lies outside the EEZ. Young fish, up to six years old, are most abundant in the Southern California Bight and school over shallow rocky banks. Older fish, 16 to 30 years old are generally found offshore in deep water and along the coastline to the north of Point Conception. They are more available on offshore banks in late spring, summer, and early fall than during the remainder of the year. They remain near the bottom or under kelp canopies during daylight and move into deeper nearby areas at night. Young juveniles are sometimes found in small schools beneath floating kelp and debris in the open ocean. Jack mackerel live 35 years or more. Half or more of all females reach sexual maturity during their first year of life. The spawning season for jack mackerel off California extends from February to October, with peak activity from March to July. Larval jack mackerel feed almost entirely on copepods. Small jack mackerel off southern California eat large zooplankton, juvenile squid, and anchovy. Large mackerel offshore primarily prey upon euphausiids, but also on small fishes. Large predators, such as tuna and billfish, and some marine mammals, like seals and sea lions, prey upon jack mackerel.

3.3.2.9 Pacific (Chub) Mackerel

Pacific mackerel (*Scomber japonicus*) is a coastal pelagic species (CPS) and one of three spawning stocks along the Pacific coasts of the US and Mexico. Only the northeastern Pacific stock extending northward from Punta Abreojos, Baja California is harvested by US fishers and managed by the Council. This stock is common from Monterey Bay to Cabo San Lucas. Pacific mackerel usually occur within 20 miles of shore, but have been taken as far offshore as 250 miles. Adults inhabit water ranging from 10°C to 22.2°C and they may move north in summer and south in winter between Tillamook, Oregon and Magdalena Bay, Baja California. They are found from the surface to depths of 300 meters and commonly occur near shallow banks. Juveniles are found off sandy beaches, around kelp beds, and in open bays. Larvae are found in water around 14°C. Pacific mackerel often school with other pelagic species, particularly jack mackerel and Pacific sardine. Pacific mackerel may reach 63 cm in length and 11 years in age. Age of maturity is two to four years. Spawning peaks from late April to July. Juvenile and adult Pacific mackerel prey upon small fish, fish larvae, squid and pelagic crustaceans. Juveniles and adults are eaten by larger fish, marine mammals, and seabirds. Pacific mackerel larvae are preyed upon by a number of invertebrate and vertebrate planktivores.

3.3.2.10 Walleye Pollock

Pollock (*Theragra chalogramma*) 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 along the Canadian and U.S. West Coast to Carmel, California. Adult walleye pollock are generally semi-demersal species on continental shelf and slope. A variety of environmental factors, including hydrographic fronts, temperature, light intensity, prey availability, and depth determine the distribution of juveniles and adults. They are not common off the West Coast, but occasionally sufficiently large enough numbers move south from Canadian waters to be targeted by West Coast commercial fishers. Adults most commonly occur between 100 and 300m. Most pollock are mature by age three. Spawning takes place at depths of 50 to 300m. Walleye pollock are oviparous and females spawn several batches of eggs, usually in deep water over a short period of time. Eggs are pelagic and are found throughout the water column. Larvae and juveniles are pelagic, and are generally found in the upper water column to depths of 60m. Adults are carnivorous and feed primarily on euphausiids, small fishes, copepods, and amphipods. In some areas, cannibalism can be an important food source for adults.

3.3.2.11 Common Thresher Shark

Thresher shark (*Alopias vulpinus*) is a highly migratory species (HMS). It is a large pelagic shark with a circumglobal distribution. In the northeastern Pacific, it occurs from Goose Bay, British Columbia south to Baja California. Abundance is thought to decrease rapidly beyond 40 miles from the coast, although catches off California and Oregon do occur as far as 100 miles offshore. This species is often associated with areas of high biological productivity, strong frontal zones separating regions of upwelling and adjacent waters, and strong horizontal and vertical mixing of surface and subsurface waters. They may migrate north-south seasonally between San Diego/Baja Mexico and Oregon and Washington. Large adults may pass through southern California waters in early spring of the year, remaining in offshore waters from one to two months for pupping. Pups are then thought to move into shallow coastal waters. Adults then continue to follow warming water and perhaps prey northward, and by late summer, arrive off Oregon and Washington. Subadults appear to arrive in southern California waters during the early summer, and as summer progresses move up the coast as far north as San Francisco, with some moving as far as the Columbia River. In the fall, these subadults are thought to move south again. Little is known about the presumed southward migration of the large adults, which do not appear along the coast until the following spring. The common thresher shark bears live young, usually 2-4 pups. Birth is believed to occur in the spring months off California. Size and age of first maturity for females is likely between 8.5-9 feet (260-270 cm) and about 4 or 5 years old. For males, size and age of first maturity is between 8-11 feet (246-333 cm) and 3 to 6 years. This species has been variously reported to reach a maximum age of from 19 to 50 years old. Primary prey items in the diet of the common thresher shark taken in the California-Oregon drift gillnet fishery included anchovy, sardine, Pacific whiting, mackerels, shortbelly rockfish, and market squid.

3.3.2.12 Eulachon

Eulachon (*Thaleichthys pacificus)* range from central California to Alaska. Off the West Coast, eulachon are managed by the respective states. Eulachon are anadromous, spending most of their life in the open ocean, schooling at depths of 150 to 750 feet (46 - 229 m). They migrate to lower reaches of coastal rivers and streams to spawn in fresh water; the largest run occurs in the Columbia River, where occasionally they travel over 100 miles upriver. Eulachon may live up to five years and reach 12 inches (30.5 cm) in length. Most eulachon reach maturity in two to three years and die after spawning. Each female lays about 25,000 eggs which stick to the gravel and hatch in two to three weeks. Upon hatching, larvae begin migrating to the sea. Eulachon feed mainly on euphasiids, copepods and other crustaceans, and they are a very important food for predatory marine animals, including salmon, halibut, cod and sturgeon.

3.3.3 Marine Mammals, Seabirds, Turtles and Salmon: Protected Species

Several species of marine mammals, seabirds, sea turtles and salmon on the West Coast have been listed as threatened or endangered 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 portion, of its range. The species listed in Table 3.3.1 are subject to the conservation and management requirements of the ESA.

In addition to these federally protected species, California lists several seabirds as endangered or species of special concern under the California Endangered Species Act. These include brown pelican, marbled murrelet, Xanthus murrelet, rhinoceros auklet, and tufted puffin.

> The following species are emphasized in this EIS:
> Steller sea lion
> California sea lion
> northern elephant seal
> harbor seal
> Dall's porpoise
> Pacific white-sided dolphin
> northern fulmars
> gulls
> Laysan albatross
> black-footed albatross
> chinook salmon
> coho salmon

Some of these species and other marine mammals and seabirds are taken incidentally in West Coast groundfish fisheries and are therefore, especially relevant to bycatch issues. They are termed emphasis species (or species groups) for purposes of discussion of the alternatives in Chapter 4 and include 6 marine mammals, 4 seabirds and 2 salmon species. The marine mammals are Steller sea lion, California sea lion, northern elephant seal, harbor seal, Dall's porpoise and Pacific white-sided dolphin. Although more than 100 species of seabirds occur along the West Coast, little information is available about the incidental take of

Table 3.4.1. West Coast species listed under the ESA.

Marine Mammals
Threatened
Steller sea lion (*Eumetopias jubatus*) Eastern Stock; Guadalupe fur seal (*Arctocephalus townsendi*); Southern sea otter (*Enhydra lutris*) California Stock
Seabirds
Endangered
Short-tail albatross (*Phoebastria (=Diomedea) albatrus*), California brown pelican (*Pelecanus occidentalis*); California least tern (*Sterna antillarum browni*)
Threatened
Marbled murrelet (*Brachyramphs marmoratus*).
Sea Turtles
Endangered
Green turtle (*Chelonia mydas*); Leatherback turtle (*Dermochelys coriacea*); Olive ridly turtle (*Lepidochelys olivacea*)
Threatened
Loggerhead turtle (*Caretta caretta*)
Salmon
Endangered
Chinook salmon (*Oncorhynchus tshawytscha)* - Sacramento River Winter; Upper Columbia Spring
Sockeye salmon (*Oncorhynchus nerka)* - Snake River
Steelhead trout (*Oncorhynchus mykiss)* - Southern California; Upper Columbia
Threatened
Coho salmon (*Oncorhynchus kisutch)* - Central California, Southern Oregon, and Northern California Coasts
Chinook salmon (*Oncorhynchus tshawytscha*) - Snake River Fall, Spring, and Summer; Puget Sound; Lower Columbia; Upper Willamette; Central Valley Spring; California Coastal
Chum salmon (*Oncorhynchus keta)* - Hood Canal Summer; Columbia River
Sockeye salmon (*Oncorhynchus nerka)* - Ozette Lake
Steelhead trout (*Oncorhynchus mykiss)* - South-Central California, Central California Coast, Snake River Basin, Lower Columbia, California Central Valley, Upper Willamette, Middle Columbia, Northern California

seabirds by West Coast groundfish fisheries. Observers aboard groundfish vessels off the West Coast during August 2001-October 2002 reported four cormorants and one gull were taken by the limited entry trawl fleet. To approximate the impact of alternatives in Chapter 4, it is assumed that any species taken by West Coast longline fisheries will be similar to the incidental takes by Alaskan longliners, for which some information is available. Seabirds taken by Alaska longliners, and considered emphasis species are northern fulmars, gulls, Laysan albatross, and black-footed albatross. No sea turtles are included as emphasis species because there is minimal turtle take by West Coast groundfish fisheries. Chinook (king) and coho (silver) salmon are included as emphasis species.

Life histories are described below for each of these emphasis species. More detailed information is provided in Appendix B, as well as descriptions for other marine mammals, sea birds, and sea turtles that occur on the West Coast.

3.3.3.1 Steller (Northern) Sea Lion

Steller sea lions *(Eumetopias jubatus*) range along the North Pacific Ocean from Japan to California. Two stocks are designated in U.S. waters with the eastern stock extending from Cape Suckling, Alaska to southern California with a total of 6,555 animals off Washington, Oregon and California. 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.

3.3.3.2 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. The population is estimated at 214,000 sea lions. During the summer breeding season, most adults are present near rookeries principally located on the southern California Channel Islands and Año 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, Pacific whiting, and salmon.

3.3.3.3 Northern Elephant Seal

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 on islands and recently at some mainland sites. The population was estimated 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.

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. They feed mainly at night in very deep water to consume whiting, skates, rays, sharks, cephalopods, shrimp, euphasiids, and pelagic red crab. Males feed in waters off Alaska, and females off Oregon and California.

3.3.3.4 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. The California stock is estimated at 30,293 seals; the Oregon/ Washington Coast stock at 26,180 seals; and the Washington inland-water stock at 16,056 seals. Harbor seals do not migrate extensively, but have been documented to move along the coast between feeding and breeding locations. The harbor seal diet includes herring, flounder, sculpin, cephalopods, whelks, shrimp, and amphipods.

3.3.3.5 Dall's Porpoise

Dall's porpoise *(Phocoenoides dalli*) are common in shelf, slope and offshore waters in the north eastern Pacific Ocean down to southern California. As a deep water oceanic porpoise, they are often sighted nearshore over deepwater canyons. These porpoise are abundant and widely distributed with at least 50,000 off California, Oregon, and Washington; however, because of their behavior of approaching vessels at sea, it may be difficult to obtain an unbiased estimate of abundance. Dall's porpoise calf between spring and fall after a 10-11 month gestation period. 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.

3.3.3.6 Pacific White-Sided Dolphin

Pacific white-sided dolphin *(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. Little is known of their reproductive biology. Longevity is not known although a 29- year-old pregnant female has been reported. White-sided dolphins inhabit California waters during winter months moving northward into Oregon and Washington during spring and summer. 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, Pacific whiting, herrings, sardines, and octopus.

3.3.3.7 Northern fulmar

Northern fulmar *(Fulmarus glacialis)* ranges along the Pacific 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. 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. 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.

3.3.3.8 Gulls

Gulls (*Larus* spp.) that occur along the Pacific Coast 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. However, it is thought that most gull populations along the Pacific Coast are stable and not considered to be at risk. Most gulls along the Pacific 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 Pacific 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. Breeding habitat for these gulls includes coastal cliffs, rocks, grassy slopes or offshore rock or sandbar islands. Pacific Coast gulls feed at the ocean's surface and their diet typically includes fishes, mollusks, crustaceans, carrion, and garbage.

3.3.3.9 Laysan Albatross

Laysan albatross (*Phoebastria immutabilis*) is the most abundant North Pacific albatross species. The vast majority of the Laysan albatross population breeds on 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. Surveys at three sites indicate breeding populations total about 400,000 breeding pairs, but this represents an average decline of 3.2% per year since 1992. Laysan albatross feed on schooling fish and squid at the ocean's surface.

3.3.3.10 Black-Footed Albatross

Black-footed albatross (*Phoebastria nigripes*) ranges throughout the North Pacific. Breeding occurs on northwestern Hawaiian Islands and Torishima Island and the species disperses from the Bering Sea south along the Pacific Coast to California. Black-footed albatross is the most numerous albatross species along the Pacific Coast and is present throughout the year. The global black-footed albatross population is estimated at about 56,500 breeding pairs and is thought to be decreasing. Black-footed albatross feed 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.

3.3.3.11 Chinook (King) Salmon

Chinook salmon (*Oncorhynchus tshawytscha*) range widely throughout the north Pacific Ocean and the Bering Sea, and as far south as the U.S./Mexico border. After leaving the freshwater and estuarine environment, juvenile chinook disperse to marine feeding areas. Some tend to be coastal-oriented, preferring protected waters and waters along the continental shelf. In contrast, others pass quickly through estuaries, are highly migratory, and may migrate great distances into the open ocean. Chinook salmon typically remain at sea for one to six years. They are most abundant at depths of 30-70m and often associated with bottom topography. However, during their first several months at sea, juveniles are predominantly found at depths less than 37 m and are distributed in the water column. Juvenile chinook are generally found within 55 km of the U.S. West Coast, with the vast majority of fish found less than 28 km offshore. Concentrations may be found in areas of intense upwelling. The historic southern edge of their marine distribution appears to be near Point Conception, California. Throughout their range, adult chinook salmon enter freshwater during almost any month of the year. For example, chinook enter the Columbia River between March and November and the Sacramento River between December and July. Chinook salmon mature at a wide range of ages, from two to eight years. Most adult females are 65-85 cm in length and males are 50-85 cm, although fish larger than 100cm are not uncommon. Chinook salmon are the most piscivorous of the Pacific salmon. Fish make up the largest part of their diet, but squids, pelagic amphipods, copepods, and euphausiids are also important.

3.3.3.12 Coho (Silver) Salmon

Coho salmon (*Oncorhynchus kisutch*), also called silver salmon, are a commercially and recreationally important species. They are found in small rivers and streams throughout much of the Pacific Rim, from central California to Korea and northern Hokkaido, Japan. Coho salmon spawn in freshwater streams, juveniles rear for at least one year in fresh water and spend about 18 months at sea before reaching maturity as adults. North American populations are widely distributed along the Pacific coast and spawn in tributaries to most major river basins from the San Lorenzo River in Monterey Bay, California, to Point Hope, Alaska. Two primary dispersal patterns have been observed in coho salmon after emigrating from freshwater. Some juveniles spend several weeks in coastal waters before migrating northwards into offshore waters of the Pacific Ocean while others remain in coastal water near their natal stream for at least the first summer before migrating north. The latter dispersal pattern is commonly seen in coho salmon from California, Oregon, and Washington. Coho salmon rarely use areas where sea surface temperature exceeds 15° C and are generally found within the uppermost 10 m of the water column. While juvenile and maturing coho are found in the open north Pacific, the highest concentrations appear to be found in more productive waters of the continental shelf within 60 km of the coast. Adults enter fresh water during October and November in Washington and Oregon and during December and January in California. Marine invertebrates, such as copepods, euphausiids, amphipods, and crab larvae, are the primary food when coho first enter salt water. Fish represent an increasing proportion of coho salmon diet as they grow and mature.

3.3.4 Miscellaneous Species

Commercial and recreational fisheries for groundfish take various other fish, including finfish, shellfish, corals and other invertebrates. There is little information about the amounts or distribution of such bycatch. Although gear size and configuration and fishing operations are not the same as for commercial fisheries, information available from groundfish assessment surveys with bottom trawl gear can give an indication of the potential types of bycatch of benthic animals. In these surveys, a variety of benthos are taken, including sea urchins, starfish, snails, octopuses, various crustaceans and small fishes. At times, coral, sponges, and other animals may be taken or damaged during fishing (and survey) operations, but the distributions of these benthic animals are poorly known on the West Coast. Pot and longline fisheries may also take some of these animals, but little is known about this bycatch.

3.3.5 Biological Associations

Most bottom-dwelling groundfish are currently managed based on distinction between nearshore, continental shelf, and continental slope species. For example, rockfishes are managed as assemblages of species grouped into nearshore, shelf, and slope categories (PFMC 2004). These categories reflect differences in fisheries catch compositions and are based primarily on depth which, in combination with distance from shore, roughly characterizes ecological zones. In addition,

> Biological associations are dynamic, changing with time of day, season, life history stage, prey availability, mating opportunities, and environmental variables. Within each of the five regional environments, species associations also vary with depth and latitude. This results in substantial variability in encounter rates in various fisheries.

groundfish that live higher in the water column are managed differently than those living on the bottom. Some groundfish, such as Pacific whiting and shortbelly rockfish inhabit midwater along the coast. For many species, the biogeographic zone varies by life history stage; many groundfish produce pelagic larvae, and juveniles of many species are more commonly found in nearshore areas than as adults. These biogeographic zones also have a north south component, with Cape Mendocino representing an important break in the distribution of many groundfish species (particularly rockfish), hence the use of 40°10' N latitude to separate northern and southern management regions. Finally, particular species may exhibit seasonal migrations, producing some annual variation in the characteristics of these different ecological zones. The nearshore, shelf, slope and pelagic environments can be characterized by combinations of the habitats described below, the species associations (and life stages) particular to these environments, and the trophic relationships between these species. Biological associations are dynamic, changing with time of day, season, life history stage, prey availability, mating opportunities, and environmental variables. Within each of the five regional environments, species associations also vary with depth and latitude. Of necessity, characterization of biological associations in the following sections provides only broad generalizations based on the available information. Most of the information also only pertains to adults; references to other life stages are noted as such.

Non-groundfish species, including other finfish, shellfish, marine mammals, marine birds, and sea turtles, also occupy specific biogeographic zones, often similar to those occupied by various groundfish species. For example, pink shrimp and Pacific halibut co-occur with several flatfish species on the northern shelf. Marine mammal communities are pelagic, but some are found primarily in nearshore waters, whereas others are more common over the shelf or slope. Sea turtles occur in midwater and sea birds are found primarily in or near surface waters all along the West Coast.

Information collected to understand biological associations of West Coast groundfish comes primarily from three sources: fishing activities, research surveys, and research studies. All of the means to collect information have limitations for the purpose of characterizing biological associations. Fishing, survey activities and research studies are often quite limited by gear selectivities, and temporal and spatial scales. Consequently, our understanding of biological associations and ecological relationships for West Coast groundfish is incomplete.

3.3.5.1 Northern Shelf Environment

The boundaries of the northern shelf environment are 40° 10' N. Lat. (Cape Mendocino) on the south and the US/Canada border to the north, and between 20 and 109 fm, up to 5.5 fm off the sea floor.

Emphasis species that commonly occur on the northern shelf include four overfished groundfish species, as well as arrowtooth flounder, English sole, yellowtail rockfish, Pacific halibut and pink shrimp. The overfished groundfish species are lingcod, canary rockfish, yelloweye rockfish, and bocaccio. Associations among these and other species, as well as habitat on the northern shelf, are more fully described below.

Marine mammals, marine birds, and sea turtles may only occasionally occur near the bottom on the northern shelf and are not considered in the northern shelf environment. These species are considered as part of the pelagic environment (Section 3.3.5.4).

Habitat Off the West Coast, the continental shelf generally broadens from south to north. It widens from a few miles at Cape Mendocino to about 50 miles off northern Washington and generally slopes gently westward. Bordering the nearshore zone, the shelf extends seaward to about 100 fm.

The shoreward edge of the shelf off Oregon is usually composed of soft substrates, primarily sand or green mud. This expanse of soft substrate is interrupted by prominent rocky banks, especially at the seaward edge of the shelf. These banks, such as Heceta Bank, Coquille Bank, Daisy Bank and Stonewall Bank, contain unique habitats formed by varied combinations of rock ridges, boulders, cobbles and pebbles. For example, submersible operations at Heceta Bank showed that diagonally stacked ridges are separated by sand, pebble, and cobble-filled depressions. A narrow band of precipitous pinnacles is located on the edge of the bank and large, round boulders are found on the eastward slope, which gradually fades to cobble and finally mud. In comparison, Coquille Bank is comprised largely of siltstone and mudstone and characterized by eroded, flat, slab-like boulders which were mostly covered by a layer of silt. No rocky ridges were observed on the bank (Barss 1994).

Off Washington, broad fans of gravel created by retreating glaciers from the northern Cascade and Olympic mountains, produce structural habitat on the seafloor. Similarly, empty shells from mussels and gastropods, and deposits of other biogenic debris, such as coral skeletons, sponge spicules, urchin tests (shells), and worm tubes, provide some shelter for fish and attachment substrate for invertebrates.

Submarine canyons, such as Astoria Canyon off the Columbia River, are also prominent features of the northern shelf. Canyon habitat is structurally complex and diverse. It is characterized by vertical walls (textured with joints, fractures and overhangs), ledges, talus slopes, and the canyon floor covered with cobble, boulder and mud substrates.

Climatic conditions influence productivity; the duration and strength of winds favorable for upwelling along the West Coast diminish northward. Wind velocities and upwelling are variable but tend to be at a maximum in the spring to early summer in the region between Point Conception (34.5° N) and the Oregon border (42° N). Off Washington upwelling is relatively minor and is largely restricted to the late spring to early fall; winter storms there result in intense downwelling events (Leet, *et al.* 2001).

Bottom water temperatures on the northern shelf make good habitat for sub-arctic and cold-temperate species. Summertime bottom temperatures observed during the 1986-1998 West Coast triennial bottom trawl surveys ranged between about 7° C and 8.5° C (Shaw, *et al.* 2000).

Biological Associations Plant life on the shelf is small and sparse. Light does not usually penetrate below 60 fm, so algae are not found below that depth (Barss1994).

Non-rocky substrates are commonly used by pink shrimp, sea pens, and weathervane scallops. In addition, English sole, petrale sole, arrowtooth flounder, Pacific halibut, big skate and longnose skate frequently co-occur on or very near the bottom in these areas. Hagfish also occur over soft substrates. All flatfish species inhabit the non-rocky substrates on the northern shelf (EFH appendix), but their distributions differ by depth and substrate type (e.g., mud versus sand). Although their distributions overlap, adult arrowtooth flounder, rex sole, curlfin sole, Dover sole, rock sole and petrale sole also occupy deeper waters than sand sole and starry flounder (EFH appendix). Sablefish (particularly juveniles), spiny dogfish, ratfish and soupfin shark also cruise over these soft bottom habitats, in search of prey. Some nearshore species, such as blue rockfish, and deeper dwelling species like yellowtail rockfish, Pacific Ocean perch and Pacific whiting move into these areas to feed.

Banks create locally shallow areas in the otherwise deeper water of the shelf and are highly productive. Rocky substrates are often covered with a distinct and diverse suite of invertebrate species including sponges, corals, anemones, crinoids, hydroids, tunicates, bryozoans, tube worms, mussels, and other animals. These creatures form a structurally complex environment for other animals, such as brittle stars, shrimp, clams, mussels, barnacles, worms, crabs and fishes.

Common fish species in rocky habitats on the northern shelf include yellowtail, canary, sharpchin, greenstriped, pygmy and rosethorn rockfishes, kelp greenling, and lingcod. Many juvenile rockfishes inhabit these areas, and dense schools above the shallower rocky ridges have been observed at Heceta Bank. These isolated rocky areas may serve as nursery grounds especially in areas where other suitable nursery habitat is unavailable.

Common fish and invertebrates seen in submersible operations at various habitat types on Heceta Bank and Coquille Bank are summarized in the Table 3.3.3 (Barss 1994).

Table 3.3.3. Species observed in submersible operations at Heceta and Coquille Bank.

NEARSHORE-SAND & MUD	ROCK RIDGE & PINNACLES	BOULDER-COBBLE	MUD
English sole petrale sole rex sole slender sole hagfish ocean shrimp sea pens scallops	juvenile rockfishes yellowtail rockfish widow rockfish basketstars anemones coral sponges crinoids	pygmy rockfish sharpchin rockfish juvenile rockfishes yellowtail rockfish canary rockfish widow rockfish rosethorn rockfish lingcod greenling yelloweye rockfish bocaccio crinoids sponges anemones shrimp sea cucumbers sea stars octopus	Dover sole rex sole slender sole sablefish thornyheads splitnose rockfish ratfish poachers eelpouts hagfish fragile urchins sea cucumbers snails sun stars brittle stars euphausiids box crabs hermit crabs

Species associations vary during the year, generally related to feeding, growth, and reproduction. Many species make seasonal spawning migrations; for example, female lingcod move to shallow water during the winter to lay their eggs in nests. Dover sole and sablefish are common on the continental slope but make seasonal migrations onto the shelf. Juveniles of many groundfish species also move to deeper areas as they grow and take advantage of new prey sizes and species.

As on rocky banks, invertebrates, such as crinoids, sea anemones, and sponges create additional structural habitat and diversity in submarine canyons. Information about species that commonly inhabit canyons on the northern shelf is very limited, although soupfin sharks and sablefish reportedly are associated with canyons, along with other habitats (See EFH appendix).

Emphasis Species Canary, yellowtail, widow and silvergray rockfish, lingcod and sablefish frequently co-occur in areas of the continental shelf. Although widow rockfish often occur near bottom, they more commonly inhabit midwater and are considered a component of the pelagic complex (Section 3.3.5.4).

Yelloweye rockfish are generally a solitary, rocky reef fish. Researchers have observed adult yelloweye rockfish associated with bocaccio, cowcod, greeenspotted, and tiger rockfish (Appendix B).

Adult bocaccio have two primary habitat preferences: some are semipelagic, forming loose schools above rocky areas; and some are non-schooling, solitary individuals (EFH appendix). Solitary bocaccio have been found in association with large sea anemones. Bocaccio are often caught with chilipepper rockfish and have been observed schooling with speckled, vermilion, widow and yellowtail rockfish (Appendix B).

English sole, petrale sole, arrowtooth flounder, Pacific halibut, big skate and longnose skate frequently co-occur. Although distributions of English sole and arrowtooth flounder overlap, arrowtooth flounder are much more abundant at deeper depths in the northernmost areas, especially off Cape Flattery, Washington. English sole are most common in the shallower waters all along the shelf. Although fishing and survey reports indicate Pacific halibut frequently occur at Heceta and other banks on the northern shelf, they probably occupy areas of low-relief and soft substrates on these banks.

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. Predation by whiting may affect the abundance of pink shrimp (Appendix B). The list of common groundfish species inhabiting rocky and non-rocky substrates in the Northern Shelf Environment is presented in Table 3.3.4 below. Other relevant fish and shellfish species to groundfish bycatch on the northern shelf are also included in the list.

Table 3.3.4. Species associations in the **Northern Shelf Environment**. Emphasis species are shown in bold; minor species are not included.

ROCKY SUBSTRATES	NON-ROCKY SUBSTRATES
Lingcod	**Arrowtooth Flounder**
Canary Rockfish	**English Sole**
Yelloweye Rockfish	**Pacific Halibut**
Yellowtail Rockfish	**Ocean Shrimp**
Bocaccio	Sablefish
Chilipepper Rockfish	Dover Sole
Greenstriped Rockfish	Pacific Sanddab
Redstripe Rockfish	Petrale Sole
Rosethorn Rockfish	Rex Sole
Silvergray Rockfish	Sand Sole
Tiger Rockfish	Soupfin Shark
Vermilion Rockfish	Spiny Dogfish
Spiny Dogfish	Big Skate
Ratfish	Dungeness Crab
Spot Prawn	

3.3.5.2 Southern Shelf Environment

The boundaries of the southern shelf environment are 40°10' N. Lat. (Cape Mendocino) on the north and the US/Mexico border to the south, and between 20 and 109 fm, up to 5.5 fm off the sea floor.

Emphasis species that commonly occur on the southern shelf include two overfished species, as well as chilipepper rockfish and ridgeback prawn. The overfished groundfish species are bocaccio and cowcod. Associations among these and other species, as well as habitat on the southern shelf, are more fully described below.

Marine mammals, marine birds, and sea turtles may only occasionally occur near the bottom on the southern shelf and are not considered in the southern shelf environment. These species are considered as part of the pelagic environment (Section 3.3.5.4).

Habitat The continental shelf diminishes southward along the California coast, from its widest (about 50 nm) at Cape Mendocino to its narrowest, only a few miles wide along the Southern California Bight. The shelf also forms very narrow rings around several islands in the Southern California Bight which rise sharply from the deep sea floor.

The southern shelf is comprised of similar substrate types as the northern shelf, although species assemblages are often different, largely due to the warmer waters south of Cape Mendocino. In addition to banks, reefs, and sandy or muddy bottoms like those described for the north, canyons are a prominent feature of the shelf. Submersible observations at depths from 40 to 150 fm in Soquel Canyon, Monterey Bay revealed a structurally diverse habitat, comprised of vertical walls (with joints, fractures, and overhangs), ledges, talus slopes, and a canyon floor with cobble, boulder and mud substrates. Invertebrates such as crinoids, sea anemones, and sponges create additional structural diversity.

Biological Associations Many of the species that co-occur on rocky and non-rocky substrates on the northern shelf similarly co-occur on the southern shelf, particularly between Cape Mendocino and the Southern California Bight. Redstripe, rosethorn, and silvergray rockfish are minor species associated with rocky substrates on the southern shelf but are considered more important on the northern shelf. In contrast, greenblotched, greenspotted, and Mexican rockfish and California scorpionfish are important species associated with rocky substrates on the southern shelf, but not in the north. Non-rocky substrates are more abundant on the northern shelf and consequently, flatfishes and pink shrimp are typically more important in the north.

Submersible observations of benthic rockfishes in Soquel Canyon revealed six distinct habitat guilds. In general, small species were associated with mud and cobble substrates of low relief and larger species were associated with high-relief habitat (Table 3.3.5). Some of these guilds observed at Soquel Canyon were remarkably similar to observations at several other sites along the Pacific Coast from Central California to Alaska. Sedentary fishes, such as bocaccio, lingcod, cowcod, greenblotched, greenspotted and yelloweye rockfish, were primarily sheltered under ledges, in crevices, and among large sea anemones on an isolated rock outcrop (Yoklavich, *et al.* 2000).

Table 3.3.5. Main habitat guilds observed in Soquel Canyon (from Yoklavich, *et al.* 2000.)

Mud	Cobble-Mud Mud-Pebble	Mud-Cobble Mud-Rock	Boulder-Mud	Mud-Boulder Rock-Mud Rock Ridge	Rock- Boulder
Stripetail R Dover sole Agonidae Shortspine Th	Halfbanded R Greenstriped R Greenspotted R Pygmy R	Stripetail R Rosethorn R Agonidae Greenspotted R Greenstriped R	Rosethorn R Greenspotted R Bocaccio	Bocaccio Rosethorn R Greenspotted R	Pygmy R Bocaccio

Emphasis Species Bocaccio occur in a wide variety of habitats, often on or near bottom features but sometimes over muddy bottoms. Adult bocaccio are often caught with chilipepper rockfish and have been observed schooling with speckled, vermilion, widow and yellowtail rockfish. Chilipepper rockfish occur over the lower shelf and upper slope at depths between 41 and 168 fm. They are semi-pelagic and are found on deep rocky reefs as well as sand and mud bottoms. At times, they form large schools. Adult cowcod inhabit the lower shelf and upper slope, primarily at depths between 82 and 164 fm in the Southern California Bight. They are often found on bottoms with high relief such as rocky reefs. Two cowcod conservation areas encompassing most of their known habitat were established to provide protection to this overfished species. Ridgeback prawns occur only south of Monterey, California, at depths ranging from 24 to 87 fm. They inhabit substrates of sand, shell and green mud. Species associations for common groundfish and other species in the Southern Shelf Environment are listed in Table 3.3.6.

Table 3.3.6. Species associations in the **Southern Shelf Environment**. Emphasis species are shown in bold; minor species are not included.

ROCKY SUBSTRATES	NON-ROCKY SUBSTRATES
Bocaccio **Cowcod** **Chilipepper** Lingcod Canary Rockfish Yelloweye Rockfish California Scorpionfish Greenblotched Rockfish Greenspotted Rockfish Greenstriped Rockfish Mexican Rockfish Tiger Rockfish Vermilion Rockfish Yellowtail Rockfish Spiny Dogfish Ratfish Spot Prawn	**Ridgeback Prawn** Sablefish California Scorpionfish Dover Sole English Sole Pacific Sanddab Petrale Sole Rex Sole Spiny Dogfish Big Skate Pacific Halibut Dungeness Crab

3.3.5.3 Slope Environment

The slope environment is bounded by the US/Canada and US/Mexico borders to the north and south, respectively, and depths greater than 109 fm, up to 11 fm off the sea floor. The slope extends westward onto the deep continental basin (>1000 fm), which covers most of the EEZ.

Emphasis species that commonly occur on the slope include two overfished species, as well as Dover sole, sablefish, shortspine thornyhead, longspine thornyhead, and spot prawn. The overfished groundfish species are darkblotched rockfish and Pacific ocean perch. Associations among these and other species, as well as habitat on the slope, are more fully described below.

Marine mammals, marine birds, and sea turtles may only occasionally occur near the bottom on the slope and are not considered in the slope environment. These species are considered as part of the pelagic environment (Section 3.3.5.4).

Habitat The continental slope forms a narrow, steep strip at the seaward edge of the continental shelf. Except for the Southern California Bight, the slope drops rapidly from approximately 100 fm to 1,000 fm, less than 50 miles from shore. The islands of the Southern California Bight rise sharply from depths of about

1,000 fm. Beyond 1,000 fm, the bottom gradually slopes downward, to depths of 2,000 fm to form the continental basin which comprises most of the EEZ.

Relatively little is known about bottom types and their distributions on the continental slope. Descriptions of bottom type have been generally identified as hard or soft, often based on experiences with bottom gear during fishing operations. An oxygen minimum zone occurs on the deep slope; thornyheads spawn in this zone at about 300-500 fm.

Biological Associations Little is known about biological associations on the deep, steep slope. Most information comes from co-occurrence of species in fisheries catches. Aurora, bank, blackgill, rougheye, sharpchin, shortraker and yellowmouth rockfish are considered important slope groundfish species on hard bottom. Bank, redbanded, rougheye, and splitnose are also important groundfish species on soft bottom. Bronze-spotted, chilipepper, greenblotched, redstripe, rosethorn, and stripetail rockfish occur on the slope, but are not a major component of fisheries catches. Other groundfish including petrale sole, rex sole, finescale codling and Pacific rattail are also considered minor species on the slope. Little is known about other fish and shellfish species on the slope, except spot prawns. Spot prawns typically inhabit rocky or hard bottoms, including reefs, coral or glass-sponge beds and the edges of marine canyons.

Emphasis Species Dover sole, shortspine thornyhead, longspine thornyhead, and sablefish comprise a deepwater assemblage (DTS) managed as a complex under the FMP. These species occur primarily over soft bottom on the slope. Shortspine thornyhead also co-occur with Pacific ocean perch, darkblotched, splitnose, redbanded and rougheye rockfishes.

Pacific ocean perch occur on the upper slope (109-150 fm) during the summer and somewhat deeper (164-246 fm) during the winter. Adults sometimes aggregate up to 16 fm above hard-bottom features and may then disperse and rise into the water column at night. Most adult darkblotched rockfish are associated with hard substrates on the lower shelf and upper slope at depths between 77 and 200 fm. As mentioned above, spot prawns are also associated with hard bottoms.

The list of common groundfish species inhabiting hard and soft substrates in the Slope Environment is given in Table 3.3.7. Other fish and shellfish species relevant to groundfish bycatch are also included.

Table 3.3.7. Species associations in the **Slope Environment**. Emphasis species are shown in bold; minor species are not included.

HARD SUBSTRATES	SOFT SUBSTRATES
Pacific Ocean Perch **Darkblotched Rockfish** **Spot Prawn** Aurora Rockfish Bank Rockfish Blackgill Rockfish Rougheye Rockfish Sharpchin Rockfish Shortraker Rockfish Yellowmouth Rockfish	**Sablefish** **Longspine Thornyhead** **Shortspine Thornyhead** **Dover Sole** Bank Rockfish Redbanded Rockfish Rougheye Rockfish Splitnose Rockfish

3.3.5.4 Pelagic Environment

The pelagic environment includes waters overlying the slope, shelf, and nearshore environments, all along the West Coast EEZ. Emphasis species that commonly occur in the pelagic environment include two overfished species, as well as market squid, mackerels, sharks, eulachon, and 16 protected species/species groups. The overfished groundfish species is widow rockfish (Pacific whiting is no longer overfished). The protected species include Steller sea lion, California sea lion, harbor seal, harbor porpoise, Dall's porpoise, Pacific white-sided dolphin, short-beaked common dolphin, long-beaked common dolphin, northern elephant seal, black-footed albatross, Laysan albatross, cormorants, northern fulmar, gulls, chinook salmon and coho salmon. California's protected species also include marbled murrelet, Xanthus murrelet, and rhinoceros auklet.

Habitat The California Current System and climate are the most influential factors in determining the diversity and distribution of marine life in the pelagic environment. Currents and climate off the West Coast are briefly described earlier in Section 3.2. The California current generally moves from north to south along the West Coast, transporting cooler water toward the equator. It flows near the coast north of Point Conception during most of the year, except in winter when southeast winds force it farther offshore, producing the Davidson Current that flows north near the coast. In some years, this counter current is stronger than normal and is forced as far north as British Columbia, Canada. South of Point Conception, in the Southern California Bight, the coast bends sharply to the east. There, the California Current breaks away from the coast and flows offshore along the continental edge until it swings back toward the mainland south of San Diego. In the Southern California Bight, the usual surface flow, called the California Countercurrent, moves north along the coast resulting in a counterclockwise gyre that mixes offshore and nearshore surface waters off southern California (Leet, *et al.* 2001).

Temperature is the most commonly correlated climatic variable used to determine associations with biological processes. The colder, northern waters are good habitat for sub-arctic and cold-temperate species, such as Dungeness crab, Pacific salmon, and petrale sole. The warmer, southern waters are suited to warm-temperate and sub-tropical species, such as California halibut and spiny lobster. The offshore environment is often more stable than nearshore and estuarine environments, where the distribution of warm and cold waters can be highly variable. For example, average monthly sea surface temperatures offshore of San Francisco indicate a distinct summer upwelling pattern with cold sea surface temperatures nearshore, as well as large yearly variations. Within this strong upwelling cell, sea surface temperatures can be colder during the summer in cold years than they are during the winter in warm years (Leet, *et al.* 2001). Local physical processes including intense winds, extended periods of calm, infusions of freshwater runoff, and currents also greatly affect the growth, survival and distribution of many marine species. In addition, seasonal-scale influences are so important to many species that their life cycle is often largely adapted to these seasonal cycles.

Biological Associations Many marine species in the pelagic environment are sub-arctic and cold-temperate species, others are warm-temperate or sub-tropical and still others prefer nearshore areas, perhaps living on land at times. In addition, some pelagic species commonly occur all along the West Coast. Consequently, these species are grouped into northern offshore, southern offshore, and/or nearshore categories to approximate species associations.

Few groundfish species are considered pelagic: Pacific whiting, Pacific cod, widow rockfish, yellowtail rockfish, shortbelly rockfish, soupfin shark, leopard shark and spiny dogfish. Some marine mammals are residents (e.g., seals, California sea lions) and others are migrants (gray and humpback whales). Groundfish species provide an important prey source for most marine mammals. Seabirds can search large expanses of the ocean for prey and generally take the most abundant and high energy prey available, especially sardines, herring, smelt, anchovies, squid, some crustaceans and juveniles of many larger fish species. Some seabirds feed near the surface, especially on large fish schools, and others may dive for their prey. More detailed information about the life histories and distributions of the numerous seabirds and marine mammals found on the West Coast is provided in Appendix B. Although protected species are wide-ranging, their distributions have been categorized as primarily northern offshore, southern offshore and/or nearshore and included in the species associations listed in Table 3.3.8 for the Pelagic Environment.

Emphasis Species Pacific whiting forms very large aggregations and migrates long distances between feeding grounds off the northern coast and winter spawning grounds off southern California. Pacific whiting and widow rockfish can co-occur; midwater trawl fisheries for Pacific whiting also catch widow and yellowtail rockfish and sometimes small quantities of canary, darkblotched, and yelloweye rockfish, Pacific ocean perch, and lingcod. Widow rockfish sometimes form large schools, sometimes associated with bottom features. At other times, they may be dispersed in mid waters or on the bottom. Adults are often caught with yellowtail rockfish off Washington.

Relevant species of other fish, shellfish, and squid include jack mackerel, Pacific mackerel, market squid, and walleye pollock. Fisheries for these species may take groundfish species, especially some overfished species, vice versa. In addition, the coastal pelagic species provide an important prey source for Pacific whiting and other marine species. At times, fisheries for Pacific whiting have taken chinook and coho salmon as bycatch and pelagic sharks, such as the common thresher shark, may be vulnerable to capture in groundfish fisheries.

The list of common groundfish species inhabiting offshore and nearshore waters in the Pelagic Environment is given in Table 3.3.8. Other fish and shellfish species relevant to groundfish bycatch are also included. All of the protected species of salmon, marine mammals, sea turtles, and sea birds that have been identified as potentially vulnerable as bycatch (takes) in groundfish fisheries off the West Coast are included in this list.

Table 3.3.8. Species associations in the **Pelagic Environment**. Emphasis species are shown in bold; minor species are not included.

NORTHERN OFFSHORE	SOUTHERN OFFSHORE	NEARSHORE
Widow Rockfish	**Widow Rockfish**	**Jack Mackerel**
Pacific Whiting	**Pacific Whiting**	**Pacific Mackerel**
Jack Mackerel	**Market Squid**	**Chinook Salmon**
Walleye Pollock	**Jack Mackerel**	**Coho Salmon**
Thresher Shark	**Pacific Mackerel**	**California Sea Lion**
Chinook Salmon	**Thresher Shark**	**Harbor Seal**
Coho Salmon	**Stellar Sea Lion**	**Dall’s Porpoise**
Stellar Sea Lion	**California Sea Lion**	**Harbor Porpoise**
California Sea Lion	**Dall’s Porpoise**	**Long-Beaked Common Dolphin**
Dall’s Porpoise	**Harbor Porpoise**	**Black-Footed Albatross**
Harbor Porpoise	**Pacific White-Sided Dolphin**	**Brandt’s Cormorant**
Pacific White-Sided Dolphin	**Short-Beaked Common Dolphin**	**Double-Crested Cormorant**
Northern Elephant Seal	**Northern Elephant Seal**	**Pelagic Cormorant**
Black-Footed Albatross	**Black-Footed Albatross**	**Glaucous Gull**
Laysan Albatross	**Laysan Albatross**	**Glaucous-Winged Gull**
Northern Fulmar	**California Gull**	**Western Gull**
California Gull	**Bonaparte’s Gull**	**Herring Gull**
Bonaparte’s Gull	Shortbelly Rockfish	**California Gull**
Shortbelly Rockfish	Soupfin, Blue, and Shortfin Mako Sharks	**Thayer’s Gull**
Soupfin and Blue Sharks	Spiny Dogfish	**Ring-Billed Gull**
Spiny Dogfish	Chinook and Coho Salmon	**Mew Gull**
Eulachon	Guadalupe and Northern Fur Seals	**Heerman’s Gull**
Northern Fur Seal	Risso’s Dolphin	**Bonaparte’s Gull**
Risso’s Dolphin	Short-Finned Pilot, Gray, Minke,	**Sabine’s Gull**
Short-Finned Pilot, Gray,	Humpback, Blue, Fin, Killer, and	Soupfin Shark
Minke, Sperm, Humpback,	Sei Whales	Spiny Dogfish
Fin, and Killer Whales	Loggerhead, Green, Leatherback, and	Pacific Angel Shark
Leatherback Sea Turtle	Olive Ridley Sea Turtles	Pacific Herring
Short-Tailed Albatross	California brown pelican	Eulachon
Arctic, Common, and	Short-Tailed Albatross	Southern Sea Otter, Sea Otter
Black Terns	Arctic, Common, and Black Terns	Risso’s Dolphin
Marbled, Xantu’s, and	Marbled, Craveri’s, Xantu’s and	Fin and Killer Whales
Ancient Murrelets	Ancient Murrelets	California Brown Pelican
Fork-Tailed, Leach’s, Sooty,	Black, Fork-Tailed, Ashy, Least,	Black, California Least, Caspian,
Short-Tailed, Pink-Footed,	Galapagos, Wilson’s and Leach’s	Forster’s, Gull-Billed,
Flesh-Footed, and Buller’s Shearwaters	Storm-Petrels	Royal and Elegant Terns
Pomarine, Parasitic and	Townsend, Black-Vented, Wedge-Tailed,	Marbled Murrelets
Long-Tailed Jaegers	Sooty, Short-Tailed, Pink-Footed, and	Wedge-Tailed Shearwater
Black-Legged Kittiwake	Bugler’s	Parasitic Jaeger
Common Murre	Shearwaters	Black-Legged Kittiwake
Pigeon Guillemot	Polarize, Parasitic and Long-Tailed	Common Murre
Parakeet, Rhinoceros, and Cassin’s	Gaugers	Pigeon Guillemot
Auklets	Black-Legged Kittiwake	Rhinoceros Auklet
Horned and Tufted Puffins	Common Murre	Black Skimmer
South Polar Skua	Pigeon Guillemot	
	Rhinoceros and Casein’s Auklets	
	Horned and Tufted Puffins	
	South Polar Skua	

3.3.5.5 Nearshore Environment

The nearshore environment extends from the high tide line seaward to 20 fm, from the US/Canada border on the north to the US/Mexico border on the south. It also includes estuarine habitats along the West Coast.

Emphasis species that commonly occur nearshore include cabezon, Dungeness crab, and California halibut. Associations among these and other species, as well as habitat in the nearshore environment, are more fully described below.

Many protected species occur in the nearshore environment, but most are highly mobile and are frequently found in offshore areas, as well. To capture their wide distribution, they are considered as part of the pelagic environment (Section 3.3.5.4).

Habitat The nearshore environment is comprised of a variety of habitats ranging from high-relief rocky reefs to broad expanses of sand and mud. The diversity of physical habitat in the nearshore environment is similar to that of the continental shelf, but being shallower, sunlight, tides, and waves are also important features. Intertidal and subtidal plant communities are highly productive and provide food and shelter for a wide variety of fish, shellfish, and invertebrates. The dominance and diversity of species varies latitudinally with temperature, as well as levels of solar radiation, wave exposure, rainfall and tidal range.

San Francisco Bay, Willapa Bay, and Grays Harbor are large estuaries and important nursery areas for many species of fish and shellfish. Flows from the Columbia River and Strait of Juan de Fuca influence the variety of marine life and are seasonally affected by the direction of the current system off the West Coast.

Biological Associations Nearshore areas north of Cape Mendocino are often dominated by black rockfish, cabezon, redtail perch, and night and surf smelt. Quillback and china rockfish, kelp greenling, and monkeyface prickleback are common in northern nearshore areas, but rarely seen in southern areas. South of Cape Mendocino, where rocky-reef habitat dominates, kelp beds are home to a variety of nearshore rockfish, abalone and sea urchins. California scorpionfish, black-and-yellow, gopher, grass, kelp, olive and calico rockfishes, and treefish are common in southern nearshore areas, but uncommon in northern areas.

Estuaries provide nursery areas for California halibut, surfperches, Dungeness crab, leopard sharks, starry flounder, and other marine species.

Emphasis Species Cabezon commonly inhabit rocky bottoms and kelp beds, although they may also be found on sandy and mud bottoms. To spawn, they deposit eggs in shallow waters on bedrock or in crevices. Adult black rockfish are semi-pelagic and commonly associated with kelp forests and rocky pinnacles. They frequently form midwater schools, but at other times they may be on the bottom. Adults are often caught with other fish, such as yellowtail and widow rockfish. Lingcod is an overfished groundfish species that is common in nearshore areas, and has been considered as an emphasis species in the Northern Shelf Environment (Section 3.3.5.1).

California halibut and Dungeness crab are abundant on sandy bottoms in the southern and northern nearshore environment, respectively. Both species co-occur with a variety of flatfishes may be taken as bycatch in some fisheries for groundfish. California halibut is commonly associated with white seabass. Dungeness crab, through all its life history stages, is an important prey species for many groundfish.

The list of common groundfish species inhabiting rocky and non-rocky substrates in the Nearshore Environment is presented in Table 3.3.9. Other fish and shellfish species relevant to groundfish bycatch are also included in the list among the emphasis species.

Table 3.3.9. Species association in the **Nearshore Environment**. Emphasis species are shown in bold; minor species are not included.

ROCKY SUBSTRATES	NON-ROCKY SUBSTRATES
Cabezon	**California Halibut**
Black Rockfish	**Dungeness Crab**
Lingcod	California Scorpionfish
Kelp Greenling	Pacific Sanddab
Black-and-Yellow Rockfish	Rock Sole
Blue Rockfish	Sand Sole
Brown Rockfish	Starry Flounder
Calico Rockfish	White Seabass
California Scorpionfish	Spiny Dogfish
China Rockfish	California Skate
Copper Rockfish	Big skate
Gopher Rockfish	Rays
Grass Rockfish	
Kelp Rockfish	
Olive Rockfish	
Quillback Rockfish	
Treefish	
Vermilion Rockfish	

3.4 The Social and Economic Environment

This section describes the human activities that directly relate to or are dependent on the groundfish resources. Table 3.4.1 identifies the most relevant components of the human environment. These components are described, focusing on those aspects (impact variables) that are predicted to change under the various alternatives. One of the most important considerations is the incentives that lead to bycatch and those that lead to bycatch avoidance and using more of what is caught. The most relevant human components of the affected environment include groundfish harvesters, seafood processors, fishing communities, seafood consumers, and the general public. Bycatch and bycatch mitigation measures (rules made to avoid and reduce bycatch) affect each of these components. In addition, bycatch mitigation measures affect fishing vessel safety and public costs to administer and enforce the fishery management program.

Information sources to characterize the groundfish industry and fishery included Leet *et al.* (2001), and several recent PFMC documents including the FEIS for the 2004 Annual Optimum Yield Specifications and Management Measures, Groundfish FMP Amendment 17 for Multi-Year Management (PFMC, 2003a),

Table 3.4.1. Socioeconomic Components of the Human Environment and Impact Assessment Variables.

Component of the Human Environment	Impact Assessment Variables
Incentives and disincentives regarding bycatch	The benefits and costs to fishers of avoiding and/or discarding fish
Commercial harvesters	Production levels of different sectors; ex-vessel revenues and operation expenses (average costs); distributional effects among commercial harvesters such as changes in level of dependence and involvement; effects on other fisheries.
Recreational fisheries	Value of the recreational experience
Tribal fisheries	Fulfillment of ceremonial and subsistence needs; revenues and costs
Buyers and processors	Gross product revenues and operation expenses (average costs)
Communities	Employment and income
Consumers of groundfish products and other members of the general public	Product prices, quality and availability; non-consumptive and non-use values
Fishing vessel safety	At-sea fatalities and injuries
Management and enforcement costs	At-sea and dockside monitoring and enforcement costs; practicability and administration costs

and the Environmental Assessment for a Vessel Monitoring System of Groundfish Fisheries (PFMC, 2003b).

The Pacific Coast groundfish fishery is a year-round, multi-species fishery that takes place off the coasts of Washington, Oregon, and California. Pacific Coast groundfish support or contribute to a wide range of commercial, recreational, and tribal fisheries. In addition, seafood buyers and processors depend on groundfish harvests. Fishing communities are made up of fishers, processors, and supporting infrastructure such as gear suppliers, grocery suppliers, other enterprises, housing and other typical community services.

Non-tribal commercial fisheries include those that target groundfish, which for the most part are regulated under a license limitation program (limited entry) implemented in 1994, and fisheries that target other species. From November 2000 through October 2001, 4,579 vessels participated in West Coast commercial fisheries. Of these, 1,341 vessels (37% of the fleet) landed some groundfish. At the beginning of 2003, there were about 500 vessels with Pacific coast groundfish limited entry permits, of which approximately 55% are trawl vessels, 40% are longline vessels, and 5% are pot/trap vessels. (In December of 2003, 92 trawl permits were eliminated through a government/industry buyback program.) Vessels without limited entry permits are categorized as open access because no federal groundfish permit is required for their activities, although some target groundfish species at least part of the time. Gears used by participants in open access commercial fisheries include longline, vertical hook-and-line, troll, pot, setnet, trammel net, shrimp and prawn trawl, California halibut trawl, and sea cucumber trawl gears.

The groundfish limited entry program applies to bottom and midwater trawl, longline, and trap (or pot) gears. Each limited entry permit is endorsed for a particular gear type and that gear endorsement cannot be changed, so the distribution of permits among gear types has been fairly stable. Each permit also has a vessel length endorsement. The total number of permits has typically changed only when multiple permits have been combined to create a new permit with a longer length endorsement. However, in December 2003 a buyback program permanently retired 92 trawl permits, roughly 35% of the total. Limited entry permits can be sold and leased out by their owners, so the distribution of permits among the three states often shifts. At the beginning of 2003, roughly 39% of the limited entry permits were assigned to vessels making landings in California, 37% to vessels making landings in Oregon, and 23% to vessels making landings in Washington.

The Council allocates harvest specifications (OYs) between the limited entry and open access categories. Most of the Pacific coast commercial groundfish harvest is taken by the limited entry fleet.

Commercial harvest rates of groundfish are constrained by annual harvest guidelines, two-month or one-month cumulative period landing limits, individual trip limits, size limits, species-to-species ratio restrictions, and other measures. This program is designed to control effort so that the allowable catch is taken at a slow enough rate to stretch the season over the full year. Cumulative period catch limits are set by comparing current and previous landings rates with the year's total available catch and predicted participation.

Participants in marine recreational fisheries fish from private and Commercial Passenger Fishing Vessels (CPFV)/charter vessels, as well as from shore. CPFV/charter vessels are vessels for hire that are typically larger and can fish farther offshore than most vessels in the private recreational fleet. Both nearshore and shelf opportunities are important for West Coast recreational groundfish fisheries.

Members of the Makah, Quileute, Hoh, and Quinault tribes participate in commercial, ceremonial and subsistence fisheries for groundfish off the Washington coast. Participants in the tribal commercial fishery use similar gear to non-tribal commercial fishers who operate off Washington, and groundfish caught in the tribal commercial fishery is typically sold through the same markets as non-tribal commercial groundfish catch.

3.4.1 Incentives and Disincentives Regarding Bycatch

Bycatch occurs when a fisher fishes for any particular species and catches something else. Under the Magnuson-Stevens Act, nearly every marine species is classified as a fish, and any fish that is not kept is classified as bycatch. The Magnuson-Stevens Act sets the highest priority as avoiding catching anything that would not be kept, especially if it would die as a result of being captured. There is also a clear priority to prevent injury and death as much as possible. Finally, if something is caught and is dead or will inevitably die, it should be used if practicable. In the groundfish fishery, trip limits are intended and used to keep harvest rates low enough through the season so the limits are not reached too early. This would be effective if fishers could always catch the right fish in the right amounts, but that is impossible in a fishery of more than 80 species, plus all the other marine creatures. The only way to avoid catching something is to not fish, or at least not fish where that species is present. The more one fishes where the fish live, the more will be caught (if he is using a type of gear that catches that species). Fishing where the fish are more abundant also increases the catch. The amount of fishing is called effort. The measure of how well the gear catches a particular species is called the selectivity or catching efficiency. These can be combined into a simple equation that describes how these are related:

$$\text{catch} = \text{effort} \times \text{selectivity} \times \text{abundance}$$

It is more appropriate to say catch is proportional to effort, selectivity and abundance, but the general relationships are the same. In simple terms, this equation says you will catch more fish if you fish harder (increase effort), use more efficient gear (increase selectivity), and/or the fish are more abundant. To reduce catch (or bycatch), reduce effort, reduce selectivity, or fish where they are less abundant. All bycatch mitigation tools work on one of these components. At the same time, it is important to keep in mind the following facts:

- **no fish species exists in isolation (they appear in assemblages or mixed groups)**
- **geographic distributions of any two or more species do not match exactly**
- **where two or more species occur in the same location or habitat, their abundances will be different**
- **a gear type is unlikely to be equally selective for all species; it will catch (or avoid) some better than others**

Taking these and other relevant factors into account, the question each fisher faces is how to catch the desirable species (the ones he wants) without catching undesirable species (ones he does not want). A slightly different angle to this question may be how to catch fewer of the undesirable fish. Another consideration is how to turn the undesirable fish into desirable/useable fish, that is, how to improve the value and use of those that cannot be avoided. A major bycatch management challenge is how to set the incentives and disincentives to get the best results at the least cost to the fishers.

Under the current management regime, quota-induced discards can occur when fishers continue to harvest other species when the harvest guideline of a single species is reached and further landings of that species are prohibited. As trip limits become more restrictive and as more species come under trip-limit management, discards increase. In addition, discretionary discards of unmarketable species or sizes are thought to occur widely.

Incentives and disincentives relating to bycatch are discussed in greater detail in Section 4.1.5.

3.4.2 Commercial Harvesters

Commercial fishing vessel owners and captains employ a variety of strategies to fill out a year of fishing. Fishers from the northern ports may fish in waters off of Alaska, as well as in the West Coast groundfish fishery. Others may change their operations throughout the year, targeting salmon, shrimp, crab, or albacore, in addition to various high-value groundfish species.

The total amount of groundfish landed in West Coast groundfish fisheries increased from under 200 million pounds in 1987 to a peak in 1996 of over 300 million pounds (Figure 3.18). However, revenues to the commercial fleet have declined significantly in recent years. While landings of Pacific whiting increased during this period, landings of other West Coast groundfish, primarily rockfish and deepwater flatfish species, have declined by nearly 50%. This general decline in groundfish landings other than whiting has been driven by declining stocks of major target species primarily rockfish—several of which have been declared overfished. Part of the decline in landings has been due to reduced harvest of the particular overfished stocks. However, a large part of the overall reduction is due to constraints on harvests of healthier stocks in order to prevent bycatch of overfished stocks.

The decline in landings of non-whiting groundfish has had a significant adverse economic impact on a number of harvesting sectors.

Table 3.4.4Groundfish landings, excluding at-sea whiting, 1987 - 2000. (PacFIN data).

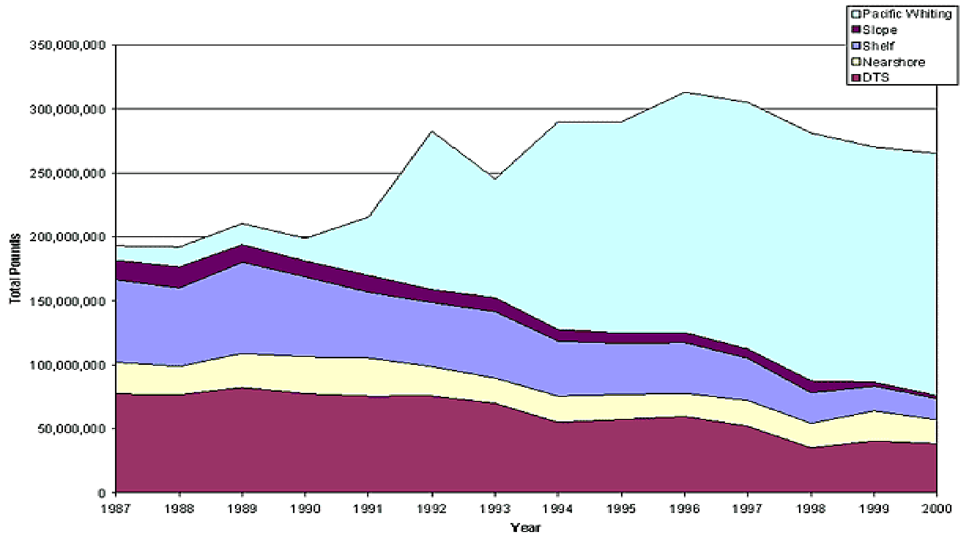


Table 3.4.2 shows exvessel revenues in the West Coast groundfish fisheries (excluding the Pacific whiting fishery) for the years 1999-2002. In general, revenues increased in 2000 by 9% from 1999 levels, then dropped by 16% in 2001 and another 16% in 2002. The declines were greater in the limited entry sector than in the open access sector. Within the limited entry sector, fixed-gear revenues fell by a greater percentage than trawl revenues, primarily due to reduction of the sablefish OY and reduced access to nearshore rockfish.

Table 3.4.2. Exvessel revenues in the groundfish fisheries (excluding the Pacific whiting fishery) by sector, 1999-2002.

	1999	2000	2001	2002
Sector	**Exvessel Revenues ($1,000)**			
Limited Entry Non-Trawl	9,814	10,946	8,693	6,852
Limited Entry Trawl	32,634	34,032	28,257	24,010
Open Access (All)	7,762	8,732	8,254	7,161
Total	**50,210**	**53,710**	**45,205**	**38,023**

Source: Data provided by the Pacific Coast Fisheries Information Network (PacFIN).

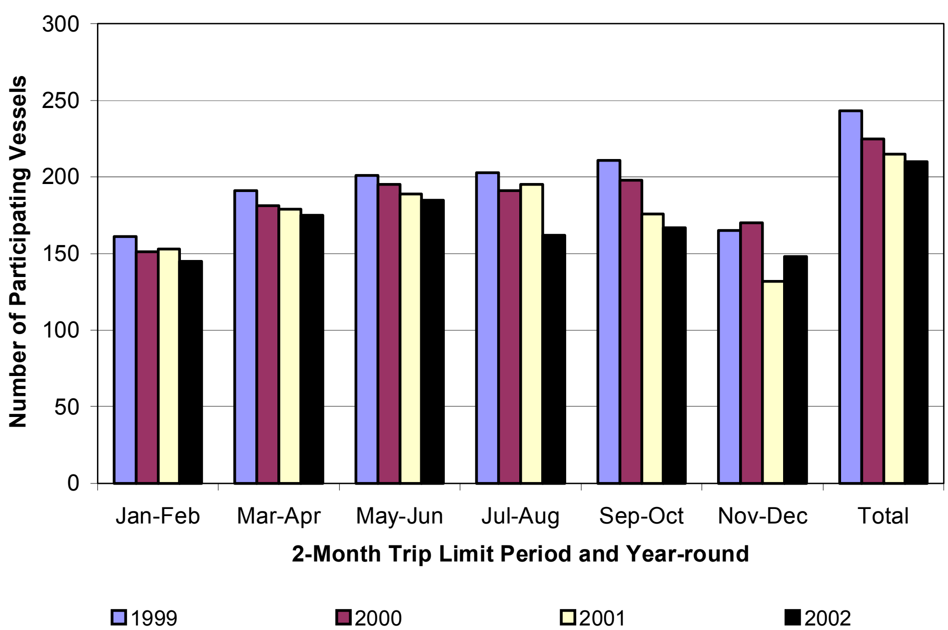
3.4.2.1 Limited Entry Trawl Fisheries

Limited entry trawl fishers target many different of the more than 80 groundfish species, with the largest landings by volume (other than Pacific whiting) of Dover sole, sablefish, thornyheads, widow rockfish, and yellowtail rockfish. Taken as a whole, the 62 rockfish species have made up the largest volume of non-whiting landings in the Pacific coast commercial groundfish fishery. Trawlers take the vast majority of the groundfish harvest by weight and value. In 2001, groundfish trawlers landed 97% of total groundfish harvest by weight (including whiting) but only 75% by value. Trawling is much more dominant north of Cape Mendocino, California (the Vancouver, Columbia, and Eureka management areas) than south of Cape Mendocino (Monterey and Conception areas).

Figure 3.19 shows the seasonal participation pattern of limited entry trawl vessels, except those vessels that participated exclusively in the Pacific whiting fishery. Participation by the non-whiting trawl sector is spread out more evenly over the six 2-month periods in comparison to the participation seen in the fixed gear sector. While there has been a decline in participation by the non-whiting trawl sector during the 4-year period, the decline is relatively small. However, the trawl buyback program approved in late 2003 eliminated 92 trawl permits, so participation will change significantly in 2004.

In addition to these mixed-species fisheries, there is a distinct mid-water trawl fishery that targets Pacific whiting. This fleet includes catcher boats that deliver to shore-based processing plants, vessels that deliver to at-sea processor ships,

Table 3.4.4Limited entry trawl vessel participation by period and year, 1999-2002, excluding whiting-only vessels. Source: PacFIN data.



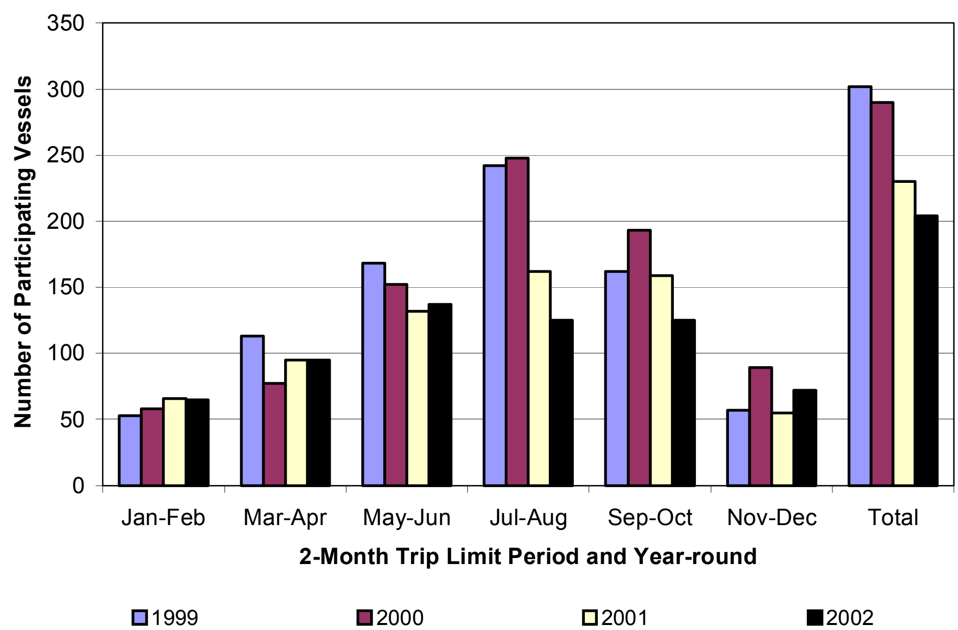
and catcher-processor vessels. Pacific whiting landings are significantly higher in volume than any other Pacific coast groundfish species. In 1998, whiting accounted for approximately 66% of all Pacific coast commercial groundfish shoreside landings by weight. However, whiting commands a relatively low price and accounts for only about 9% of commercial groundfish shoreside landings by value.

3.4.2.2 Limited Entry Fixed-gear Fisheries

Limited-entry fixed-gear vessels use longline or trap (pot) gear. Sablefish has long been an important target species in this sector; however, some shelf and slope rockfish species have also been important and valuable targets. In recent years, nearshore rockfish and other species have been harvested by the live-fish fishery. Although about 230 fixed-gear permits are issued, only about 180 vessels are active in a given year.

Figure 3.20 shows limited entry fixed-gear vessel participation from 1999 through 2002. During the 4-year period, the number of unique limited entry vessels participating in the groundfish fishery declined from 302 in 1999 to 204 in 2002. Declines in participation have been most noticeable during the summer months—in the July-August period the number of participating vessels declined from 242 to 142. The establishment of a sablefish permit endorsement, the tier system, and ability fixed gear vessels to stack permits have facilitated a reduction in fleet capacity.

Table 3.4.4Limited entry fixed-gear vessel participation by period and year, 1999-2002. Source: PacFIN data.

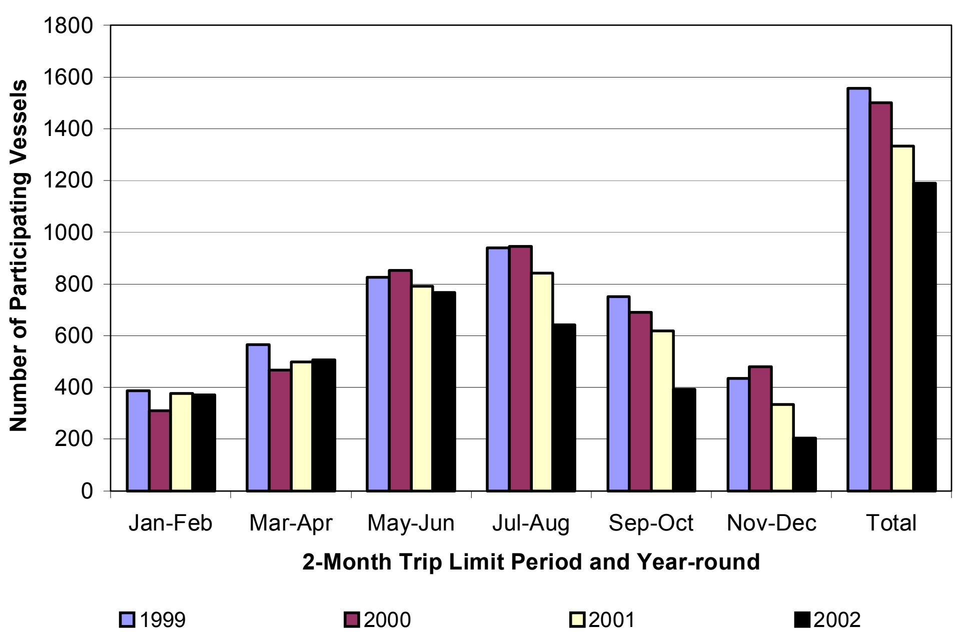


While non-trawl vessels took only 2% of the coastwide groundfish harvest by weight, their harvest accounted for about 25% of the exvessel value due to the prevalence of relatively high value sablefish and live fish landed in this fishery. When whiting is excluded from the totals, non-trawl landings are 10% to 12% by weight and 25% to 27% by value (percent of coastwide total groundfish excluding whiting).

3.4.2.3 Open Access – Directed Groundfish Fishery

Several thousand vessels without limited entry permits have made commercial groundfish landings since the limited entry program went into effect in 1994. Many open access fishers have traditionally targeted groundfish, while others catch groundfish incidentally in other target fisheries. Most open access vessels targeting groundfish use hook-and-line gear for sablefish, rockfish, and lingcod. Others use pot gear, primarily for sablefish and some rockfish species. In southern and central California, some vessels have used setnet gear to target rockfish, including chilipepper, widow rockfish, bocaccio, yellowtail rockfish, olive rockfish and, to a lesser extent, vermilion rockfish. Setnet gear is rarely used now due to area and species restrictions and the greater value of live fish. (Fish caught with setnets usually are dead before the nets are retrieved.) From 1999 through 2002, approximately 1,200 to 1,500 vessels per year made small groundfish landings (Figure 3.21). In 2003 (not shown) the number was substantially less. The seasonal fishing pattern is similar to that seen in the limited entry fixed gear sector, with higher levels of participation during the summer months, but some level of participation throughout the year. In 1999,

Table 3.4.4Open access vessel participation by period and year, 1999-2002. Source: PacFIN data.



about 1,000 open access vessels landed their catch in California, about 400 in Oregon, and about 100 in Washington. Since 1999, commercial fishers in California have been required to purchase a nearshore fishery permit to land shallow nearshore rockfish, California scorpionfish, cabezon, greenlings, and California sheephead. This has resulted in a substantial decrease in the number of open access vessels landing these groundfish from 1,100 in 1999 to 202 in 2003.

It is difficult to determine whether an open access vessel targets groundfish or targets other species, because fishing intentions or strategies are not explicitly reported. In this EIS, a given trip or vessel is considered to target groundfish during a fishing trip if it is fishing with any gear other than groundfish trawl and if over 50% of the revenue from landings in that trip were from groundfish species. Other commercial fisheries taking groundfish are described below in the section titled "Other Fisheries That Affect Groundfish (Open Access Non-groundfish Fisheries")

In the directed open access fishery, fishers target groundfish in the dead and/or live fish fishery using a variety of gears. The terms dead and live fish fisheries refer to how the fish are landed and sold. The dead fish fishery has historically been the most common way to land fish and made up 80% of the directed open access landings by weight coastwide in 2001. More recently, the greater market value for live fish has led to increased landings of live groundfish. Fish are caught using pots, stick gear, and rod-and-reel, and kept aboard the vessel in a seawater tank, to be delivered to fresh markets—such as the large Asian-American communities in California—that pay a premium for live fish. Determining landings from this fishery is difficult because fishing intentions or strategies are not known. 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. Using this criterion, 20% of coastwide directed open access landings by weight in 2001 are considered live fish, compared to only 6% in 1996. This growth in landings may be attributed to the price premium awarded live fish.

3.4.3 Recreational Fisheries

Recreational fishing has been part of the culture and economy of West Coast fishing communities for more than 50 years (PFMC, 2003d). Recreational fishing is conducted from shore, such as beaches, banks, piers, docks, and jetties and from boats, including private, rental, party and charter boats. Groundfish are both targeted and taken incidentally when other species, such as salmon, are targeted. Historically, most recreational fishing along the northern coast targeted salmon and groundfish, especially rockfish, were taken incidentally. Recreational fishing in the open ocean has been on an increasing trend since 1996; however, charter effort has decreased while private effort increased during this period. Coastwide, about twice as many angler trips for groundfish were taken by private anglers (1.33 million) as charter anglers (0.63 million) in 2001. Of these trips, 33,000 private angler trips for groundfish were taken off Washington and Oregon combined, with the remaining 1.3 million trips taken off California. Similarly, a total 59,000 angler trips aboard charter vessels were taken off Washington and Oregon in 2001 and 569,000 private angler trips for groundfish were taken off California. Angler trips for groundfish comprised 43% of all charter trips but only 16% of all private trips. Along the northern coast, recreational fishing traditionally targeted salmon, but rockfish and lingcod often provided a bonus to anglers.

The estimated number of recreational marine anglers in Southern California was two and a half times the number in the next most numerous region, Washington state. While the bulk of recreational fishers in all areas were residents of those areas, a significant share were non-residents. Oregon had the greatest share of non-resident fishers at more than one-fifth of total ocean anglers.

While the contribution of groundfish catches to the overall incentive to engage in a recreational fishing trip is uncertain, it seems likely that the possibility or frequency of groundfish catch on a trip adds to overall enjoyment and perceived value. Some effort shift from salmon to groundfish likely occurred around 1996, when salmon seasons were shortened.

Fishing effort, both private and charter, is related to weather, with relatively more effort occurring in the milder months of summer and less in winter. This seasonal trend 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. Groundfish seasons, until recently were also more restrictive in Washington; the lingcod season is closed from November through March.

In 2001, the estimated total catch of all groundfish species coastwide was similar for charter (1,445 mt) and private recreational anglers (1,632 mt). About half of these catches were made up of nearshore rockfish species, followed by lesser amounts of shelf rockfish, other nearshore groundfish and lingcod.

3.4.4 Tribal Communities and Fisheries: Social, Economic and Historical Information about West Coast American Indian Groundfish Fisheries[2/]

Four Indian tribes in Western Washington exercise treaty rights to harvest groundfish and other marine species in the Pacific Ocean off the northwest coast of the U.S.: the Hoh, Makah, and Quileute Tribes and the Quinault Indian Nation. Each has reservation lands, but their fishing is not confined to the reservation. Each of these tribes has USUAL AND ACCUSTOMED FISHING AREAS (U & A) that extend into the groundfish fishery management area (FMA). Information relating to Treaty rights and litigation is provided in Appendix C.

In pre-treaty times, Native American settlements were widely dispersed throughout Western Washington. Coastal tribes fished and hunted various species of fish, shellfish, and marine mammals for sustenance and trade. They took these species from ocean waters, beaches, and rivers. Fish were vital to the Indian diet and played an important role in tribal ceremonial and religious practices as well as the native economy.

The sea and waterways provided major advantages to Indian existence. The Indians invariably lived next to waterways, traveled on them, and depended on the resources of the waters for their major livelihood. Some of the coastal groups engaged in marine hunting on the open sea and in the Straits of Juan de Fuca. Saltwater and/or freshwater fishing was actively pursued by virtually every adult male throughout the area. Fishing was the universal male occupation.

The water resources were rich, but with tremendous local diversity. Types of marine life differed in the open sea, in bays, rivers and lakes. Topographic features such as depth of water and nature of bottom or shoreline predicated presence or absence of specific species in a given locale. Availability varied not only from area to area, but also seasonally. This depended not only on presence or absence of a given species in local waters at different times of the year, but also on seasonal availability of suitable bait. Furthermore, storms, rough seas, and fog made fishing impossible at certain times. In addition to area and seasonal variations, there was considerable fluctuation in abundance and availability from year to year. Some of this was regular and predictable, as in the case of runs of certain species and races of salmon. Other causes were erratic, such as flooding and alterations in watercourses.

2. Sources for this section include American Indian Reservations and Trust Areas, 1996 (updated 2000); U.S. Census of 1990 and 2000; Lane PhD; National Park Service "Tribes of the Olympics;" Jim Harp personal communication; "*Land of the Quinault*" published in 1990 by the Quinault Indian Nation; and Craig Bowhay (NWIFC).

Tribal communities used a wide variety of fish, wildlife, and plants for food, medicines, and trade. Food was unevenly distributed over space and time. The successful and efficient use by tribal communities required an intimate knowledge of local environments and the locally available species and a repertoire of specialized taking techniques. In the case of fishing, gear and techniques were specific not only to a species but also to water conditions.

Fishing methods varied according to the locale, but generally included trapping, dip-netting, gill-netting, reef-netting, trolling, long-lining, jigging, set-lining, impounding, gaffing, spearing, harpooning, raking and so on. Species of fish taken included salmon and steelhead, halibut, cod, flounder, ling cod, rockfish, herring, smelt, eulachon, dogfish, trout, crab, clams, seals, otters, whales and many others. Throughout most of the area, salmon was the staple food and the most important single food resource available to the native population. Western Washington tribes traded fish with each other and with tribes across the Cascade Mountains during treaty times.

The initial effect of the influx of non-Indians into western Washington was to increase the demand for fish both for local consumption and for export. Almost all of this demand, including that for export, relied on Indians to supply the fish. Non-Indians did not engage as fishing competitors on any scale until the late 1870s.

Available evidence suggests that Indian fishing increased in the pre-treaty decade for three major reasons: (1) to accommodate increased demands for local non-Indian consumption and for export; (2) to provide money for the purchase of introduced commodities like calico, flour, and molasses; and (3) to obtain substitute non-Indian goods for native products no longer available because of non-Indian movement into the area.

Customary use rights varied according to the type of locale and the gear being used. Techniques such as spearing or trolling in saltwater, which involved individual effort, were not regulated or controlled by anyone else. The deeper saltwater areas, Puget Sound, the straits, and the open sea, served as public thoroughfares, and as such, were used as fishing areas by anyone traveling through such waters. However, both within the straits and off the West Coast in the open sea, there were halibut banks known to the Indians, used by them, and claimed as private property.

3.4.4.1 The Hoh Tribe

The 443-acre Hoh reservation is located in Jefferson County, on the Pacific Coast of northern Washington. The reservation lies within the boundaries of the Olympic National Park, and in the area of the Hoh River drainage system. The Hoh River empties into the Pacific and serves as the reservation’s northern boundary. The Hoh U&A within the FMA is between 47°54'18"N (Quillayute River) and 47°21'00"N (Quinault River) and east of 125°44'00"W.

The Hoh people's principal freshwater fisheries were on the Hoh River and its tributaries from the upper reaches to the mouth. In treaty times, the Tribe's U&A fishing places included the entire Hoh river system and the Quillayute, Dickey, Bogachiel, Calawah, Soleduck, Queets and Quinault river systems. Their saltwater fisheries were in the area adjacent to Hoh Territory. The Hoh were primarily dependent on salmon for their staple food. Although they had a summer troll fishery in the coastal water, they relied on the fall runs in the river for their winter stores. The upriver fisheries were of strategic importance.

Prior to the treaties, the Hoh had devised fish taking techniques adaptable for a variety of water and weather conditions. They constructed artificial falls by placing hemlock logs across the smaller streams. During periods of high water, they would catch salmon below the falls with special falls nets. They observed certain rituals to assure continued fish runs.

Currently, Hoh tribal members harvest shellfish, smelt, sturgeon, sablefish, rockfish, Dungeness crab, salmon (spring, summer fall chinook, and fall coho), steelhead, trout, and halibut within their U & A.

3.4.4.2 The Makah Tribe

The 27,950-acre Makah reservation is located on the northwestern tip of Washington's Olympic Peninsula in Clallam County. It includes Cape Flattery and Koitlah Point. Vancouver Island, Canada is across the Strait of San Juan de Fuca. The reservation lies 70 miles west of Port Angeles, and 17 miles from the nearest neighboring community, Sekiu. Unlike many other tribes in the U.S., the Makah Tribe still holds title to a substantial portion of their ancestral land base, engendering a high degree of continuity in both place-oriented identity and subsistence practice (Sepez 2000). The Makah U&A includes Washington state statistical area 4B and that portion of the FMA north of 48°02'15"N (Norwegian Memorial) and east of 125°44'00"W.

The Makah lived in 5 villages that were occupied all year long (Neah Bay, Ozette, Biheda, Tsoo-yess, and Why-atch). In addition, there were temporary residences at locations that attracted people seasonally. These places allowed Makah people to harvest and process special food resources such as halibut and summer salmon. Makah people made use of the abundant resources of the ocean, tidelands, forests, and rivers, and Makah fishermen and sea mammal hunters traveled far from the sight of land in large cedar canoes. They hunted whales in the open ocean, especially gray and humpback whales, and archaeological evidence indicates the Makah used other varieties of whales as well. Archaeological data indicate the Makah people hunted whales for some 2,000 years before the present. In addition to hunting whales, Makah hunters pursued a variety of seals and sea otters.

The Makah people created a thriving commercial maritime economy which was well established prior to 1855. Their wealth, power and culture depended on the sea; the Makah were primarily a seafaring people who spent their lives either on the water or close to the shore. Most of their subsistence came from the sea. They fished for salmon, halibut and other fish, and hunted for whale and seal. Halibut and whale were especially important. What they did not consume themselves, they traded to other tribes for many of the raw materials and some of the finished articles used in the daily and ceremonial life of the village. The Makah imported some basic needs such as housing materials and ocean-going canoes used for sea mammal hunting and ocean fishing. The Makah were fairly unique in their use of Pacific halibut, which were particularly abundant and available offshore. The Makah claimed ownership of the lucrative halibut fishing banks, and this ownership was respected by competing tribes. They had a highly developed technology capable of efficiently harvesting the resource, and intensive processing and marketing of the finished product. At the time of the treaties, the Makah people relied more heavily on halibut than on salmon or steelhead for their diet and trade. In addition to the marine products which the Makah consumed themselves and sold to other native people, they produced a considerable surplus for sale to non-Indians.

Currently, Makah tribal members harvest halibut, whiting, rockfish, lingcod, sablefish, flatfish, salmon, steelhead, sturgeon, shellfish, other groundfish, and gray whales within their U&A.

3.4.4.3 The Quileute Tribe

The 694-acre Quileute reservation is located entirely in Clallam County, Washington, on the south banks of the Quillayute River along the Pacific Ocean. It is surrounded on three sides by the Olympic National Park, and the fourth side of the Reservation is on the Pacific Ocean—First Beach. Just beyond the reservation lies Quillayute Needles National Wildlife Refuge. The surrounding waters also fall within the Olympic Coast National Marine Sanctuary. The Quileute Reservation encompasses the mouth and about one mile of mainstem of the Quillayute River and a jetty on its north side; and James Island and the small islands between the mouth and James Island, all of which are connected at low tide to the mainland. The headquarters for the tribe is in La Push, and most Quileute live in Clallam County; however, some enrolled members live in other counties of the state (e.g., adjacent Jefferson to the south) and even outside Washington. Virtually all of the lands surrounding the reservation are timberlands—the largest is Olympic National Park, then private large timber growers, with some small farms and resorts present, especially at Three Rivers, six miles away. The closest city is Forks, population about 2500, 15 miles away. Beyond Forks is more timber, private and state forests (WDNR), Olympic National Forest, and Olympic National Park. Small communities of perhaps a few hundred people are located along U.S. 101. The state's Olympic Experimental Forest was established in state forests of this region. The Quileute

U & A includes the FMA between 48°07'36"N (Sand Point) and 47°31'42"N (Queets River) and east of 125°44'00" W. The National Park Service operates Rialto Beach to the North and Second Beach and Third Beach to the South. These beaches fall within the Quileute Tribe's U & A Fishing Grounds.

The Quileute Tribe are descendants primarily of the Quil-leh-ute and other bands of Indians residing on the watershed of the Quileute and Hoh River systems. The Quileute culture was centered around the ocean, river, and forest. Whales, seals, and other marine animals were hunted and the rivers were fished for Quileute subsistence, ceremony and trade with other tribes. The last whaling days were held in 1910; the last seal days were in 1955. They used canoes for the ocean or river. At the time of the treaty, the Quileute (including the Hoh) relied primarily on salmon and steelhead taken in their long and extensive river systems. These Indians took canoes far up into the foothills country by following the river system, not only to take salmon and steelhead, but also to hunt land game in the foothills. The reliance on fish as a food staple is reflected in their calendar. Quileute Indian names for some months are related to fish or fishing activities, such as "Beginning of the spawning of the steelhead salmon" or "time for silver salmon." Quileute people continue to fish in rivers, lakes and the ocean. Fishing grounds in the river are still used by individual families, and those in the lakes and ocean continue to be used in common. Traditionally, they caught fish with drag nets, scoop nets and fish traps, fish baskets, dip nets, spears, hooks and lines. Quileute aboriginal fishing gear included a stake trap stretching across a stream with open spaces at intervals in which dip nets were suspended; triangular fish traps which often could catch a canoe-load of fish at a time; and sloping dams across a river along which dip or bag nets were suspended from the downstream side into which the fish would jump in their attempts to get over the dam.. Quileute today continue to use nets in the river and troll for salmon in the ocean, as well as using modern methods of fishing for groundfish, crab, and tuna, all of which are fished commercially. They collect bivalves and other invertebrates along the coast for ceremony/subsistence purposes.

Before, during and after treaty times, the Quileute (and Hoh) U&A fishing areas included the Hoh River from the mouth to its uppermost reaches, its tributary creeks; the Quillayute River, including its major tributaries—the Dickey River (and Lake Dickey), the Sol Duc River (and Lake Pleasant), the Bogachiel River, and Calawah River, and their respective tributary creeks; Lake Ozette, and adjacent tidewaters from Sand Point (north) to Queets River (south) and westward well into the open ocean. In the rivers, the Quileute caught salmon and trout species as well as herring and smelt. Along the adjacent Pacific Coast, Quileute people caught salmonids, smelt, rockfish, puggy, cod, halibut, flatfish, bullheads, devilfish, shark, herring, sardines, sturgeons, seal, sea lion, porpoise and whale. The Quileute had the canoes, the gear, and the expertise for an open-sea fishery many miles from shore. They also harvested Dungeness crab and a variety of invertebrates and littoral shellfish, including but not limited to anemones, sea cucumbers, razor clams, California and blue mussels, butter clams, and littleneck clams.

The Quileute Tribe has regulated its marine and freshwater fishery for many years. The Quileute today commercially harvest groundfish (including halibut, sablefish, lingcod, and rockfish), Dungeness crab, tuna, smelt, salmon, and steelhead from the marine environment. Seals, sea lions, bivalves (California and blue mussels, razor clams, littlenecks, and butter clams), and other invertebrates are harvested ceremonially and for subsistence. In fresh water, they harvest smelt, salmon, trout, and steelhead commercially as well as for ceremony and subsistence. Salmonids include chinook, coho, sockeye, steelhead, sea trout, and cutthroat trout.

3.4.4.4 The Quinault Indian Nation

The 208,150 acre Quinault Reservation is located in Grays Harbor and Jefferson Counties on the western shore of the Olympic Peninsula. The western boundary of the triangular reservation is the Pacific Ocean coastline, stretching about 26 miles. On the other sides, the Reservation is surrounded by a mixture of public and private lands. The northern boundary is primarily shared with the Olympic National Park and Olympic National Forest. Private land holdings border the south and southeastern boundaries. Much of the surrounding forest is managed for timber production by the Washington Department of Natural Resources and private interests. To the east lies Olympic National Park, and beyond it, Lake Quinault and a Forest Service wilderness area. The Olympic National Park was designated a Biosphere Reserve by UNESCO in 1976 and a World Heritage Site by UNESCO in 1981, based on an evaluation by the International Union for the Conservation of Nature.

The Reservation's 26 miles of coastline is part of a unique, largely undeveloped, stretch of coastline widely recognized for its international, national, and regional importance. In 1907, the Copalis National Wildlife Refuge, encompassing portions of the Reservation, was established. In 1970, the Copalis Refuge, together with the Quillayute Needles and Flattery Rocks Refuges were designated as wilderness areas. Recently, the Olympic Coast National Marine Sanctuary was established adjacent to and north of the Reservation. The Quinault U&A includes the portion of the FMA between 47°40'06"N (Destruction Island) and 46°53/18"N (Point Chehalis) and east of 125°44'00"W.

The Quinault Indian Nation includes descendants of Quinault, Queets, Quileute, Hoh, Shoalwater, Chehalis, Cowlitz and Chinook ancestors. The Quinault hunted and fished the Clearwater, Queets, Salmon, and Quinault Rivers (including Lake Quinault and the Upper Quinault tributaries), the Raft, Moclips, and Copalis Rivers, and Joe Creek. They also relied on ocean fisheries in the waters adjacent to their territory.

In addition to the salmon and steelhead fished in the rivers, the Quinault Nation also fishes the ocean areas adjacent to its territory for chinook and coho salmon, halibut, eulachon, trout, smelt, lingcod, rockfish, sablefish, sturgeon, flatfish, various other groundfish, albacore tuna, and shellfish (including razor clams) within their U & A.

The Quinault Indian Nation has regulated its river fisheries since 1916, both for a commercial and sports fishery. It has regulated its off-reservation river fisheries and ocean fisheries since 1974. As a self-regulating tribe, the tribe also regulates the fishery and all other activities on Lake Quinault and its Reservation beaches. Along with the rivers and streams that run through the Quinault Reservation, Lake Quinault is entirely within the Reservation. Reservation beaches and Lake Quinault are closed to non-members except by permission of the Quinault government. The tribe has on occasion closed its waters to all fishing and prohibited certain types of gear in order to conserve fish runs.

3.4.4.5 Tribal Communities: Income, Poverty, Economy, Infrastructure

The overall population of Washington state was just under 6 million in the year 2000 census. American Indian and Alaska Native persons make up 1.6% of Washington population (Table 3.4.3) and 0.9% of US population. The population of Clallam County was 64,525 in 2000 and 56,494 in1990. Clallam County had 2,695 American Indian and Alaska Natives in 1990 and 3,303 in 2000, making up 5.1% of the county population. The population in Grays Harbor County was 67,194 in 2000, and Jefferson County was 25,953.

Enrollment figures for the Hoh Tribe indicate 147 members in 1977-1998 (Tiller and Chase 1999). Enrollment figures for the Makah were 2,300, with 706 for the Quileute and 2,217 for the Quinault. Other enrolled members live off-reservation in nearby Forks, other portions of Clallam County, other Washington counties, and elsewhere in the nation.

Table 3.4.3. Profile of Selected Economic Characteristics of Northwest Indian Tribes, 2000. Data set: Census 2000 American Indian and Alaska Native Summary File (SFAIAN) - Sample Data, 5/24/04.

	Washington	Clallam County	Grays Harbor Co	Jefferson Co.	Hoh Reservation	Makah Reservation	Quilleute Reservation	Quinault Reservation
Population (16 yrs and older)	4553591	52,214	52,065	21,502	139	912	249	910
Tribal service population a/	--	--	--	--	97	1,868	700	3,203
% American Indian or Alaska Native	1.6%	5.1%	4.7%	2.3%	--	--	--	--
Unemployment rate	6.2%	7.7%	8.3%	6.7%	NA	23.7%	27.4%	14.7%
Number of Households	2272261	27187	26807	11649	31	470	124	413
Median household income	$45,776	$36,449	$34,160	$37,869	$21,925	$24,091	$21,750	$26,488
Median family income	$45,776	$44,381	$39,709	$45,415	NA	$27,946	$21,250	$27,500
Per Capita Income	$22,973	$19,517	$16,799	$22,211	NA	$10,986	$9,589	$9,621
Poverty Status (1999)								
Families	7.3%	8.9%	11.9%	7.2%	34.6%	26.8%	37.3%	27.3%
Individuals	10.6%	12.5%	16.1%	11.3%	42%	31.3%	34.5%	27.2%

a/ "Tribal service population" is the tribe's estimate of all American Indians and Alaska Natives, members and non-members, who were living "on or near' the tribe's reservation during the 2001 calendar year and who were eligible to use BIA funded services. Typically, Indians included in a tribe's service population live within a reasonable distance of the reservation from where they can access the tribe's services.

Income Census 2000 figures for Washington State as a whole show median household money income of $45,776 with 10.6% of persons below poverty (see Table 3.4.3). Washington's per capita income for 2000 was $30,380. For comparison, median household money income for the Nation as a whole was $37,000 with 13.3% persons below poverty (1997 model-based estimate for US). Clallam County median household income was $25,434 (1990 Census) and per capita income of $12,798 (1990 Census). Clallam County's per capita income is $19,517 for 2000. The median family income is $44,381. Grays Harbor median household money income, 1997 model-based estimate, is $31,091 with 16.2% persons below poverty. (2000 Census)

Poverty Status Washington's poverty status in 1999 for families is 7.3% and 10.6% for individuals. Clallam County's poverty in 1999 for families is 8.9% (2000 Census) and 12.5% for individuals. Jefferson County's poverty in 1999 for families is 7.2% and 11.3% for individuals. Grays Harbor County's poverty in 1999 for families is 11.9% and 16.1% for individuals.

Census figures (2000) consider all Native Americans in the vicinity of the reservation (the service area), not just the stated tribe. Various data sources differ in their population estimates and tribal enrollment figures, which makes it difficult to precisely determine conditions for individual tribes. However, the data are consistent in their general description of social and economic conditions on and near the reservations and for the Indian people in the region.

For the Hoh reservation, poverty rates for individuals is 42% and 34.6% for individuals with families. For the Makah Tribe, the poverty rate is 31.3% for individuals and 26.8% for families. For the Quileute, according to 2000 Census figures (taken from Factfinder Page on Internet), Median Household Income for the Quileute Tribe was $21,750, compared to $36,449 for Clallam County, $45,776 for the State of Washington, and $41,994 for the U.S. The percentage of Quileute individuals below the poverty level is well above the national and regional levels: 34.5% for the reservation, compared to 12.5% for Clallam County. On the Quinault reservation, 27.3% with families and 31.5% of individuals lived in poverty (2000 Census).

Economy Hoh: Most is derived from fishing and shell fishing (NPS/Tribes of the Olympics). The tribe operates a fish hatchery program.
Makah: The fishing industry represents the most important aspect of the Makah's economy. Presently, about 110 tribal members find full-time employment in fishing for salmon, halibut, whiting, sablefish and other groundfish, and sea urchins. A fish buying and processing plant employs another 25 members.

Quileute: The economy of the Quileute Tribe is now, as in the past, strongly tied to fishing. Reductions in the fishery resources that have resulted in reduced allowable harvests have impacted the tribe's economy. Restoration efforts have improved the condition of some salmon populations, but benefits have been offset by reductions in marine fishing opportunities. The tribe has a small fishing fleet, and the small boats typically must stay in port during small craft warnings. The tribe is working to obtain larger vessels to overcome this handicap, but is facing financial constraints.

The largest source of income to Quileute is the fishery. While only 10% of the labor force is actually participating in the fishery, almost 50% of the government staffing is dedicated to natural resources; QNR is a major employer on the reservation. Further, other reservation businesses such as the seafood packing plant, the marina, the restaurant, and the resort are tied to local fishing. Other funds come into the community for government operations under federal and state programs, including leasing to the USCG, operation of public utilities, housing, a clinic, a tribal school, a tribal court, and other government functions. The tribe is continuously striving to improve and enlarge its resort along First Beach.

Quinault: (NPS/Tribes of the Olympics) The tribe has its own seafood processing plant that processes a variety of seafood products and markets them under the label "Quinault Pride."

Labor Force Status The 1990 Census indicated there were 70 Hoh members 16 years and over in the areas, 41 of whom were in the labor force. The online data from the 2000 Census do not show the Hoh reservation. On the Quileute Reservation, according to 2000 Census figures (Factfinder on the Internet), the number of persons 16 years and over is 249, of which 14.6 % are in the labor force. Eleven enrolled members work directly in the fishery, and related positions in the seafood plant, the restaurant, the resort, and Natural Resources are tied directly to the fishery. An estimated 50 more tribal members work in these positions.

Infrastructure Makah: Makah have a marina which opened in 1997. It is open year round and consists of 200 slips, ranging from 30' to 70'. The marina can accommodate vessels up to 200' in length. Each slip has running water and full electrical service. A waste water pump out station is also located at the marina.

Quileute: The Quileute marina was completed in the 1990s (some parts open before final completion). Some 90 slips are available, 50 for vessels up to 60' and 8 for larger vessels. The marina has 30-amp power plug-ins and fresh water faucets/hoses between each slip, and a waste water pump-out station has been constructed. State Route 110 links US Hwy 101 to the Reservation and goes all the way to the waterfront. A seafood packing plant is located at the mouth, adjacent to the marina and the road. Sport fishermen, commercial fishermen, pleasure craft, and the Coast Guard use the marina.

The waters off the Pacific coast that include the Quileute U&A are considered some of the most dangerous on the coast. A U.S. Coast Guard station is based in La Push in the harbor of the Reservation—La Push is the only safe harbor between Neah Bay and Westport. The tribe has a marina with some 90 slips, 50 of which can hold vessels up to 60 feet in length. There are 8 places on the ends of the slips for larger vessels. The tribe leases a seafood packing plant on its premises to an outside company, which serves buyers on the reservation as well as commercial enterprises in Port Angeles and elsewhere. The dangerous bar at the mouth of the Quillayute and the high seas just off shore, as well as hidden and visible sea stacks, make the Coast Guard an essential part of this coast. During severe weather, the Coast Guard sometimes closes the bar. A jetty protects the boats from the Quillayute River currents. The Army Corps of Engineers regularly dredges the river to keep the port open. It is the only safe harbor between Neah Bay and Westport.

Quinault: The tribe owns a seafood processing plant established in 1961 in Taholah, WA. The tribe also owns a receiving facility in the city of Aberdeen and a marina in Ocean Shores.

3.4.4.6 Tribal Groundfish Fisheries

The Makah Tribe has the largest fleet of groundfish and/or halibut vessels, followed by the Quinault (Table 3.4.4). Most tribal fishers who target groundfish and/or halibut fish with hook-and-line gear. Only the Makah Tribe also uses trawl vessels that are equipped to fish midwater trawl gear. Tribal fisheries harvest a variety of groundfish and other marine fish species (Table 3.4.5). The primary groundfish species targeted by tribal fisheries are sablefish and Pacific whiting. Tribal fishers also take small amounts of black rockfish in their *USUAL AND ACCUSTOMED FISHING AREAS*. The Tribes and NOAA Fisheries have negotiated formal allocations for sablefish and Pacific whiting. In addition, the tribes' anticipated black rockfish catches are taken into account when the Council makes its annual harvest recommendations. There are also several groundfish species taken in tribal fisheries for which the tribes have no formal allocation.

Table 3.4.4 Number of Tribal longline and trawl vessels used to fish for groundfish and/or halibut (source: Jones, NWIFC).

	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

In most recent years, Pacific whiting accounted for the bulk of tribal groundfish harvest tonnage (PFMC, 2003d). In 1999 and 2000, 32,500 mt of whiting was set aside for treaty Indian tribes of the U.S. OY of 232,000 mt for 2000. In 2001 and 2002, the whiting OY was reduced to 190,400 mt and 129,600 mt, respectively, and the tribal allocations for those years were also reduced to 27,500 mt and 22,680 mt, respectively. To date, only the Makah Tribe has fished on the tribal whiting allocation.

In terms of exvessel revenue, sablefish landings have provided well over half of total tribal groundfish revenue in each year except 1998, 1999 and 2002 (PFMC, 2003d). Approximately one-third of the tribal sablefish allocation is taken during an open competition fishery. This portion of the allocation tends to be taken during the same period as the major tribal commercial halibut fisheries in March and April. The remaining two-thirds of the tribal sablefish allocation is split among the tribes according to a mutually agreed-upon allocation scheme.

The bulk of tribal groundfish landings, other than Pacific whiting, occur during the March-April halibut and sablefish fisheries. A small number of tribal fishers use bottom trawl gear. Most continental shelf species taken in the tribal groundfish fisheries are taken during the halibut fisheries, and most slope species are similarly taken during the tribal sablefish fisheries. About one-third of the tribal sablefish allocation is taken during an open competition fishery, in which member vessels from the sablefish tribes all have access to this portion of the overall tribal sablefish allocation. The open competition portion of the allocation tends to be taken during the same period as the major tribal commercial halibut fisheries in March and April. Tribe-specific sablefish allocations are managed by the individual tribes, beginning in March and lasting into the autumn, depending on vessel participation management measures used. Participants in the halibut and sablefish fisheries tend to use hook-and-line gear, as required by the IPHC for halibut.

In 2004, tribal sablefish longline fisheries were allocated 10% of the total catch OY (751 mt) and then were discounted 3% of that allocation for discard mortality, for a landed catch allocation of 728.5 mt. For the commercial harvest of black rockfish off Washington State, the treaty tribes have a harvest guideline of 20,000 lb (9,072 kg) north of Cape Alava (48°09'30" N. lat.) and 10,000 lb (4,536 kg) between Destruction Island (47°40'00" N. lat.) and Leadbetter Point (46°38'10" N. lat.).

In addition to these hook-and-line fisheries, the Makah Tribe annually harvests a whiting allocation using midwater trawl gear. Since 1996, a portion of the U.S. whiting OY has been allocated to the Pacific Coast treaty tribes. To date, only the Makah Tribe has fished on the tribal whiting allocation.

Table 3.4.5. Groundfish catch (excluding whiting) and bycatch (in pounds) in Indian fisheries, 2000-2003. Data from Rob Jones (NWIFC) 5/17/04.

	Makah Midwater Trawl				**Makah Bottom Trawl**			
	2000	2001	2002	2003	2000	2001	2002	2003
black rockfish	0	0	0	0	0	53	0	23
lingcod	0	6	215	66	7	508	9,603	29,544
canary	306	1,366	3,151	895	24	0	1,068	624
yelloweye	0	0	53	0	0	0	0	0
widow	2,036	11,549	27,639	20,438	0	0	0	3
yellowtail	67,872	190,494	577,510	548,664	563	505	5,909	31,025
POP	0	0	0	0	0	0	0	0
darkblotched	0	102	2,898	32	0	0	0	0
shortspine thornyhead	0	0	0	0	0	0	283	1,364
	Makah Troll				**Makah Longline**			
	2000	2001	2002	2003	2000	2001	2002	2003
black rockfish	0	0	0	84	0	0	0	0
lingcod	1,958	773	2,006	1,935	3,434	6,138	10,793	11,715
canary	381	607	1,189	753	19,547	2,330	597	931
yelloweye	988	43	83	0	523	2,075	1,819	0
widow	0	32	0	5	3	19	0	0
yellowtail	8,948	7,060	7,071	17,994	0	382	235	690
POP	0	0	0	0	0	0	0	0
darkblotched	0	0	0	0	0	0	0	0
shortspine thornyhead	0	0	0	0	7,662	10,081	9,229	11,531
sablefish (pounds)					490,229	464,723	227,740	493,616
	Quileute Longline				**All Tribes Total** a/			
	2000	2001	2002	2003	2000	2001	2002	2003
black rockfish	30	0	0	0	30	53	0	107
lingcod	144	1,599	1,074	119	5,543	9,024	23,691	43,379
canary	74	25	117	20	20,332	4,328	6,122	3,223
yelloweye	2,365	4,224	3,287	520	3,876	6,342	5,242	520
widow	0	0	0	0	2,036	11,963	27,874	21,136
yellowtail	63	19	74	154	77,449	198,097	590,564	597,837
POP	0	0	0	0	0	0	0	0
darkblotched	0	0	0	0	0	102	2,898	32
shortspine thornyhead	624	482	91	137	8,286	10,563	9,603	13,032
sablefish	164,016	143,591	92,438	76,352	964,007	896,825	434,447	823,380

a/ includes sablefish taken by Quinault fishers

In 2001 and 2002, the landed catch OY was set at 190,400 mt and 129,600 mt, respectively, and the tribal allocations for those years were 27,500 mt and 22,680 mt, respectively. In 2003 and 2004, landed catch OY was set at 148,200 mt and 250,000 mt, respectively, and the tribal allocations for those years were 25,000 mt and 32,500 mt, respectively. Makah vessels fit with midwater trawl gear have also been targeting widow rockfish and yellowtail rockfish in recent years.

Twelve western Washington tribes fish for halibut, including the four tribes that fish for groundfish. Specific halibut allocations for the treaty Indian tribes began in 1986. The tribes did not harvest their full allocation until 1989, when the tribal fleet had developed to the point that it could harvest the entire Total Allowable Catch (TAC) off Washington, Oregon and California. In 1993, judicial confirmation of treaty halibut rights occurred and treaty entitlement was established at 50% of the harvestable surplus of halibut in the tribes' combined U&A fishing grounds. In 2000, the courts ordered an adjustment to the halibut allocation for 2000-2007, to account for reductions in the tribal halibut allocation from 1989-1993. For 2000 through 2007, the non-tribal fisheries will transfer at least 25,000 lb per year to the tribal halibut fisheries, for a total of 200,000 lb to be transferred to the tribal fisheries over the period. Tribal allocations are divided into a tribal commercial component and the year-round ceremonial and subsistence component.

Tribal commercial halibut fisheries have historically started at the same time as Alaskan and Canadian commercial halibut fisheries, generally in mid-March. The tribal halibut allocation is divided so that approximately 80–85% of their allocation is taken in brief open competition derbies, in which vessels from all halibut tribes compete against each other for landings. In 2003, two of these unrestricted openings were held in the spring: a 48-hour opening on March 1-3 and a 36-hour opening on April 15-16. In addition to these unrestricted openings, 15-20% of the tribal halibut allocation is reserved for restricted fisheries, in which participating vessels are restricted to a per trip and per day poundage limit for halibut. Three restricted opening opportunities were available in 2003: March 1-31, April 2-6, and April 22-30. Similar to the unrestricted openings, these restricted openings are available for vessels from all halibut-fishing tribes.

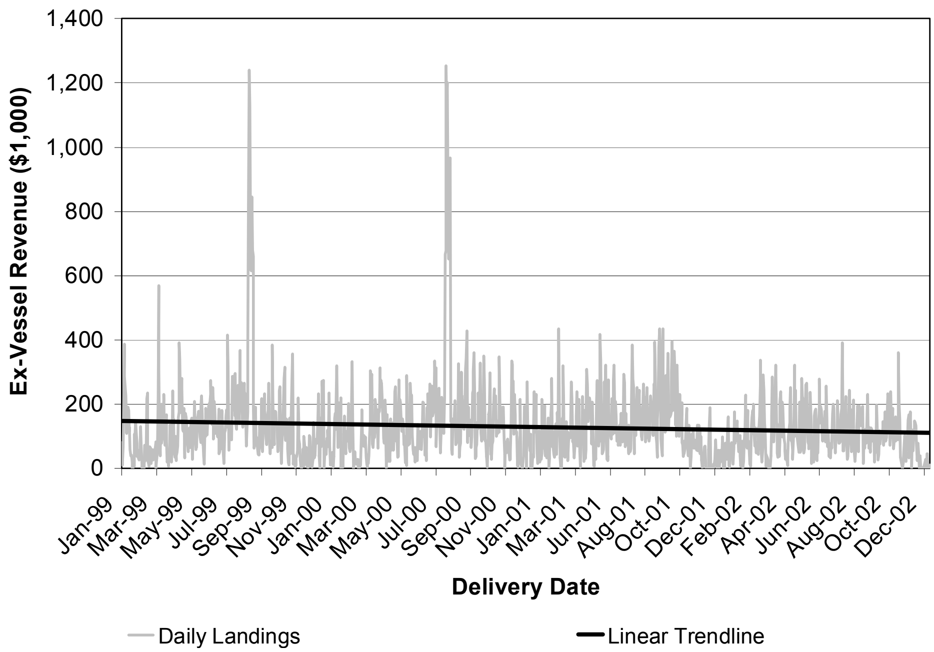
3.4.5 Buyers and Processors

With the exception of the portion of Pacific whiting catch that is processed at sea, all other Pacific coast groundfish catch is processed in shore-based processing plants along the Pacific coast. The majority of the whiting catch is delivered to Oregon processing plants, so total groundfish landings in Oregon are substantially larger than the other states. By weight, 2002 commercial shoreside groundfish landings were distributed 28% to Washington, 56% to Oregon, and 16% to California. In contrast, the exvessel value was 22% to Washington, 40% to Oregon and 32% to California. The difference is because Oregon processors handle a relatively high proportion of the whiting landings, while California fishers land proportionately more high value species.

One of the primary goals of the West Coast Groundfish FMP is to ensure a steady flow of fish to buyers and processors throughout the year. This section examines flows of non-whiting groundfish to buyers and processors and attempts to determine the impact of 2-month cumulative trip limits.

Figure 3.22 shows ex-vessel value of West Coast groundfish landings (excluding Pacific whiting) from 1999-2002. While the data reflect a general downward trend in revenues, they also show that there is a relatively steady overall flow of groundfish landings. In other words, the management regime appears to be relatively successful in maintaining a steady flow of product to seafood processors. It should be noted that fishery-wide data may mask variation in product flow to individual processors.

Table 3.4.4Value of daily landings of groundfish (excluding Pacific whiting), 1999-2002. Source: PacFIN.



However, data also suggest that large buyers of groundfish have been hit hard by decreases in groundfish harvest. There was a 36% decline in buyer counts between 1995 and 2000 for those entities where groundfish was greater than 33% of their purchases and total purchases were greater than $10,000 (OCZMA, 2002). The number of buyers with total purchases greater than $1.5 million decreased by 56%.

The precipitous decline in the number of business entities is due both to reduced deliveries of groundfish and the overall consolidation within the processing industry (OCZMA, 2002). The buyer/processor sector has become quite concentrated, with approximately 5% of the buyers responsible for 80% of purchases (PFMC, 2003b). The largest buyers tend to handle trawl vessels more than smaller buyers. Of the 38 largest buyers of groundfish (those with purchases in excess of $1 million), 73% bought from trawl vessels.

3.4.6 Fishing Communities

The groundfish fisheries have historically provided West Coast commercial harvesters and processors with a relatively steady source of income over the year, supplementing the revenues earned from more seasonal fisheries. By maintaining year-round fishing and processing opportunities, the 2-month cumulative trip limits have promoted year round employment in coastal communities. However, the downward trend in revenues caused by lower catch limits and area closures has had a significant negative economic impact on local businesses that are directly or indirectly involved in and are supported by the groundfish fisheries. In particular, the decrease in groundfish catches has had a direct and significant negative impact on individual fishing enterprises. Fishery participants have suffered from a loss of earning potential, investment value and lifestyle. Some fishing operations have been forced to change fisheries or leave the industry. The groundfish crisis has also had a significant effect on the shoreside part of the industry (Chambers, 2002). Included are individuals or firms that process, distribute and sell fishery products and enterprises that provide goods and services to the fish-harvesting sector, such as chandlers, gear manufacturers, boatyards, tackle shops, bait shops and insurance brokers. While the percentage of business derived from the groundfish fisheries may be relatively small for some of these firms, any permanent loss of income during this extended period of stagnation in the U.S. economy could affect their economic viability.

On the other hand, when examined from a community frame of reference, the economic contribution of the harvesting and processing of groundfish fishery resources to the total economy of even small coastal communities is diluted by the relative scale of other economic activities, such as tourism and the wood products industry.

Those who have become unemployed face the social and psychological costs of job loss. Individuals who lose their jobs typically experience heightened feelings of anxiety, depression, emotional distress and hopelessness about the future, increases in somatic symptoms and physical illness, lowered self-esteem and self-confidence, and increased hostility and dissatisfaction with interpersonal relationships. In addition, both spouses and children of such individuals are at risk of similar negative effects. Families may find it difficult to pay bills and afford transportation, health care, and even food and clothing. The results of this financial strain may be high levels of psychological distress among some family members as well as an increase in physical health problems.

In addition to economic losses associated with declines in landings and revenues, there has been the loss of lifestyle to contend with. It is likely that enjoyment of the lifestyle or work itself is an important motivation for fishing among fishery participants. Moreover, some individuals may be motivated to fish for a living by a long-term family tradition. The loss of fishing-related jobs has caused some individuals to abandon the fishing life style. A decrease in the economic viability of the commercial fishing lifestyle has, in turn, diminished the influence of local maritime culture in some communities. The groundfish fisheries are a historically important component of an industry that is deeply intertwined with the social and cultural resources of some coastal communities. For example, the Newport Beach dory fishing fleet, founded in 1891, is a historical landmark designated by the Newport Beach Historical Society.

It is also important to recognize that fishing communities are typically dynamic and continually adapting to change (Gilden, 1999). Despite reductions in groundfish fisheries, other substantial and well managed fisheries remain available to West Coast fishers — Dungeness crab, sardines, Pacific shrimp and albacore tuna (OCZMA, 2002). Many commercial groundfish fishers have already diversified their fishing operations to include these non-groundfish fisheries. Processors, wholesalers, distributors and brokers are obtaining their groundfish from other sources or have looked for substitute products. This period of transition for the communities involved in the groundfish fisheries has been eased by Congressional appropriations for economic adjustment and recovery programs. In 2000, for example, the Federal government appropriated $5 million in social services to the states of California, Oregon and Washington to mitigate the effects of the groundfish crisis. While this level of government assistance is unlikely to continue, coastal communities are expected to continue to find ways to successfully adapt to contracting groundfish fisheries, although many more individual businesses involved in these fisheries will likely face economic hardship and possible bankruptcy.

3.4.7 Consumers of Groundfish Products and Other Members of the General Public

Consumers of groundfish products have a number of substitutes for West Coast groundfish products in the regional food distribution (PFMC, 2003d). Most supermarkets and restaurants do not rely on local supplies to stock their shelves or prepare menus (although some retail or restaurant patrons may place a premium on knowing the product they are purchasing is locally caught (Parrish et al., 2001)). Locally caught products are often replaced with close substitutes obtained from elsewhere in the global supply chain. Although rockfish caught in West Coast fisheries are considered to be of high quality and are valued in West Coast fresh markets, similar products from South America, Mexico, Canada or Alaska can substitute for West Coast production.

Marine ecosystems and species associated with them provide a broad range of benefits to the American public (National Research Council 2001). Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. For example, in addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing and research and education (Carter 2003; Parrish et al. 2001).

Furthermore, some people may not directly interact with the marine environment, but derive satisfaction from knowing that the structure and function of that environment is protected.

Members of the public, in particular representatives of various environmental organizations, have advised the Council and NOAA Fisheries to endorse the recommendations of the National Research Council 2001 report and the 2003 PEW Oceans Committee report regarding MPAs to protect large numbers of species, their interrelationships, and maintenance of natural processes. They believe these positive effects on marine ecosystems and associated species would lead to a significant increase in the levels of the range of benefits these ecosystems and species provide. However, MPA-related changes in these benefits have not been estimated. It is also important to note that some individuals may hold religious or philosophical convictions that humankind has an ethical obligation to preserve species and ecosystems, notwithstanding any utilitarian benefits. Parrish et al. (2001) note that a 1999 survey conducted by the Mellman Group for SeaWeb found a high level of approval for the establishment of MPAs. Seventy-five percent of the individuals surveyed favored having certain areas of the ocean as protected areas; 60% believed that there should be more marine sanctuaries; and 3% believed there were already too many marine sanctuaries. Survey respondents cited the following as convincing reasons for creating MPAs: 1) distinctive areas should be protected similar to what is done for national parks (65%); 2) less than 1% of U.S. waters are in MPAs (63%); 3) MPAs would be an important step in improving the health of oceans (58%); 4) harmful activity should be restricted in order to preserve ocean beauty for future generations (57%). Support for MPAs diminished by only 1% when respondents were first read a statement outlining potential negative socioeconomic effects of creating MPAs and increased by 6% when respondents were first read a statement outlining potential positive effects of creating MPAs.

Additional surveys and polls are needed to better understand the values and motives underlying public support of measures that protect marine species and ecosystems, as well as the extent of public support.

3.4.8 Fishing Vessel Safety

Low earnings on the part of individual harvesters limit funds for maintenance and safety equipment. Poor maintenance, bad weather and a desperate need to fish may to lead to significant incidence of injury and losses in life and capital (Young, 2001). In addition, as revenues in the fishing industry decline, vessel owners and captains report it has become more difficult to find, hire, and keep qualified crew. While there are many skilled and capable crew members working on West Coast commercial fishing boats, many who once would have been attracted to the industry are discouraged by increasing regulations and by the apparent lack of a promising future. Conversely, the industry attracts people who are unable to find work elsewhere, and who lack the requisite skills and training.

Some are itinerant, and do not stay long enough to be fully trained or invested in vessel operations—including safety (Gilden and Conway, 2000). To the extent that the groundfish crisis will deepen in the future, these negative effects on fishing vessel safety are likely to continue.

3.4.9 Management and Enforcement

The current groundfish management program relies heavily on trip limits to control fishing effort, with a major goal to maintain commercial groundfish production over the year. Usage of the term "trip limit" has evolved over the past 20 years; initially it referred to the amount of fish a commercial vessel was allowed to catch and retain on a single fishing trip. Over time, this was modified to include trip frequency limits and ultimately the amount of groundfish that may be caught and retained during a specified period of time, typically one or two months. A critical feature of trip limits is that they do not directly limit the amount of catch, but rather only the amount groundfish that may be retained and delivered for sale. Commercial vessels are allowed (and expected) to discard unusable fish and any fish in excess of a specified limit. This approach creates what is referred to as perverse incentives, which means some of the effects are contrary to what is desired. Specifically, trip limits are intended to slow the rate of groundfish harvest so the fishery may remain open all year. However, in reality, it is only the rate of retention that is directly controlled, and the actual catch is only indirectly controlled. Some amount of discarding (called *REGULATORY BYCATCH*) is required each time a vessel reaches a retention limit. Under trip limits, a vessel is not restricted from continuing to fish, but only restricted from retaining any more of the particular species. Also, only the amounts retained and delivered must be reported and recorded under the no action alternative; commercial vessels are not required to report any discarded fish.

This trip limit program was more successful when stocks were near pristine levels and trip limits were fairly liberal; relatively few vessels bumped up against the limits. However, as trip limits were reduced in response to declining stock size and/or premature OY attainment, the rate of discard of many species became critical. Lack of accurate records of total catch (that is, retained plus discarded) could jeopardize efforts to rebuild overfished groundfish stocks and could lead to unintentional overfishing. In addition, there were few records of incidental take (bycatch) of non-groundfish species.

Federal funds have not been available to monitor bycatch in the West Coast groundfish fishery until recently, and NOAA Fisheries has relied primarily on state monitoring programs that have not adequately recorded total catches. To avoid a costly and controversial on-board observer program, in the face of excessive competition and depleted stocks, NOAA Fisheries and the Council have developed an increasing complex management approach, usually without the means to monitor its effects and effectiveness. As regulations have become more complicated and restrictive, compliance has dropped along with public respect for the management program.

Beginning in 2002, large areas, corresponding to general locations of overfished groundfish species, have been closed to reduce the likelihood those species might be caught accidentally. To the degree the closures correspond to where the overfished fish are, this approach can effectively prevent bycatch of those species. However, traditional enforcement methods are inadequate for such extensive boundaries. Also, the shape of a closed area influences both monitoring complexity and ease of compliance.

3.4.10 Catch and Bycatch Monitoring Programs

[This section includes material from the NOAA Fisheries report titled *Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs*, December 2003, as well as information on the observer program from the NOAA Fisheries Northwest Fishery Science Center website and the 2003 NOAA Fisheries Bycatch Plan. Those documents are hereby incorporated by reference.]

Several types of monitoring programs have been developed to estimate fisheries bycatch. These include the use of data collected aboard fisheries research vessels and chartered vessels, self-reporting by fishermen and/or other industry representatives, at-sea fisheries observers, video cameras, digital scanning devices, alternate platforms or remote monitoring, and stranding networks. The choice of which method to use for monitoring bycatch in any particular fishery is based on a number of factors. These factors may also determine the practicability of bycatch monitoring and reduction methods.

- **Quality –** in general, how precise and how accurate are the data that are collected?
- **Completeness –** does sampling cover the entire range of the fishery or fisheries that interact with the species of concern?
- **Credibility –** how well do the data stand up to scrutiny by affected stakeholders and other constituents?
- **Cost –** what are the relative expenses associated with the sampling method, and are there economies of scale that can be realized?
- **Timeliness –** how quickly are the data available to fisheries scientists and managers?
- **Safety –** how safe is the methodology compared to other monitoring methods, and what safeguards are in place to ensure the safety of the data collectors?
- **Logistics –** how easily is the monitoring program implemented and maintained?

Most of the fishery data collection programs are conducted under state regulatory authority rather than federal regulations. The notable exceptions are the at-sea whiting fishery and the federal groundfish observer program.

3.4.10.1 State Commercial Fish Ticket Programs and the Pacific Fishery Information Network (PacFIN)

Washington, Oregon and California state regulations require completion of a written record (fish ticket) of the amounts of fish landed by commercial fishing vessels. The federal groundfish management program acknowledges these data collection programs and relies on this source of information for most commercial groundfish catch statistics. Although all three states collect the same type of information, each state defines the format of its fish tickets and the species categories.

In California, official landing receipts must be completed for all fish or shellfish purchased or received by commercial fish dealers (persons licensed as a fish receiver or multi-function fish business). There are several types of landing receipts, and the fish dealer determines which landing receipt is used based on the fishing gear used and the market categories that compose the landing. The fish dealer is legally obligated to include the date, market category, landing weight, price, port, gear, area fished, vessel registration number and name, dealer number and name, and fisher license number and name on each landing receipt. The market categories listed on the landing receipts represent individual species or groups of species. Market categories are defined by different sizes of fish, price, or mandated by federal/state regulations. Historically, as many as 94 groundfish market categories have been officially recognized by CDFG, including 47 nominally single species rockfish market categories and 10 multi-species rockfish market categories.

In Oregon, any fish dealer who purchases groundfish from a commercial fisher is required to complete an Oregon Fish Receiving Ticket, indicating the weight and value of the fish purchased. ODFW determines the physical format of the ticket and the official market categories under which the fish must be landed. Market categories have been established for all species that must be separated before or upon delivery. More than 89 official market categories have been used by ODFW.

Washington's Marine Fish Receiving Ticket is the official document used to record the landed weight and value by species of designated marine food fish. Additionally, the fish ticket must identify the fisher, their address, vessel name, vessel registration number, the fishing gear, date of landing, area fished, the processor purchasing the fish, whether the fish were caught within three miles of the coast (state waters), within 200 nautical miles (federal waters) or outside 200 nautical miles (international waters), and the number and amount of fish retained by the crew for personal use. Market categories recorded on the fish ticket are established by WDFW in accordance with the selling practices of the fish processors. Several codes and species descriptions are preprinted on the fish ticket: any other market categories must be handwritten onto the fish ticket. The processor is required to list purchases of any species with an explicit trip limit in a separate market category.

The PacFIN central database includes fish-ticket and vessel registration data provided by the Washington, Oregon, and California (W-O-C) state fishery agencies. In addition, the W-O-C data sources supply species-composition and catch-by-area proportions developed from their port sampling and trawl logbook data systems. NOAA Fisheries/NWR supplies the central database with limited-entry permit data, and U.S. Coast Guard vessel data is also incorporated.

3.4.10.2 State Logbook Programs

West Coast groundfish trawl vessels are required by state regulations to record their retained catch in logbooks; they are not required to record amounts of discarded fish or other species. Although some other commercial vessels are also required by state regulations to record catch information in logbooks, that information is seldom entered into electronic databases for analysis. Some information from trawl logbooks is integrated with other information for management and for stock assessments.

The accuracy of self-reporting (logbooks) has been evaluated from comparisons of discard information derived from logbooks or vessel trip report systems and observers (either on the same trips or operating in similar areas). For example, researchers compared logbook data submitted by Hawaii longline fishermen to observer data (Walsh 2000). The study compared the accuracy of logbook data on important commercial species versus species of lesser importance, or species caught in great numbers. The study also examined the accuracy of fish identifications and compared logbook data to landings receipts (fish tickets). The study found biases due to under reporting in logbooks, species identification errors by both novice observers and fishermen, difficulties by both groups in counting abundantly caught species, and incorrect use of logbooks (e.g., recording data in the wrong area of the logbook). The study also determined that the most common errors in logbooks were under reporting of catches and rounding of values reported for abundantly caught species catch. Logbooks may not be reliable for estimating bycatch of abundantly caught species or species of lesser economic value (NMFS 2003c).

The costs of logbook programs to the agency include producing and distributing the logbooks, data entry, database maintenance, and analytical costs. These costs are typically less than the costs of observer programs, if compared on a per sea day basis.

In summary, where fishers are required to record bycatch, logbooks may provide qualitative estimates; however, the accuracy of these data is of concern. Logbooks are more useful in providing estimates of total effort by area and season that can then be combined with observer data to estimate total bycatch. With respect to safety, there are minimal concerns associated with logbook programs, compared to at-sea data collection programs. Logistics associated with processing the data collected have limited the usefulness of the data. However, this may be improved by recent technology advancements designed to increase the speed at which data are transferred while also improving the quality of data submitted.

3.4.10.3 State Port Sampling

West Coast port samplers are typically state employees or contracted biologists (typically through PSMFC) trained to collect fishery information and biological samples of fish that are brought to shore. Samplers collect information primarily on catch, but also bycatch when available. As with logbook data, there are significant concerns about the completeness and accuracy of bycatch data collected by port samplers. Biological sampling is limited to only the landed catch, and does not include sampling of any discarded species. This is a major shortcoming, especially when discard rates are substantial. In addition, port sampling typically results in only a small sample of total fishing effort.

It would be possible to create a port sampling program in conjunction with a requirement that fishers retain all their catch and a system to verify that no discard takes place. In effect, this would be an onshore observer program that could avoid much of the cost associated with at-sea programs. This type of program has been use for the shore-based whiting fishery to monitor salmon bycatch. However, there are substantial issues relating to full retention, such as disposal of unmarketable species and disposition of marketable fish beyond local market needs.

3.4.10.4 Recreational Sampling West Coast recreational data have been collected under the annual Marine Recreational Fisheries Statistics Survey (MRFSS) and cooperative angler surveys administered by states. The objective of MRFSS is to provide estimates of recreational catch and effort over fairly large strata (by state and two-month wave). The MRFSS data are collected by two independent, but complementary, surveys: 1) a telephone survey of households in coastal counties, and 2) an intercept (i.e., interview) survey of anglers at fishing access sites. The intercept survey is analogous to the commercial port sampling program, with similar advantages and disadvantages. Estimates of bycatch by recreational fishermen are made based upon self-reporting during the intercept. In addition, some recreational catch and bycatch data are collected by observers on charter fishing vessels.

Central California Marine Sport Fish Project The Central California Marine Sport Fish Project has been collecting angler catch data from the Commercial Passenger Fishing Vessel (CPFV) industry intermittently for several decades in order to assess the status of the nearshore California recreational fishery. The project has focused on rockfish and lingcod angling and has not sampled salmon trips. Reports and analyses from the project document trends by port area in species composition, angler effort, catch, and, for selected species, catch per unit effort (CPUE), mean length and length frequency. In addition, total catch and effort estimates are made based on adjustments of logbook data by sampling information.

Before 1987, catch information was primarily obtained on a general port basis from dockside sampling of CPFVs, also called party boats. This did not allow documentation of specific areas of importance to recreational anglers and was not sufficient to assess the status of rockfish populations at specific locations.

CPFV operators are required by California law to record total catch and location for all fishing trips in logbooks provided by the CDFG. However, the required information is too general for use in assessing the status of the multi-species rockfish complex on a reef-by-reef basis. Rockfish catch data are not reported by species and information on location is only requested by block number (a block is an area of 100 square miles). Many rockfishes tend to be residential, underscoring the need for site-specific data. Thus, there is a strong need to collect catch information on board CPFVs at sea. However, locations of specific fishing sites are not revealed since that information is confidential. In May 1987 the Central California Marine Sport Fish Project began on-board sampling of the CPFV fleet. Data collection continued until June 1990, when state budgetary constraints temporarily precluded further sampling, resumed in August 1991, and continued through 1994. The program depends on the voluntary cooperation of CPFV owners and operators. Angler catches on board central and northern California CPFVs were sampled from fourteen ports, ranging from Crescent City in the north to Port San Luis (Avila Beach) in the south. For additional information on this program, see the PSMFC web site at: (www.psmfc.org/recfin/ccmsp.htm).

Oregon Marine Recreational Observation Program In response to overfished species declarations and increasing concerns about fishery interactions with these species, ODFW started this program to improve understanding of recreational impacts. There were three objectives to this project; (1) document the magnitude of canary rockfish discard in the Oregon recreational fishery; (2) improve the biological database for several rockfish and groundfish species; and (3) gather reef location information for future habitat mapping.

A seasonal sampler was stationed in each of the ports of Garibaldi, Newport and Charleston to ride recreational groundfish charter vessels coastwide in Oregon from July through September, 2001. The Garibaldi sampler covered boats out of

Garibaldi, the Newport sampler covered both Newport and Depoe Bay, and the Charleston sampler covered Charleston, Bandon, and Brookings charter vessels. During a typical day the sampler would ride a 5 to 8 hour recreational groundfish charter trip and spend the remainder of the day gathering biological and genetic data dockside from several rockfish and groundfish species for which little is known mostly due to their infrequency in the catch. When allowed by the captain, the sampler also obtained GPS locations of fishing sites for future use by the Habitat Mapping Project of the Oregon Department of Fish and Wildlife (ODFW) Marine Resources Program. Results from this program have been incorporated into recreational fishery modeling by ODFW. For more information on this program as well as other fishery research and survey programs see the ODFW Marine Program web site at: http://hmsc.oregonstate.edu/odfw/reports/finfish.html.

WDFW Ocean Sampling Program In addition to its at-sea data collection program, WDFW collects at-sea data through the Ocean Sampling Program. The at-sea portion is not intended to be an observation program for the purposes of enumerating the bycatch alone but is coupled with shore-based sampling of anglers to calculate an estimated discard weight. At-sea samplers record biological information from discarded species. Shorebased creel surveys of anglers provide the estimate of total number of discards. Combining these two data sources yields estimates of the weight of total fishery discard by species.

3.4.10.5 Federal Vessel Monitoring System (VMS) As of January 1, 2004, every limited entry groundfish vessel is required to carry a Vessel Monitoring System (VMS) unit at all times the vessel is operating. VMS in other regions has proven to be an effective, cost-saving technology for the monitoring and enforcement of large restricted areas over great distances. A VMS is an automated, real-time, satellite-based tracking system operated by NOAA Fisheries and the U.S. Coast Guard that obtains accurate geographic position reports from vessels at sea. The cost of VMS transmitting units has decreased as new technologies have emerged. At this time, VMS transceiver units range in price from approximately \$800 to \$5,295 per unit, installed (PFMC, 2003b). The more expensive units allow two-way communications between the vessel and shore such that full or compressed data messages can be transmitted and received by the vessel.

VMS does not replace or eliminate traditional enforcement measures such as aerial surveillance, at sea patrol boats, landing inspections and documentary investigation (PFMC, 2003b). Traditional enforcement measures may need to be activated in response to information received via the VMS. However, VMS positions can be efficient in identifying possible illegal fishing activity and can provide a basis for further investigation by one or more of the traditional enforcement measures. In doing so, it makes certain activities of investigating officers more cost effective because less time will be spent pursuing false trails and fishing operators who are following the rules. Furthermore, VMS positions in themselves can also be used as the basis for an enforcement action.

Another major benefit of VMS is its deterrent effect (PFMC, 2003b). It has been demonstrated that if fishing vessel operators know that they are being monitored and that a credible enforcement action will result from illegal activity, then the likelihood of that illegal activity occurring is significantly diminished. Beyond the enforcement benefits of the VMS program, NOAA Fisheries expects to use VMS data to better characterize fishing activities by geographic area. This data, in combination with observer and landings data, will improve the NOAA Fisheries' ability to estimate species -specific catch by area.

3.4.10.6 Electronic (Video) Monitoring Electronic monitoring (EM) is an automated alternative to some human data collection systems. EM equipment can provide accurate, timely, and verifiable fisheries data at a lower cost than that provided by an at-sea observer. EM is an integrated assortment of electronic components combined with a software operating system. An EM typically includes one or more video cameras, a CPU with removable hard drive, and software that can integrate data from other components of a vessel's electronic equipment. The system autonomously logs video and vessel sensor data during the fishing trip without human intervention. When the vessel has completed its fishing operations and returned to port, the video and other data are transferred to a separate computer system for analysis. Video records are typically reviewed by human samplers on shore, but electronic techniques are being to developed to automate some of this activity.

Electronic monitoring has been tested in various Canadian fisheries and has successfully addressed specific fishery monitoring objectives. NOAA Fisheries is testing EM equipment in the 2004 shore-based whiting fishery, where discarding is limited by an EFP. Electronic monitoring is a relatively new technology, and standards for data confidentiality and privacy are still being developed.

The cost of an EM unit is about $6,000, plus the additional costs for the labor and analysis components. The estimated overall costs in Canadian fisheries currently using EM systems are $212 (Canadian dollars) per vessel per day for electronic monitoring compared to $470 per day for observers. The cost of video monitoring includes the cost of the equipment (3-5 cameras per vessel and a CPU with a removable hard drive), installation of cameras on vessels, and post-cruise analysis of the video stream. The estimated cost to equip 10 vessels for 60 days, including analysis of video, is approximately $90,000 (McElderry, pers. comm.). The equipment cost could be lower on a per day basis if the units were installed for a longer time period; however, the costs of analyses are more fixed. A report on the use of video monitoring in the Canadian halibut longline fishery provided as Appendix D.

3.4.10.7 Observer Programs Observer programs are a reliable method for estimating bycatch. The quality of the data and the precision and accuracy associated with bycatch estimates are determined by sample size and the design and execution of a robust sampling scheme. Realizing the potential for timely access to observer data can increase the benefits of an observer program relative to other data collection methods. For example, real-time access by fishermen to observer data in the Alaska groundfish fisheries has resulted in reduced bycatch of halibut and, consequently, longer groundfish fishing seasons. Real-time access by fishery managers in Alaska also allows for inseason management of groundfish quotas in terms of total catch and of non-groundfish bycatch quotas. In the West Coast groundfish fisheries, real-time access by fishery managers to observer data collected in the at-sea whiting fishery allow for in-season management. In addition (similar to the North Pacific program), whiting vessels typically submit daily catch and bycatch information to a third party that complies and distributes summaries to the fleet to help minimize salmon bycatch. Information on rockfish bycatch hot spots is also reported and share among the fleet.

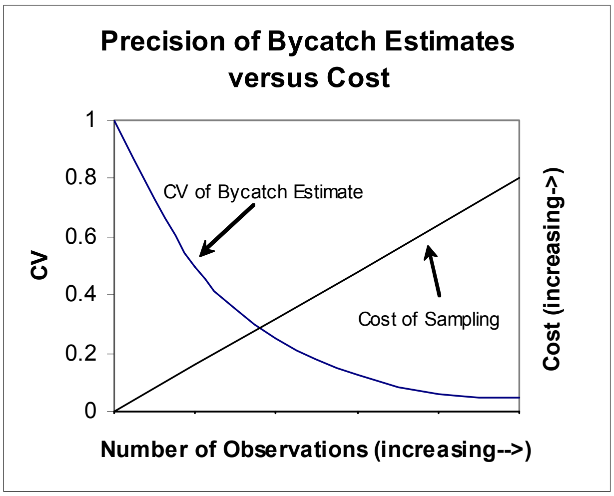
Observer programs can be one of the most expensive monitoring methods available for estimating bycatch, especially if fisheries managers intend to use the data for inseason management. Estimates of cost per observation day are quite variable between fisheries and between regions. Estimates range from $350 to $2000 per observation day (at-sea day). Direct expenses include the cost of recruiting and training observers, salaries and benefits (including premium pay while at sea and on-call pay while waiting for a vessel to depart), contractor profit, travel costs, gear and equipment, and insurance (which can be up to 30% of the cost of a sea day). Variations in these factors influence the wide range of cost estimates. Other factors include logistical difficulties for observers to join trips (lengthy travel, onshore travel costs), insurance, food[3/], data entry, quality control, training, analytical costs and program management. Some of the cost differences arise from differences in who pays for these various costs, whether the program is large enough for economies of scale and the geography of the fishery. Increased costs are associated with observation of seasonal fisheries, fisheries operating in remote areas, low effort fisheries that require 100% coverage, fisheries with unpredictable levels of effort, and fisheries where fishermen embark unpredictably out of any number of ports.

The logistics associated with implementing observer programs and deploying observers can be substantial. Considerations include procurement of observer

3. Some programs also provide a food allowance to the observer or the vessel while the observer is deployed at sea ($20-25/day). Indirect expenses include the salaries and benefits of NOAA Fisheries employees that oversee the largely-contracted workforce, sampling design and data analytical support, data entry, and database design and maintenance.

services, observer training, moving observers around, minimizing down time, and deployment of observers in highly mobile fisheries or fisheries operating out of many ports. Experience in deployment of observers can minimize logistical difficulties.

Table 3.4.4Trade-offs between precision (CV) and cost in observer programs.



The precision of a bycatch estimate is related to the cost and sampling rate of an observer program. The measure of precision commonly used in reference to observer programs is the coefficient of variation, or CV, associated with the estimate of bycatch (the lower the CV, the greater the level of precision). However, at some level of sampling, only incremental decreases in CV may be obtainable despite large increases in sampling (as illustrated in the figure below). As the number of observers or observations increases, the costs increase. The precision of bycatch estimates also increases, but the rate of improvement is slower.

Observer programs are a reliable method for estimating bycatch. The quality of the data and the precision and accuracy associated with bycatch estimates are determined by sample size and the design and execution of a robust sampling scheme. Identification and accounting for sources of bias is critical, as are measures to increase both cost effectiveness and safety of observers.

On the West Coast, NOAA Fisheries and the states of Washington, Oregon, and California conduct at-sea observations of various groundfish fisheries. The at-sea whiting observer program is a well-established, mature program while others are considered pilot or developing programs (Table 3.4.6). The shore-based whiting fishery has been observed both at sea and on shore, and in 2004 video monitoring (EM) is being tested.

NOAA Fisheries West Coast Groundfish Observer Program. Onboard fishery observers collect information on fishing activities and help provide accurate accounts of total catch, bycatch, and discard associated with different fisheries and fish stocks. The West Coast Groundfish Observer Program (WCGOP) includes the NWFSC Observer Team and collaborators from the Pacific States Marine Fisheries Commission that direct the program, train new observers, and manage and analyze the bycatch data. The NWFSC's two programs deploy observers on vessels in three of the nine West Coast commercial fisheries (at-sea whiting, groundfish bottom trawl, non-trawl gear groundfish). As part of this program, fisheries observers are placed on commercial fishing vessels to monitor and record catch data, including species composition of retained and discarded catch. Observers also collect critical biological data such as fish length, sex, and weight. The data collected are used in combination with state-collected logbook and fish ticket information to estimate the bycatch in the these West Coast fisheries.

Observers collect information on total catch, species composition of the catch (including any protected resources and seabirds), age structure data from several species and the fishery's interactions with species of concern. This fishery is a major source of salmon bycatch on the coast. Under the Biological Opinion on the effects of the groundfish fisheries on endangered and threatened salmon stocks, the at-sea whiting fishery is anticipated to take up to 11,000 chinook salmon per season as bycatch. With close to 100% of the hauls in the fishery sampled, the program closely monitors the number of chinook taken. The majority of the annual cost of the deploying the observers is paid for by industry. The cost of training, in-season support and debriefing observers is supported by NOAA Fisheries. Currently the annual cost of the program is approximately $535K ($500K paid for by industry).

The WCGOP[4/] began deploying observers on groundfish vessels in August 2001. The focus of this program is to collect total catch and discard data (including protected resources and seabirds) from commercial groundfish trawl and non-trawl gear (longline, pot, etc.) vessels. The program is designed to provide estimates of fleet-wide discards in commercial fisheries; fish tickets are the mandated landings accounting mechanism. As the program is currently designed, logbook data must be available to fully utilize observer data. This is because observers initially record hail weights (i.e., at-sea estimates) and logbook data for retained catch, and these values must be adjusted by fish ticket information to achieve total catch estimates. Observers in this program collect species composition of the discard and data on target fisheries interactions with species of concern. Observers also collect critical biological data such as fish length, sex, and weight. The observer program's data is already being used in the bycatch model that guides West Coast groundfish fisheries management. The WCGOP initially targeted the trawl and non-trawl limited entry fleets for observer coverage. Observer coverage initially extended to about 10% of the West Coast limited entry fleet effort, but increased to about 20% by the summer of 2002 (Elizabeth Clarke, NMFS NWFSC, pers. comm.). The program currently deploys about 40 observers coast wide on the limited entry trawl and fixed-gear groundfish fleet, as well as on some open-access vessels operating off California. Given the skewed distribution of bycatch in West Coast groundfish fisheries, many observations in each sampling strata (i.e. target effort by gear type by area)

4. see Appendix A for the first two annual reports

are needed to estimate representative bycatch rates of overfished groundfish species. The seasonality of bycatch is an important management consideration.

Table 3.4.6. Survey of fishery-specific bycatch observation programs, enhancements and bycatch vulnerability in West Coast groundfish fisheries. (From *Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs* NMFS 2003c)

Fishery	Target Species	Gears	Observer Program Status	Next step in design	Vulnerability to fish bycatch	Vulnerability to Marine Mammal Bycatch	Vulnerability to other ESA species bycatch and Seabirds
At-sea Whiting Fishery	Pacific whiting	pelagic trawl	mature	maintain	Moderate (e.g., widow and canary rockfish)	Low	High (salmon)
Shorebased Whiting Fishery	Pacific whiting	pelagic trawl	pilot	maintain	Moderate (e.g., widow and canary rockfish)	Low	High (salmon)
Bottom Trawl Fishery	flatfish, rockfish, roundfish, various sharks/skates	bottom trawl	developing	mature	High (e.g., canary rockfish, darkblotched rockfish, bocaccio)	Low	Moderate
Non-trawl Fishery	sablefish, rockfish, lingcod, various roundfish	hook-and-line, pot, setnet	developing	mature	High (e.g., canary rockfish, lingcod, bocaccio, cowcod)	Low	Low

Next, the program may expand to also cover open access vessels operating off Oregon in 2004, pending revisions to state regulations. Few vessels land open access groundfish into Washington ports and this fleet and has been covered on a limited basis.

Overall costs of this program, averaged over the number of days observers spend onboard West Coast groundfish fishing vessels, results in a daily cost of about $900. This includes equipment, transportation, some training and data analysis, and other costs. The cost of observer coverage excluding support and data analysis is about $300 per day. Currently (2004), every at-sea processing vessel carries at least 2 observers at the vessel's expense. Vessels operating under certain exempted fishing permits (EFPs) also pay the expenses of observers required under the terms of the permits, as these observers are generally in addition to those provided by NOAA Fisheries.

The WCGOP stresses that observers are intended for scientific data collection only, and do not have any enforcement role. The information they collect is essential for a clear understanding of the amount and distribution of bycatch of all species.

At-Sea Pacific Whiting Observer Program Since the inception of the U.S. whiting fishery in the late 1980s, all at-sea processing vessels have carried observers. Initially, this was a voluntary program, but now it is part of the NWFSC observer program. Since its beginning, this data reporting program has provided fishery managers the catch data necessary for managing the fishery on a real time basis, allowing each sector of the fishery to take its full allocation. This data set has not only provided valuable information in the management of Pacific whiting, but has also provided an extensive amount of information on bycatch species. Observer catch and bycatch data have been used for the assessment of widow rockfish, although changes in management and operation of the fleets has reduced the value of this data source. (Widow rockfish and Pacific whiting are co-occurring species, which means that significant bycatch of widow rockfish may occur in the midwater trawl nets used for Pacific whiting.)

To increase the utilization of bycatch that is otherwise discarded as a result of trip limits, Amendment 13 to the groundfish FMP implemented an increased utilization program on June 1, 2001, which allows catcher/processors and motherships in the whiting fishery to exceeded groundfish trip limits without penalty, providing specific conditions are met. These conditions include provisions for 100% observer coverage, non-retention of prohibited species, and donation of retained catch in excess of cumulative trip limits a bona fide hunger relief agency or processing of excess catch into mince, meal, or oil products. These provisions have allowed the at-sea Pacific whiting fishery to operate efficiently while meeting management goals, and have continued to provide scientists, through the observer coverage, with important biological information.

Shore-based Pacific Whiting Observation Program The shoreside whiting observation program (SWOP) was established in 1992 to provide information for evaluating bycatch in the directed Pacific whiting fishery and for evaluating conservation measures adopted to limit the catch of salmon, other groundfish and prohibited species. Though instituted as an experimental monitoring program, it has been continued annually to account for all catch in targeted whiting trip landings, enumerate potential discards, and accommodate the landing and disposal of non-sorted catch from these trips. In 1995, the SWOP's emphasis changed from a high observation rate (50% of landings), to a lower rate (10% of landings) and increased collection of biological information (e.g., otoliths, length, weight, sex, and maturity) from Pacific whiting and selected bycatch species (yellowtail rockfish, widow rockfish, sablefish, chub (Pacific) mackerel (Scomber japonicus), and jack mackerel (Trachurus symmetricus)). The required observation rate was decreased when studies indicated that fish tickets were a good representation of what had actually been landed. Focus shifted again due to 1997 changes in the allocation of yellowtail rockfish and increases in yellowtail bycatch rates. Since then, yellowtail and widow bycatch in the shoreside whiting fishery has been dramatically reduced because of increased awareness by fishermen of the bycatch and allocation issues involved in the SWOP program. The SWOP is a cooperative effort between the fishing industry and state and federal management agencies to observe and collect information on directed Pacific whiting landings at shoreside processing plants. Participating vessels apply for and carry two EFPs issued by NMFS. Permit terms require vessels to land unsorted catch at designated shoreside processing plants. Permitted vessels are not penalized for landing prohibited species (e.g., Pacific salmon, Pacific halibut, Dungeness crab), nor are they held liable for overages of groundfish trip limits. Participants in the SWOP are mid-water trawlers carrying EFPs, designated shoreside processing plants in California, Oregon, and Washington, the Council, the NMFS, PSMFC, ODFW), CDFG, and WDFW. (Excerpt from latest ODFW on the shore-based Pacific Whiting program review (Wiedoff and Parker 2002), for the complete report go to: http://hmsc.oregonstate.edu/odfw/reports/hake.html).

Since 1997, an EFP has been adopted annually that allows suspension of at-sea sorting requirements in the shore-based whiting fishery enabling full retention and subsequent port sampling of the entire catch. However, EFPs are intended to provide for limited testing of a fishing strategy, gear type, or monitoring program that may eventually be implemented on a larger fleet-wide scale. They are not a permanent solution to the monitoring needs of the shore-based Pacific whiting fishery. Results of the shore-based Pacific whiting EFPs indicate that it is feasible to retain and appropriately monitor the incidental take of salmon and groundfish other than Pacific whiting in the shore-based Pacific whiting fishery. A permanent monitoring program for the shore-based Pacific whiting fleet is being developed because of it is called for in the Pacific Coast salmon and groundfish fishery FMPs and the 1992 Biological Opinion analyzing the effects of the groundfish fishery on salmon stocks listed under the Endangered Species Act

(ESA). The issue of salmon retention in the groundfish trawl fisheries was brought before the Council in 1996 in the form of Amendment 10 to the Pacific Coast Groundfish FMP and Amendment 12 to the Pacific Coast Salmon FMP. Based on an Environmental Assessment drafted to analyze these amendments, the Council recommended the EFP process be used temporarily until a permanent monitoring program could be developed and implemented in the shore-based Pacific whiting fishery.

NOAA Fisheries is preparing a preliminary draft Environmental Assessment that includes a range of alternative monitoring systems for the shore-based Pacific whiting fishery. The alternatives currently focus on three major issues: 1) staffing the monitoring program (i.e., federal observers, state monitors, video cameras, or a combination thereof); 2) tracking and disposition prohibited species and groundfish overages; and 3) funding of the monitoring program. Implementation of the permanent monitoring program is anticipated to occur in 2005. NOAA Fisheries and the GMT have expressed concerns about the current EFP program and its adequacy of ensuring full retention and total catch accounting. This is particularly a concern in regards to the rebuilding of widow rockfish. NOAA Fisheries is testing onboard video cameras in the summer of 2004 as a means of verifying total retention.

WDFW Groundfish At-Sea Data Collection Program The WDFW at-sea data collection program was initiated in 2001 to allow fishery participants access to healthier groundfish stocks while meeting the rebuilding targets of overfished stocks, and to collect bycatch data through an at-sea sampling program. The data collected in these programs could assist with future fishery management by producing valuable and accurate data on the amount, location and species composition of the bycatch of rockfish associated with these fisheries, rather than using calculated bycatch assumptions. These data could also allow the Council to establish trip limits in the future that maximize fishing opportunities on healthy stocks while meeting conservation goals for depleted stocks.

Over the past four years, WDFW has implemented its at-sea data collection program through the use of federal EFPs. In 2001, 2002, 2003 and 2004, WDFW sponsored and administered a trawl EFP for arrowtooth flounder and petrale sole, and in 2002, WDFW also sponsored a midwater trawl EFP for yellowtail rockfish. The primary objective for these experimental fisheries was to measure bycatch rates for overfished rockfish species associated with these trawl fisheries. Fishery participants were provided access to healthier groundfish stocks and were constrained by individual vessel bycatch caps. Samplers collected rockfish bycatch data on a per tow basis and ensured that each vessel complied with its bycatch cap; every vessel participating in the EFP was required to have 100% sampler coverage.

Initially, WDFW used federal Disaster Relief funds to defray most of the costs associated with these sampling programs. When the funds were exhausted, the industry began paying the majority of the costs. In 2003 and 2004, the average cost to participants was approximately $4,000-4,500 per month observed (for sampler salaries, safety equipment, and sampling supplies). Additional program costs are incurred by WDFW for staff time to administer, monitor, and oversee the sampling program, and to analyze the data.

Samplers/monitors have been hired as temporary employees of the WDFW and assigned to a duty station based on the vessel's home port. Each sampler is required to complete a two-week training course, consistent with the NOAA Fisheries Observer Training Manual. Samplers receive U.S. Coast Guard safety training–including survival suit immersion test and vessel safety– and WDFW training on fish identification, random sampling theory, data collection methods, current groundfish management issues, and additional safety measures. WDFW fishery managers and biologists were involved in hiring and training the samplers as well as administering and monitoring the program. WDFW scientific technicians sampled the catch dockside, collected biological data, and entered the data into an electronic database. Research scientists have analyzed the preliminary data from the 2001, 2002, and 2003 EFPs, and have finalized summary reports.

Tribal Observer Program The tribal whiting fishery is a cooperative venture between Makah midwater trawl vessels and a floating processing ship. As with the catcher-processor and mothership whiting fisheries, the processing vessel carries two observers at all times. Tribal vessels actively communicate information on areas of known interactions with species of concern. Makah trawl vessels often participate in paired tows in close proximity where one vessel has observer coverage. If landings on the observed vessel indicate higher than anticipated catches of overfished species, the vessels relocate and inform the rest of the fleet of the results (Steve Joner, Makah Fisheries Management, pers. comm., February, 2004). Trip limits for tribal nontrawl vessels are intended to constrain directed catches while allowing for small incidental catches. Tribal directed groundfish fisheries are required to retain all rockfish. Thus, bycatch (discard) of rockfish is minimized.

3.4.11 Other Fisheries that Affect Groundfish (Open Access Non-groundfish Fisheries)

This section is provided so the reader will have a more complete picture of the West Coast fisheries that affect the groundfish resources and groundfish fisheries. These are other fisheries that may take groundfish as bycatch, but are not managed by the groundfish FMP.

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. To distinguish landings and vessels from fisheries that target species other than groundfish but take groundfish incidentally from the directed open access fishery for groundfish, the following criterion is used. If revenues from groundfish represent less than half of total revenue for a vessel landing some amount of groundfish, those landings are considered incidental, and the corresponding vessel can be classified as having made a landing in the incidental open access sector.

These incidental open access fisheries may also account for substantive amounts of bycatch, especially for overfished groundfish species. A range of fisheries, identified by the target species, comprise this sector. These include ocean (pink) shrimp, spot prawn, ridgeback prawn, California and Pacific halibut, Dungeness crab, salmon, sea cucumber, coastal pelagic species, highly migratory species, and the gillnet complex. A summary description of these fisheries follows.

3.4.11.1 California Halibut Fishery

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. Trawling for California halibut is permitted in federal waters (3-200 nm from shore) using trawl nets with a minimum mesh size of 4.5 inches. Trawling is prohibited within state waters (0-3 nm) except in the designated California halibut trawl grounds, which encompass the area between Point Arguello (Santa Barbara County) and Point Mugu (Ventura County) in waters beyond 1 nm from shore. Bottom trawls used in this area must have a minimum mesh size of 7.5 inches and trawling is closed here from March 15 to June 15 to protect spawning adults. Also, California requires a nearshore trawl bycatch permit to land shallow nearshore rockfish, California scorpionfish, California sheephead, cabezon and greenlings. An open access trawler with a bycatch permit has been allowed to land a maximum of 50 pounds per landing of these species in recent years.

Historically, commercial halibut fishers have preferred setnets because of these restrictions. Setnets with 8.5-inch mesh and maximum length of 9,000 feet are the main gear type used in Southern California. 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 1 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.

3.4.11.2 Dungeness Crab Fishery

The Dungeness crab fishery is divided between treaty sectors, covering catches by Indian Tribes, and a non-treaty sector. The crab fishery is managed by the states of Washington, Oregon, and California with inter-state coordination through the Pacific States Marine Fisheries Commission. This fishery is managed by season, sex and size of crab. Only male crabs may be retained in the commercial fishery (thus protecting the reproductive potential of the populations). The fishery has open and closed seasons, and a minimum size limit is imposed on commercial landings of male crabs. In Washington, the Dungeness crab fishery is managed under a limited entry system with two tiers of pot limits and a December 1 through September 15 season. In Oregon, 306 vessels made landings in 1999 during a season that generally starts on December 1. 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. Distinct fisheries occur in Northern and Central California, with the northern fishery covering a larger area. 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.

3.4.11.3 California Gillnet Complex Fishery

The gillnet complex is managed by the State of California and comprises two gear types. Fishers use setnets to target California halibut (discussed above), white seabass, white croaker, and sharks. Driftnets are used for California halibut, white croaker, and angel shark. Most of the commercial catch is sold in the fresh fish market, although a small amount is used for live bait. Currently, the only restriction on catches of white croaker off California is a small no-take zone off Palos Verdes peninsula. In the early 1990s, California's set gillnet fishery was subject to increasingly restrictive state regulations addressing high marine bird and mammal bycatch mortality. This forced the fleet into deeper water where shelf rockfish became their primary target. However, as open access rockfish limits became smaller, there was a shift from targeting shelf rockfish with setnets to the use of line gear in the more lucrative nearshore live-fish fishery. Thus, many fishers that were historically setnet fishers have changed their target strategy in response to increasing restrictions and changing market value.

3.4.11.4 Pink Shrimp Fishery

The pink (ocean) shrimp fishery is managed with uniform coastwide regulations by the states of Washington, Oregon, and California. The Council has no direct management authority. The season runs from April 1 through October 31. Pink shrimp may be taken for commercial purposes only by trawl nets or pots. Most of the pink shrimp catch is taken with trawl gear with a between-knot mesh size ranging from 3/8 inch to one inch between knots. In some years the pink shrimp trawl fishery has accounted for a significant share of canary rockfish incidental catch. Since canary rockfish was designated as overfished, all canary rockfish harvests have been greatly restricted. To reduce bycatch of canary rockfish in the shrimp trawl fishery, the states have mandated the use of finfish excluders.

3.4.11.5 Pacific Halibut Fishery

Pacific halibut harvest levels and gear restrictions are set by the International Pacific Halibut Commission (IPHC), with implementing regulations set by Canada and the U.S. in their own waters. A license from the IPHC is required to participate in the commercial Pacific halibut fishery. Commercial halibut fishers use bottom setline gear; any halibut caught in trawls or traps must be released. The commercial sector off the West Coast, IPHC Area 2A, has both a treaty and non-treaty sector. The directed commercial fishery in Area 2A is confined to south of Point Chehalis, Washington, Oregon, and California. In the non-treaty commercial sector, 85% of the harvest is allocated to the directed halibut fishery and 15% to the salmon troll fishery to cover incidental catch. When the Area 2A total allowable catch (TAC) is above 900,000 pounds, halibut may be retained in the limited entry primary sablefish fishery north of Point Chehalis, Washington (46°53'18" N latitude). In 2001, the TAC was above this level for the first time, and 56% (47,946 pounds) of the allocation was harvested. Area 2A licenses, issued for the directed commercial fishery, have decreased from 428 in 1997 to 260 in 2003.

3.4.11.6 Salmon Troll Fishery

The ocean commercial salmon fishery, both non-treaty and treaty, is under federal management with a suite of seasons and total allowable harvest. The Council manages fisheries in the EEZ while the states manage fisheries in their waters (within three nm). All ocean commercial salmon fisheries off the West Coast states use troll gear. Chinook and coho are the principal target species with limited pink salmon landings in odd-years. However, commercial coho landings fell precipitously in the early 1990s and remain very low. Reductions in landings are mainly due to diminished opportunity as salmon populations have declined. Many natural salmon runs on the West Coast have been listed under the ESA. Ocean fisheries are managed based on zones that reflect the distribution of salmon stocks and are structured to allow and encourage capture of hatchery-produced stocks while depressed natural stocks are avoided. 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.

3.4.11.7 Spot Prawn Fishery

Spot prawn trawling is now prohibited coastwide under state regulations. Prior to the prohibition, the prawn trawl fishery was categorized in the groundfish open access (exempted trawl) sector. California had the largest trawl prawn fishery with about 54 vessels operating from Bodega Bay south to the U.S./Mexico border. The State of California has banned the use of trawl gear for this species due to concerns over bycatch of overfished groundfish and other species. Standard gear was a single-rig shrimp trawl with roller gear, varying in size from eight-inch disks to 28-inch tires. Washington and Oregon have also phased out its trawl fishery by converting their trawl fisheries to pot/trap fisheries. In California, area and season closures for the trawl fleet were previously implemented to protect spot prawns in the Southern California Bight during their peak egg-bearing months of November through January. These closures, along with the development of ridgeback prawn, sea cucumber, and other fisheries, and also greater demand for fresh fish, kept spot prawn trawl landings low and facilitated growth of the trap fishery with a live prawn segment. The fleet operates from Monterey Bay - where 6 boats are based - to Southern California, where a 30 to 40 boat fleet results in higher production. In both fishing areas traps are set 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 and Wilson-Vandenberg 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. Other recent regulations include closures, trap limits, and an observer program.

3.4.11.8 Ridgeback Prawn Fishery

The ridgeback prawn fishery is managed by the State of California. In 2003, California has also prohibited trawling for this species due to concerns about bycatch of overfished groundfish and other species in this fishery. Ridgeback prawns occur from Monterey, California to Cedros Island, Baja, California, at depths ranging from less than 145 feet to 525 feet. According to Sunada *et al.* (2001) this 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 used single-rig trawl gear.

Prior to the trawl prohibition, the fishery was closed during June through September to protect spawning female and juvenile ridgeback prawns. An incidental take of 50 pounds of prawns or 15% by weight was allowed during the closed period. During the season, a maximum of 1,000 pounds of other finfish could be landed with ridgeback prawns, of which no more than 300 pounds per trip could be groundfish, per federal regulation. Other regulations included 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 codends or 3 inches for double-walled codends and a logbook requirement.

3.4.11.9 Sea Cucumber Trawl Fishery

Along the West Coast, sea cucumbers are harvested by diving or trawling. Only the trawl fishery for sea cucumbers, which is also classified as an open access (exempted trawl) fishery, is allowed an incidental catch of groundfish. Sea cucumbers are managed by the states. 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.

Two species of sea cucumbers are fished in California: the California sea cucumber, also known as the giant red sea cucumber, and the warty sea cucumber. 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. In 1997 the state established separate, limited entry permits for the dive and trawl sectors. Permit rules encourage transfer to the dive 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 abalone 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.

3.4.11.10 Coastal Pelagic Species (CPS) Fisheries

CPS include northern anchovy, Pacific sardine, Pacific (chub) mackerel, jack mackerel and market squid. They are largely landed with round haul gear (purse seines and lampara nets). Vessels using round haul gear are responsible for 99% of total CPS landings and revenues per year. The southern California round haul fleet is the most important sector of the CPS fishery in terms of landings. This fleet is primarily based in Los Angeles Harbor, along with fewer vessels in the Monterey and Ventura areas. The fishery harvests Pacific bonito and tunas as well as CPS. The fleet consists of about 40 active purse seiners averaging 20 m in length. Although these fisheries are concentrated in California, CPS fishing also occurs in Washington and Oregon. In Washington, the sardine fishery is managed under the Emerging Commercial Fishery provisions as a trial commercial fishery. The target of the trial fishery is sardines; however, anchovy, mackerel, and squid are also landed. The fishery is limited to vessels using purse seine gear. It is also prohibited inside of three miles and logbooks are required. Eleven of the 45 permits holders participated in the fishery in 2000, landing 4,791 mt of sardines. Three vessels accounted for 88% of the landings. Of these, two fished out of Ilwaco and one out of Westport. In Oregon, the sardine fishery is managed under the Developmental Fishery Program with annually-issued permits; 15 permits were issued in 1999 and 2000 and 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.

The Council manages these fisheries under its CPS FMP. 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. In 2003, the Council established an interim management line for allocation of the annual Pacific sardine harvest guideline. The management line splitting the northern and southern components of the fishery occurs now at Point Arena (~39° N latitude). 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.

3.4.11.11 Highly Migratory Species (HMS) Fisheries

HMS include tunas, billfishes, dorado and sharks. Management of HMS is complex due to the multiple management jurisdictions, users, and gear types targeting these species. Adding to this complexity are 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 states have regulated the harvest of HMS in the past, but the Council recently approved an FMP for fisheries prosecuted in the West Coast EEZ and by vessels originating from West Coast ports fishing beyond the EEZ. There are five distinctive gear types used to harvest HMS commercially, with hook-and-line gear being most common. Other gear types used to target HMS are driftnet, pelagic longline, purse seine, and harpoon. While hook-and-line can be used to take any HMS species, traditionally it has been used to harvest tunas. Drift gillnet for swordfish, tunas and sharks off California and Oregon is most likely to intercept groundfish, including spiny dogfish and yellowtail rockfish.

Albacore is commonly caught with troll gear. The majority of albacore are taken by troll and jig-and-bait gear (92% in 1999), with a small portion of fish landed by gillnet, drift longline, and other gear. These gears vary in the incidence of groundfish interception depending on the area fished, time of year, as well as gear type. Overall, nearly half of the total landings of albacore (millions of pounds coastwide) were landed in California. Other gear includes pelagic longline, used to target swordfish, shark and tunas; and harpoon for swordfish off California and Oregon. Some vessels, especially longliners and purse seiners, fish outside of the U.S. EEZ, but may deliver to West Coast ports.

3.5 References (Biological Resources)

Barss, B. 1994. Shelf-slope habitat. *In* Marine Resource Program Review, May 5 & 6, 1994. Oregon Dept. of Fish and Game, Newport, OR.

GFNMS. 2003. Food web of the Gulf of the Farallones. Gulf of the Farallones National Marine Sanctuary. Accessed at www.gfnms.nos.noa.gov.

Larson, R.J., and D.A. Wilson-Vandenberg. 2001. Other nearshore rockfishes. Pages 185-188 *in* California's Living Marine Resources: A Status Report. W.S. Leet, C.M. Dewees, R. Klingbeil, and E.J. Larson (eds.). California Dept. of Fish and Game, Sacramento, CA.

Leet, W.S., C.M. Dewees, R. Klingbeil, and E.J. Larson (editors). 2001. California's Living Marine Resources: A Status Report. California Dept. of Fish and Game, Sacramento, CA. Accessed at www.dfg.ca.gov/mrd.

Nordeen, C. (In prep.) Assessment of Seabird Bycatch in the Pacific Coast Groundfish and Pacific Halibut Longline Fisheries of the Northwest Region, May 2003. NOAA Fisheries, Northwest Region, Seattle, WA.

OCNMS. 2003. Geology in the Olympic Coast National Marine Sanctuary. Olympic Coast National Marine Sanctuary website. Accessed March 27, 2003 at www.ocnms.nos.noaa.gov/LivingSanctuary/geology.html

PFMC. 2002. Status of the Pacific Coast groundfish fishery through 2001 and acceptable biological catches for 2002 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

PFMC. 2003. Final Environmental Impact Statement for the Proposed Groundfish Acceptable Biological Catch and Optimum Yield Specifications and Management Measures, 2003 Pacific Coast Groundfish Fishery. January 2003. Pacific Fishery Management Council, Portland, OR.

PFMCa (2003) Amendment #17 to the Pacific Coast Groundfish FMP regarding Multi-Year Management (May 2003). Pacific Fishery Management Council, Portland, OR.

PFMCb (2003) Draft Environmental Assessment for a Vessel Monitoring System for the groundfish fishery (July 2003). Pacific Fishery Management Council, Portland, OR.

Shaw, F.R., M.E. Wilkins, K.L. Weinberg, M. Zimmermann, and R.R. Lauth. 2000. The 1998 Pacific West Coast bottom trawl survey of groundfish resources: Estimates of distribution, abundance, and length and age composition. NOAA Tech. Memo. NMFS-AFSC-114.

Sunada, J.S., J.B. Richards, and L.M. Laughlin. 2001. Ridgeback Prawn. Pages 124-126 *in* California's Living Marine Resources: A Status Report. W.S. Leet, C.M. Dewees, R. Klingbeil, and E.J. Larson, (eds.). California Dept. of Fish and Game, Sacramento, CA.

Yoklavich, M.M., H.G. Greene, G.M. Cailliet, D.R. Sullivan, R. N. Lea, and M.S. Love. 2000. Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. Fish. Bull. 98: 625-641.