A REVIEW OF TRADITIONAL AND ECOSYSTEM-BASED FISHERY MANAGEMENT IN THE MONTEREY BAY NATIONAL MARINE SANCTURARY

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ABSTRACT

The MBNMS study area appears to be heavily protected from overfishing and the many layers of regulations from the different management agencies prevent a large number of exploitable species from being fished at any appreciable level. This is particularly true of species in soft bottom areas of the nearshore and shelf habitats, the shelf break habitat, the deep slope habitat and the rise habitat. In federal waters a small number of species are presently being fished at moderate to optimum exploitation levels and the few species that were overfished in the past are now in rebuilding plans and their habitat has been heavily protected by the Rockfish Conservation Area (RCA). The most recent available landings (2006) show that the ports in or near the MBNMS have had large to extreme declines in the value of their landings over the previous 10 years. These most recent declines are primarily due to increased management measures (e.g., reduced catch limits and the RCA), in response to earlier stock declines, and do not reflect continuing declines of these species, especially the dominant exploited species. Numerous stock assessments show that the populations are responding to these management measures with total groundfish biomass rising substantially since about 1999. Thus management measures made prior to the establishment of the many MPAs in the MBNMS study area is preserving and enhancing ecosystem function and biodiversity. The ports of Santa Cruz, Monterey and Morro Bay are presently in severe decline and the loss of fishing infrastructure is a real threat to the fishing industry in these ports. Further declines in the value of the fisheries in the study area should be expected due to the very extensive areas protected by the federal MPAs, state MPAs and state waters trawl closures since 2006 (i.e. 62% of the total study area). It appears that the several agencies that have designated areas in the MBNMS as MPAs have acted in an un-coordinated manner resulting in the present situation with 64% of the MBNMS study area in MPAs, no analyses of the combined affects of MPAs and previous management actions, and no coherent overall strategy or goal.

INTRODUCTION

This section of the report is centered on the description of the present regulatory mechanisms that protect living marine resources and the present status and trends of these resources in relation to achieving overall ecosystem health, habitat protection, and sustainable resources including fished species. This analysis will show that many of the habitats in the study area have an array of permanent protective regulations in place to protect benthic organisms and the habitats themselves, and effectively prohibit the harvest most of their resident species. A number of species have been heavily exploited in the past are currently in a rebuilding status with most fishing gear excluded from the depleted species core habitat. These exclusions are resulting in greatly reduced landings of other species that share the depleted species' habitat. These spatial closures have not been declared permanent, and are expected to be lifted when the resources sufficiently recover, following the principle of "adaptive management"

promoted by the Pacific Fisheries Management Council (PFMC) and California's Marine Life Management Act (MLMA). The most optimistic version of the stock rebuilding model for bocaccio rockfish, the principal species of concern in central California, suggests that stock could be rebuilt as early as 2022 and the most pessimistic version suggests that the stock will not rebuilt until some time after 2033.

Traditional Fisheries Management

In the past when species were thought to be over exploited traditional fishery management largely relied on methods to reduce the efficiency of fishing gear, to exclude specific fishing gear from areas where the gear was thought to adversely impact other species or fisheries, or to close fishing for part of the year. Traditional management has also included a wide array of size limits, bag limits and restrictions that limit entry to commercial fisheries. In California this has resulted in a very large legacy of regulations that often failed to produce sustainable and profitable fisheries

A large proportion of the most important exploited stocks were harvested at rates that could not be maintained and some populations were driven to low or very low levels; for example Pacific sardine and Pacific mackerel in the 1950s, petrale sole in the 1970s, bocaccio and canary rockfish in the 1980s and lingcod and darkblotched rockfish in the 1990s.

Traditional fisheries management failed to produce sustainable fisheries for a number of species in California. However, there are also instances where the biology and behavior of a species has resulted in traditional fisheries management that produced sustainable fisheries. Dungeness crab and California spiny lobster are examples of invertebrate fisheries where traditional management (closed seasons, size limits, escape ports, and in the case of crab, no landings of females) has resulted in fisheries that have fluctuated have but been sustained under heavy fishing effort for many decades. These two species are captured with traps or pots that do little harm to the animals or the benthic substrate, and as these animals are particularly robust out of the water they can be sized and/or sexed and returned to the sea with little mortality. Some offshore groundfish species (i.e. California halibut and sablefish) can be returned to the sea with little mortality but it is not the case with most of the offshore groundfish species.

Biomass-based Single Species and Ecosystem-based Resource Management

Fortunately traditional fishery management for most of the larger exploitable populations, has evolved in recent decades to include quota-based management system with annual ABCs (acceptable biological catch) and optimum yields being established by control rules that utilize estimates of stock size determined by stock assessments. Stock synthesis population models were developed in the late1970s, and by the early 1980s it was apparent from these analyses that the populations of several important groundfish species had been in downward spirals for several decades. By the early 1980s the Pacific Fisheries Management Council (PMFC) limited the annual harvest of several rockfish species and, by the early 1990s, was actively establishing annual harvest guidelines that sharply scaled back the exploitation rates of the important groundfish species. By the late-1990s rebuilding plans were being developed

for species that had been overfished. The stock assessment process has been subject to a very rigid peer review process, the number of species with approved stock assessments has increased with time, and assessments are updated on a regular basis. Over the last decade allocation of the catch, limited entry and reduction of by-catch have been emphasized. Most groundfish species now have 2-month catch limits that are seasonally and regionally specific, and virtually all California commercial fisheries now have limited entry. Recent improvements in habitat assessments and mapping have fostered the development an extensive network of federal marine protected areas (MPAs) to protect essential fish habitat (EFH) areas and other marine MPAs have been, and are, being developed by the State of California.

Much of the concern with overfishing on the West Coast in the past decade has centered on rockfishes. The effect of PFMC regulations can be seen in the trend of landings of rockfishes in the southern management zone (i.e. south of 40 10' N latitude); landings averaged about 15,000 metric tons in the mid-1980s, about 8,000 tons in the mid-1990s and about 500 metric tons in 2006 (pers. comm. Jan Mason ERL/NMFS/SWFSC). As will be shown later there are now many exploitable species that cannot be harvested at rates large enough to provide an economically viable fishery or depress their populations. Within the study area the number of these species far exceeds the number of species that are fully harvested, over-harvested or depressed

The most recent re-authorization of the Magnuson-Stevens Fishery Conservation Act strengthens its emphasis on ecosystem management. The Pacific Fisheries Management Council (PFMC) had already started to enact ecosystem based management, beginning in 1999 with an ecosystem forage allotment and automatic reductions in harvest rates during periods with unfavorable environmental conditions in the sardine management plan. This was followed by enactment of a network of essential fish habitat areas to preserve unique and diverse habitat areas, reductions in by-catch in groundfish fisheries, exclusion of the swordfish fishery from the feeding grounds of the endangered Pacific leatherback turtle, and the weak stock management utilized in the several Rockfish Conservation Areas. Development of a California Current Ecosystem Fisheries Management Plan (FMP) is now underway by the PFMC.

EFFECT OF REGULATORY CHANGES ON LANDINGS

If recent regulatory actions are in fact contributing to the recovery of fish stocks now, then an obvious consequence would be a near-term reduction in landings (i.e. fishing mortality). Unfortunately, these near-term reductions in landings can be and have been particularly detrimental to the fisheries that depend on these stocks. To assess the effectiveness of these regulations on reducing fishing mortality (and landings) and provide some sense of the impact to the fisheries, I review here the effect of these regulatory changes on landings."

To assess the effects that major changes in regulations had on the fisheries in the MBNMS study area, the most recent available landings (2006) were compared with the landings a decade earlier, prior to the regulatory changes. The major regulatory changes between 1996 and 2006 were greatly reduced quotas for groundfish, the closure of the RCAs, vessel buyouts

to reduce the number of trawlers and the State of California nearshore fishery management plan. It should be noted that the RCA closure also resulted in greatly reduced landings for several important species that were not overfished. For example, in the first full year after the RCA went into effect (2004) the optimum yield of chilipepper rockfish was 2,000 metric tons but coastwide landings were only 58.3 metric tons.

The total landings in the Monterey Port Area (Santa Cruz, Moss Landing and Monterey) increased from 25,774 tons in 1996 to 29,969 tons in 2006 (Table 1). This increase was due to greatly increased catches of two pelagic species, sardine and anchovy. The landings of all other species with landings greater than 100 tons had major declines, and 18 out of 20 species with landings between 10 and 100 tons also declined.

Pelagic species, which are little protected by MPAs, comprised about 96% of the landings in 2006, rising from about 80% in 1996. Shelf break rockfish species, which were most affected by the federal RCA, had enormous declines in landings with 2006 bocaccio, widow and chilipepper landings being only 2% of their 1996 landings. The species most likely to be affected by additional MPAs in federal waters are those dwelling on the continental slope. As a group the landings of slope species declined by a factor of 4, with total 2006 landings of only 806 tons. With pelagic species and slope species removed the landings of all other species declined by more than a factor of 5, from 2,068 tons in 1996 to only 372 tons in 2006.

It is clear that federal and state regulations greatly reduced the landings of the vast majority of demersal and littoral species, with healthy stocks (i.e. chilipepper rockfish, Engish sole and sanddab) having reductions in landings essentially equal to overfished species (i.e. bocaccio, widow rockfish and lingcod).

As will be described later, extensive MPAs have been created in the study area since 2006, and major areas that were open to fishing for demersal and littoral species in 2006 are now closed to fishing for these species. If effective, the State MPAs will markedly lower the landings of the 'everything else' group discussed here; although total landings of these species were only 1.2% (372 tons) of the 2006 landings, many of the species are important due to their high value. Because the shelf break species have already largely been removed from the fishery by the RCA, it is unlikely that the landings from this habitat will be much affected by the recent MPAs; the single exception to this is spot prawn. The extensive trawl closure MPAs may reduce the landings of the slope species even below the very diminished 2006 levels. As will be shown in the later section (Status of Living Resources-Stock Assessment) the reductions in fishing effort and landings during the 1996-2006 period have resulted in rebounding populations of many, but not all, groundfish species.

Table 1. Landings in the Monterey Port Area in 1996 and 2006, and 2006 landings as a percentage of 1996 landings. (species with landings less than 10 tons were omitted).

	1996 Tons	1996 Percent	2006 Tons	2006 Percent	Percent of 1996
TOTAL Landings	25,774		29,969		116%
Total pelagic species	20,482	79.5%	28,812	96.1%	141%
Total slope species	3,228	12.5%	806	2.7%	25%
Total everything else	2,068	8.0%	372	1.2%	18%
Pelagic species					
Sardine	8,805	34.2%	19,523	65.1%	222%
Anchovy	3,917	15.2%	8,416	28.1%	215%
Squid	5,150	20.0%	561	1.9%	11%
Chinook salmon	937	3.6%	37		4%
Mackerel unspec.	877	3.4%	189		22%
Herring	274	1.1%	41		15%
Albacore	238		22		9%
Swordfish	221		19		8%
Opah	20		1		5%
Thresher shark	15		<1		0%
Bluefin tuna	13		<1		0%
Other	14		4		31%
Slope species					
Grenadier	994	3.9%	46		5%
Sole, Dover	849	3.3%	214		25%
Sablefish	773	3.0%	273		35%
Thornyhead longspine	281	1.1%	81		29%
Rockfish, splitnose	160		96		60%
Thornyhead shortspine	83		45		54%
Thornyheads	56		na		na
Rockfish group slope	na		14		na
Rockfish, blackgill	28		17		59%
Rockfish, bank	4		22		573%
Everything else					
Rockfish, chilipepper	674	2.6%	11		2%
Rockfish, widow	174		4		2%
Rockfish, group small	127		0		0%
Rockfish, bocaccio	126		2		2%
Sanddab	124		4		3%
Sole, Petrale	123		94		77%
Sole, English	109		9		8%

Sole, rex	107	12	11%
Lingcod	84	6	8%
Rockfish, unspec	81	2	2%
Croaker white	60	5	9%
California halibut	56	35	63%
Skate unspec	38	8	22%
Rockfish, group red	37	3	7%
Spot prawn	35	31	89%
Rockfish, shortbelly	24	0	0%
Dungeness Crab	17	83	492%
Spiny dogfish	15	8	55%
Rockfish, yellowtail	12	1	8%
Surf smelt	11	0	0%
Other	33	32	96%
Species more than 100 tons	22	6	
Species more than 1% of total landings	11	3	

To assess the affects that changes in regulations have had on the economics of fisheries in the study area the past and near present value of the landings of the five major ports within and adjacent to the MBNMS were compared (Princeton-Halfmoon Bay, Santa Cruz, Moss Landing, Monterey and Morro Bay). The most recent available landings, 2006, were compared to the 1996 landings adjusted to constant 2006 dollars using the consumer price index prepared by the Bureau of Labor Statistics (a 1996 dollar was worth $1.28 2005 dollars).

All five ports had large reductions in the value of their landings from 1996 to 2006, and their total value declined from $31 million in 1996 to $13 million in 2006 (Table 2). Monterey had the largest decline with the 2006 value being only 14.4% of the 1996 value. Santa Cruz and Morro Bay each declined to about 29% of their 1996 values, and Moss Landing declined to 47.7%. The decline at Princeton-Halfmoon Bay was considerably less than the other ports (75.3%); however, two species (Chinook salmon and Dungeness crab) that were unaffected by recent regulations produced 83% of the 2006 landings value. Of particular concern to the economics and sustainability of the fishing infra-structure at the fishing ports, the number of species with sizeable value (i.e. $100K per year) declined very sharply at four of the ports. The most marked reduction was at Monterey (13 to 2 species) but Santa Cruz (5 to 2 species), Princeton-Halfmoon Bay (11 to 5 species) and Morro Bay (15 to 6 species) each lost more than half of their species with value greater than $100K. Moss Landing (14 to 13 species) differed from the other port in that it had little change in the number of high value species. Monterey, Santa Cruz and Princeton-Halfmoon and Morro Bay have become heavily dependent upon the landings of a very small number of species. The lack of species diversity at these ports puts the long-term viability of their fisheries (and fishing communities) in jeopardy.

Landings in the Monterey Port Area have become very heavily dependent on sardine and anchovy (96% by weight in 2006). The landed weight of all other species were less than 4 % of the 2006 landings but 51% of the total value landed.

Table 2. Decadal change in the value ($1000s) and weight (tons) and of landings at ports in or adjacent to the MBNMS study area, (dollars adjusted to constant 2006 dollars).

	Value 1996	Value 2006	2006 as a % of 1996	Species with value > $100,000 1996	2006
Princeton-Halfmoon Bay	$6,354	$4,786	75.3%	11	5
Santa Cruz	2,178	622	28.6%	5	2
Moss Landing	10,233	4,877	47.7%	14	13
Monterey	6,037	868	14.4%	13	2
Morro Bay	6,471	1,906	29.5%	15	6
TOTAL	31,273	13,059	41.8%	23	13

	Tons 1996	Tons 2006	% of 1996
Princeton-Halfmoon Bay	2,656	1,398	52.6%
Santa Cruz	896	147	16.4%
Moss Landing	12,493	29,646	237.3%
Monterey	12,383	179	1.4%
Morro Bay	2,675	434	16.2%
TOTAL	31,102	31,803	102.2%

DESCRIPTION OF CURRENT FISHING REGULATIONS

Assessment of the affects of the large array of regulations and determination of the need for additional protection for individual species, fisheries or habitats is not an easy task and it should be realized that determination of need should be an adaptive process that can easily be altered when additional information becomes available or the environment changes. MPAs of the type being enacted by the State of California and the Pacific Fisheries Management Council (i.e. Essential Fish Habitat Areas (EFHs)) are considered by many to be permanent, and as such they are poor candidates for adaptive management. Due to the relative difficulty in altering MPAs, as well as the large investment of resources and time required for effective monitoring and analysis of MPA effects (i.e. benefits vs. costs), the affects and impacts of this type of resource management should be thoroughly analyzed before MPAs are enacted.

The regulations discussed below are those that apply to the study area (roughly Pigeon Point to Cambria) and they may or may not apply to other areas. To describe the present situation regulations have been divided into three classes (Table 3). The first class includes regulations that alone are unlikely to produce sustainable fisheries or ecosystem function; but may be valuable additions to the other two classes. The second class includes methods that have the potential to produce sustainable fisheries and ecosystem function when several of the methods are combined. The third class includes regulatory methods that can produce sustainable

fisheries and ecosystem function with no other regulations, although optimum management will most likely include methods from the other two classes.

Table 3. Classification of fishing regulations

Methods that alone are unlikely to produce sustainable fisheries
- Closed seasons – indirect control of effort, protection of spawners
- Specific gear regulations – mesh sizes, number of hooks, escape ports
- Specific species regulations – size limits, bag limits, protection of spawners

Methods with the potential in combination to produce sustainable fisheries
- Limited entry – direct control of fishing effort
- SSS management – size, sex and season control in some invertebrate fisheries (i.e. Dungeness crab, lobster)
- Area-based fishing gear closures
- Marine Protected Areas

Methods likely to produce sustainable fisheries
- Biomass-based quotas or harvest guidelines – direct control of annual catch.

These methods should be complimented by non-fishery management regulations that are designed to conserve ecosystem qualities (i.e. control of pollution, sedimentation, shoreline development and other environmental hazards).

METHODS UNLIKELY TO PRODUCE SUSTAINABLE FISHERIES

Closed Seasons

Closed seasons are an easy, but blunt, way to reduce fishing effort and they have been commonly used in California fisheries. Often the closures are designed to occur during the spawning season or seasons when the market quality of the species is low (i.e. crab or lobster molting seasons). Closed seasons, varying in different regions, have been a major management tool in the salmon fishery. In recent years fishing effort has been geographically directed away from regions that have reduced salmon runs by having open seasons only in areas with healthy runs. Effort reduction in recreational fisheries is not practical with limited entry, therefore closed seasons are used to reduce fishing effort; for example recreational fishing for groundfish is now closed in the MBNMS from December to May. Closed seasons are often undesirable in commercial fisheries because of their adverse affects on marketing and they are seldom used unless economically desirable (i.e. in the herring fishery where the economics is based on the seasonal harvest of eggs).

Specific gear regulations

A wide range of regulations limiting the dimensions, designs and use of particular fishing gear are used to regulate the take of individual species or species groups. They have been used to prevent harvest of small and/or immature animals, to reduce the efficiency of fishers, to reduce catch rates, to reduce bycatch, to reduce damage to the habitat and to limit the use of specific gear types. In California any fishing gear that is not specifically allowed is illegal.

Beach seines, Danish seines and Scottish seines are illegal as are a wide range of fish traps, dredges and several types of trawl nets. In addition, as will be discussed later, many gear types have area or time/area closures that prevent their use in specific areas or depth zones.

This type of regulation can greatly assist by reducing bycatch (i.e. mesh size limitations), by preventing capture of immature or sub-legal sizes of targeted species (i.e. escape ports in crab pots and lobster traps) and by reducing damage to the habitat (exclusion of large rollers on trawl nets). Most of the fisheries in the MBNMS have gear regulations that were designed to prevent the take of non-target species and these are often among the most important regulations affecting the take of fishes and invertebrates. However, regulations that concern the design of fishing gear have not proven to be sufficient by themselves to achieve sustainable fisheries for the majority of target species and enactment of other types of regulations will usually be required to achieve a sustainable fishery.

Species-specific regulations

Species-specific regulations have been enacted for many reasons over the history of California's fisheries. Sport fisheries are particularly rich, or encumbered, with this type of regulations: including species-specific size limits, bag limits, closed seasons, and allowable fishing gear. The purpose of nearly all of these regulations is to reduce the take of fish by recreational fishers without seriously reducing the number of fishers. This type of regulation is not as common in commercial fisheries; however, some species have been removed from commercial exploitation (i.e. kelp bass), some species cannot be landed by fishing boats using specific fishing gear (i.e. salmon, Dungeness crab and rock crabs cannot be landed by trawlers) and some fishing gear is tightly regulated to insure that it primarily catches the target species (halibut trawls, drift gillnets for swordfish, gillnets for California halibut and white seabass). Species-specific annual catch limits have become a major management tool and are discussed later.

METHODS WITH THE POTENTIAL TO PRODUCE SUSTAINABLE FISHERIES

Limited entry – direct control of fishing effort

Limited entry is a regulation that is only used for commercial fisheries as it is considered undesirable to place any limits on who can fish recreationally. Theoretically, sustainable fisheries could be achieved if the number of fishers, or more commonly the number of fishing boats, were limited to the number that could not catch more than the maximum sustained yield of individual species. In practice it has proved nearly impossible to reduce the number of fishing boats to the level where it would not be possible to overfish most species. There are many reasons for this including the fact that most fishing boats catch more than one species and many fish in more than one fishery. This factor alone makes it very unlikely that the number of fishing boats could be correctly set for a wide range of species. Limited entry can be used to reduce the number of fishing boats to the number that could produce a profit from a fishery and limited entry, based roughly on this premise, now occurs in the majority of California's fisheries. However, it does not appear that most of the existing limited entry

fisheries are set low enough to result in sustainable fisheries without inclusion of additional strong management measures. The trap fishery for spot prawn may be the single exception.

SSS management – size, sex and season regulations

Management based on regulation of the size limits, closed seasons and no landings of females, the so called size-season-sex (SSS) management, has proven successful in maintaining productive and profitable fisheries for certain crustaceans (i.e. Dungeness crab and California Lobster in the Pacific Coast EEZ). In each case the fishing gear is pots or traps and the configuration of the gear, (including escape ports for under-sized animals) is highly evolved to produce a fishery where sub-legal or female animals are seldom damaged by the fishing operation and if caught they can be returned to the sea with minimal mortality. The minimum size limit is usually set so that most animals will reproduce one or more years before they become large enough to be retained and landed. These fisheries have remained biologically productive in spite of the build up of very large number of fishing boats engaged in the fisheries. It is possible that this productivity has been at least partially maintained by the reduction in the population sizes of the fishes that prey on the juvenile crabs and lobsters.

Area-based Gear Regulations

Area based closures for specific types of fishing gear have been used for fishery management for many decades. This type of closure is relatively easy to enforce and it allows targeting of protection to specific areas where conflicts occur while allowing fishing gear to be used in other areas. It should be noted that these types of regulations have become quite complex and there has been a general increase in the areas and gears regulated over time. The difficulty with area-based gear regulations is that there is a tendency to make total exclusions rather than measured exclusions. For example, trawling the bottom of the ocean has often been compared to plowing a field. Both cause physical alteration of the substrate and alter biological communities. The effects of both are highly dependent upon the methods used and the characteristics of the habitat and both constitute a trade off between habitat alteration and food production and most people would agree that their use should be regulated. The State of California has prohibited all trawling in state waters north of Point Arguello. Following the analogy with farming, on a policy level what are the chances that all plowing will be prohibited in California?

Fishing gear that is very effective at catching the target species has at times been considered damaging (because it can cause depletion of the species); however, for the purposes of this discussion efficiency by itself is not considered to be damaging, although the total catch may need to be regulated to prevent overfishing. For the purposes of this discussion, fishing gear is considered to be damaging if it causes mechanical alteration of the substrate or takes individuals of non-target species (bycatch) that are either not brought on board the fishing boat or discarded after being brought on board. Based on these criteria I have divided common fishing gear into several general classes based on my opinion of what the likely damage the gear type can cause. The design of fishing gear is very important in reducing undesirable bycatch and physical alteration of the substrate; this is the reason that trawl gear occurs in all three classes.

Most Damaging Gear Types:

- Dredges - mechanical damage and bycatch
- Small-mesh trawls - mechanical damage and bycatch
- Trawls with large rollers - mechanical damage and bycatch
- Large-mesh trawls on hard bottom - mechanical damage and bycatch
- Set gillnets - bycatch

Intermediate gear types:

- Large-mesh trawls on soft bottom – mechanical damage and bycatch
- Danish seines – mechanical damage and bycatch
- Drift gill-nets – bycatch
- Pelagic long-lines – bycatch
- Beach seines - bycatch

Least damaging gear types:

- Hook and line
- Vertical longlines
- Bottom longlines
- Traps and pots
- Surface seines (i.e. purse-seines and lamparas)
- Mid-water trawls
- "Light touch" trawls on soft bottom (i.e. California halibut trawls)

Under California regulations fishing gear that is not declared legal for a particular area or species is by definition illegal. This has created numerous artifacts, for example, shrimp trawling with small mesh trawls was allowed for many years whereas beach seines and Danish seines were illegal.

Bottom and mid-water trawls

Trawl gear has been the principal fishing method used in the MBNMS for taking bottom fishes, and the five species presently listed by the Pacific Fisheries Management Council as having been overfished were primarily harvested with trawl nets. Bottom trawling necessarily disturbs the bottom, although the amount of disturbance varies with the type of trawl gear and the bottom substrate. Trawl gear has the potential to take significant numbers of non-targeted species, the young of targeted species, and it can alter bottom sediments and biogenic benthic habitats. Bottom trawling can also damage, or cause the loss of, other fixed fishing gear such as crab pots. Mid-water trawling has much less potential for associated alteration or damage to the habitat because it is designed to fish off of the bottom.

The potential adverse affects of bottom trawling have been known for a long period of time and trawling has been prohibited within 3 nautical miles of most of the coast of California and mesh size has had a minimum of 4 1/2 inches for at least 6 decades. The local exception to this is that a deep-water portion of state waters, between Yankee Point and Point Sur was open to trawling outside of 1 mile for about 3 decades prior to 2004. On October 1 2006

trawling was stopped in all state waters in the MBNMS (state waters are normally 3 nautical miles from the nearest point of land, including offshore rocks, but in Monterey Bay they extend up to 12 nautical miles from shore).

When stock assessments showed that a number of bottom fish stocks were overfished the Pacific Fisheries Management Council (PFMC) created the Rockfish Conservation Areas (2003) that prevents trawling, other commercial bottom fish fisheries and sport fishing for bottomfishes within a complicated and changing area associated with the depth distribution of various overfished rockfish species. The RCA is a long-term spatial closure and it is discussed later under marine protected areas

The PFMC, in response to litigation, developed the Essential Fish Habitat Program resulting in placement of numerous no trawling Essential Fish Habitat (EFH) areas and a lesser number of no bottom contact EFH areas along the coasts of California, Oregon and Washington. The EFH areas went into effect on June 12, 2006. The MBNMS study area contains a very large area in EFH areas with no trawling (discussed later under marine protected areas). In addition, the PFMC prohibited trawling in waters deeper than 700 fathoms and shallower than 3500 fathoms for the entire California to Washington area.

More recent federal regulations prohibited large rollers on trawl footropes to prevent trawlers from trawling on higher profile bottom areas to prevent damage to biogenic habitats associated with rough bottom while allowing trawling on low profile, smoother bottom.

The study area has not been an active area for shrimp or prawn trawling and presently there is no trawling allowed for invertebrates in the area.

Mid-water trawls are not currently being used in the study area and with the exception of the foreign (mostly Russian) fishery for Pacific whiting in the mid 1960s to mid 1970s and a small amount of use for chilipepper and widow rockfish they have not been used extensively in the MBNMS.

Gill and trammel nets

Gill and trammel nets are entanglement nets and for regulatory purposes they are divided into set nets and drift nets depending upon if they are attached (set) to the bottom or drifting with the currents. In the study area set nets have primarily been used for shore or bottom fishes (gill nets for rockfishes, lingcod, white croaker and surf perch; and trammel nets for California halibut and white seabass and lingcod). Drift gillnets are primarily used in the offshore waters of the study area to take highly migratory species (primarily swordfish).

Gill nets began to be used extensively in the study area for nearshore and shelf rockfishes in the early 1970s and the problem of bycatch of protected species (birds and marine mammals) resulted in this gear being largely prohibited within nearshore waters of the study area by 2000.

Gillnet restrictions within MBNMS study area:

* Between Point Reyes and Point Arguello gillnets and trammel nets may not be used in waters less than 60 fathoms (110 m) (Title 14, sec 104.1) except that gillnets less than 3 1/2 inches can be used from Yankee Point to Point Sal (F&G code sec 8664.5 f)

Other F&G Code restrictions superceded by the above title 14 regulation but still on books.

* Between Pillar Point and Waddel Creek gillnets cannot be used in waters less than 60 fathoms (110 m) (F&G code 8664.8)
* Between Waddel Creek and Yankee Point gillnets cannot be used in waters less than 30 fathoms (55 m) (F&G code 8664.5 a)
* Between Yankee Point and Point Sal gillnets cannot be used in waters less than 30 fathoms (55 m) (F&G code 8664.5 b)
* gillnets can be used for taking rockfishes and lingcod in waters deeper than:
  40 fathoms (73 m) from Pigeon Point to Point Santa Cruz (F&G code 8693 b).
  100 fathoms (183 m) from Santa Cruz Point to the Point Sur lighthouse (F&G code 8692 a)
  75 fathoms (137 m) from Point Sur lighthouse to Pfeiffer Point. (F&G code 8692 b)
  40 fathoms (73 m) from Piedras Blancas to Point Sal. (F&G code 8693 b)
* Set gillnets and trammel nets with a minimum 8 1/2' mesh can be used to take California halibut and they can only be used between the shore and the 30 fathom contour; they cannot be used to take rockfishes or lingcod (sec. 8625).

The total additional affect of the other regulations listed above is that gillnets cannot be used to take rockfishes and lingcod in waters between 60 fathoms and 100 fathoms (110-183 m) between Santa Cruz Point to the Point Sur Lighthouse and between 60 and 75 fathoms (110-137 m) between Point Sur Lighthouse and Pfeiffer Point.

Minimum mesh size for rockfish and lingcod is 4 1/8 inches between Point Reyes and Pigeon Point, 5 1/2 inches (sec 8693) between Pigeon Point and Point Santa Cruz and 4 1/8 inches elsewhere.

Under federal RCA regulations recreational and commercial, non-trawl bottom fishing (which includes gillnets) is prohibited in waters between 30 - 150 fathoms (55-274 m.) from 40 10' to 34 27' North latitude.

Therefore in the study area set gillnets cannot presently be use between the shore and 150 fathoms (274 m), with the exception that 3 1/2 inch gillnets can be used between 0 and 30-fathoms from Yankee Point to Point Sal. In central California 3 1/2 inch gillnets have been used to take herring and white croaker; presently no set gillnets or trammel nets are being fished in the Monterey Bay area (pers. com. Joe Pennisi, Monterey) and landings of white croaker (fishing gear unknown) totaled only 6 tons in the Monterey and Morro Bay Port Areas.

Drift gillnets with a minimum mesh size of 14 inches can be used in California to take highly migratory species (i.e. swordfish and thresher sharks). The area that drift gillnets can be used in has set seasons under State of California regulations (sec 8575)

February 1 - April 30	No drift gillnets in California
May 1 - August 14	No drift gillnets within 75 nm of the mainland
August 15 - January 31	No drift gillnets within 12 nm of mainland

Under federal regulations drift gillnets cannot be used in the Pacific Leatherback Conservation Area during the period of August 15 to November 15. The conservation area is bound on the south by a line from Point Sur to a location west of Point Arguello (34 27' N : 123 35' W) then due west to 129 W. The northern boundary is a line from the coast to 129 W along 45 N latitude (in Oregon).

Beach and demersal seines

Beach seines are illegal in California; pole seines (20 feet long) can be used to take surf smelt; however, these nets are not used in water much deeper than 1 meter. Demersal seines (i.e. Danish and Scottish seines) are illegal off of California; however, there has been some interest in experimental permits for the use of this type of gear.

Surface seines

Surface seines are commonly used for capture of pelagic fishes or squid, and in California waters purse-seines and lampara nets are used to catch coastal pelagic fishes (sardine, anchovy, jack mackerel and Pacific mackerel) and market squid. Small amounts of non-target species are taken in the coastal pelagics fishery, however, the majority are other coastal pelagics (i.e. sardine caught when fishing for mackerel), lightly exploited species (i.e. jack smelt, sand-dabs) and generally they are landed rather than being discarded bycatch. Marine protected areas are not thought to be effective in protecting pelagic species due to their great mobility; a great deal of attention was made in development of boundaries of the State of California marine reserves and conservation areas to allow surface fisheries to be used in areas deeper than 50 meters. Therefore State Marine Reserves and most State Marine Conservation Areas are the only areas where surface seines cannot be used in the MBNMS.

Purse-seines are also the major fishing gear used to capture tunas but this fishery does not occur in the MBNMS.

Traps and pots

Fish traps and pots are generally legal in California, the design of the gear is usually narrowly described in State of California regulations and the fisheries require a limited entry permit. Different types of traps and pots are used to capture crabs, spot prawns, nearshore fishes and sablefish and trapping for hagfish occurred in the past and this may re-develop in the future. Bycatch with traps and pots is generally relatively small in comparison to other types of fishing gear and some of the bycatch is somewhat artificial, in that the bycatch is of exploited

species which cannot be landed due to lack of limited entry permits and/or gear specific regulations preventing their sale. The trap and pot fisheries in the MBNMS are relatively low volume and high value fisheries that have become some of the areas major fisheries based on the value of their landings. Trap and pot fisheries of the type carried out in the MBNMS are often considered to be among the most ecologically benign fisheries.

Hook and line

Salmon can only be taken by hook and line gear, mostly pole and line and trolling gear. Hook and line gear, both recreational and commercial, are now the primarily gear used to catch bottom and shore fishes in the shallower habitats of the study area. Many types of gear are used including hand lines, pole and line, vertical longlines, bottom longlines and trolling gear. Presently recreational fishers cannot use hook and line gear to take groundfishes in waters deeper than 30 fathoms and commercial fishers cannot use hook and line gear to take groundfish in waters deeper than 30 fathoms and shallower than 150 fathoms. Bottom longlines have been used to take sablefish and other groundfishes for decades and this gear is still used to take sablefish in waters deeper than 150 fathoms.

Commercial hook and line fisheries are also relatively low volume and high value fisheries. Hook and line gear is often relatively inefficient for harvesting many species of fish; however, the large number of commercial and recreational fishers that use this type of gear make it capable of producing overfishing for some important species. In the study area, if no other regulations were in existence and no other fishing gear utilized, probably salmon, California halibut, 'reef' fishes and possibly sablefish could be overfished with hook and line gear but the majority of species dwelling on soft bottom and small species generally could not be overfished due to their low catchablity with hook and line gear. The major attention given to nearshore hard bottom habitats in the recent MLPA process was partially due to the perception that shallow hard-bottom habitats were vulnerable to hook and line fisheries.

Drift longlines are used extensively elsewhere in the world to take highly migratory species. This fishing gear has not been allowed off of California.

Marine Protected Areas

Both federal and State of California fishery management agencies have very recently created extensive marine protected areas in the MBNMS study area. The federal and state definitions of what constitutes a MPA are very similar; with a single exception, the State of California does not consider an area to be a MPA unless it has a name. The federal essential fish habitat areas, which prohibit trawling and have area names, qualify as MPAs under both federal and state guidelines. However, the recent state regulation that prohibits trawling in state waters makes state waters an MPA under federal guidelines but it does not make the area an MPA under state guidelines because it is not a "named area". For the purposes of this report I have not considered area-based gear closures with boundaries defined by depth contours, such as the several gillnet area closures discussed previously described, as MPAs; although under the federal definition these areas might be considered MPAs. I decided that considering multiple, and often overlapping, gear-based area closures to be MPAs would introduce too

much complexity. However, due to the importance of trawl fisheries, I have considered area-based trawl closures with geographically defined boundaries as MPAs (i.e. the EFH and state waters trawl closures). The distinction of geographically defined boundaries was important for the GIS analysis carried out by MBNMS personnel.

State Marine Protected Areas

The State of California south-central MPA network consisting of 29 marine reserves and conservation areas became affective on September 21, 2007. The entire MBNMS study area nearshore habitat and the majority of the shelf habitat are within state waters (Figure 1). However, the network covers all state waters between Pigeon Point and Point Conception so the habitat summaries for the MPA network cover a larger area than the state waters portion of the study area and cannot be used directly to assess closed areas in the study area. All of the State MPAs prohibit commercial fishing for bottomfishes; however, some allow recreational fishing for bottomfishes. The calculations of areas discussed later only include the State MPAs that prohibit all fishing for bottomfishes and they also exclude the estuarine MPAs.

Federal Essential Fish Habitat Areas (EFH areas)

Following litigation and extensive essential fish habitat analyses the PFMC established a network of EFH marine protected areas that went into effect on June 12, 2006 (Figure 1). The network extends along the entire U.S. west coast and it was designed specifically to protect habitats that are considered to be essential fish habitat. The network is primarily intended to provide ecosystem protection and it's value for management of exploited species is of secondary importance. The network includes areas where no trawling is allowed, where no bottom contact of fishing gear is allowed and areas where no bottom contact gear is allowed within an off-bottom buffer (i.e. Davidson Seamount). The MBNMS study area has extensive EFH no trawl areas but no EFH no contact areas. The Davidson Seamount EFH (775.5 sq. mi.) lies offshore of the MBNMS.
Three EFH no trawl areas lie partially or entirely within the MBNMS study area:

Monterey Bay/Canyon	831.3 sq. mi.	831.3 inside study area
Point Sur Deep	84.4 sq. mi.	84.4 inside study area
Big Sur Coast/Port San Luis	3,991.8 sq. mi.	519.3 inside study area
TOTAL of 3	4,907.5 sq. mi.	1,435.0 inside study area

Federal Rockfish Conservation Areas

The Federal Rockfish Conservation Areas (RCAs) were enacted in 2003 as part of the rebuilding plan for overfished groundfishes (Figure 1). These areas prohibit fishing for groundfishes and they prohibit any fishing gear that is likely to catch groundfishes, but they do not apply to pelagic fisheries for salmon, coastal pelagics, highly migratory species or invertebrates taken in traps or pots. The RCAs extend along the entire west coast but they vary in the depths protected depending upon the species that are overfished in individual regions and they vary in depth depending upon fishing gear types. In the MBNMS the

original recreational and non-trawl commercial RCA closure approximated the area between the 20 fathom and 150 fathoms contours (37–274 m). Presently the recreational RCA extends from 30 fathoms (55 m) to 200 miles offshore from June to November and from the shoreline to 200 miles from December to May. The present RCA for commercial non-trawl fishers is from 30 to 150 fathoms (55-274 m). The original trawl closure (January 2003) was from 50 to 150 fathoms (91-274 m). The trawl closure has varied seasonally and has undergone considerable changes with time to allow harvest of healthy flatfish stocks while still protecting depressed rockfish species. The present trawl RCA in the MBNMS (Figure 1) extends from 100 to 150 fathoms (183-274 m) and it does not change seasonally. The two types of closures in the RCA overlap in the no trawl closure area, making this area a no-bottomfishing area. In addition, where the non-trawl RCA is within State waters, where trawling is not allowed, the area is also a no bottomfishing area.

Other Area-based Trawl Closures

Trawling for groundfish has been illegal in California within 3 miles of most of the mainland for many decades. However, trawling was allowed outside of 1 mile from shore in the area between Yankee Point and Point Sur until recently. Trawling for shrimp and prawns is not allowed inside of 3 miles in the MBNMS. Starting on October 1 2006, trawling was not allowed in any State waters (Figure 1). State waters is defined as 3 miles offshore from the nearest point of land (including offshore rocks) for most of the State. Monterey Bay is less than 24 miles from headland to headland therefore State waters extends to 3 miles offshore of a line between the north and south ends of the bay. In the center of the bay this is as much as 12 miles offshore (Figure 1).

Federal regulations enacted along with the EFH closures, in June 2006, prohibit all trawling between 700 (1280 m) and 3500 fathoms (6400 m), the expected limit of any future fishery along the entire length of Washington, Oregon and California (Figure 1).

When combined the many types of areas closed to trawling dominate the ocean off of central California, occupying 64% of the area of the MBNMS study area (Figure 2). The areas where trawling in the study area is allowed include three areas on the upper and lower slope and one large and two small areas on the inner shelf break and outer shelf (i.e. between State waters and the RCA).

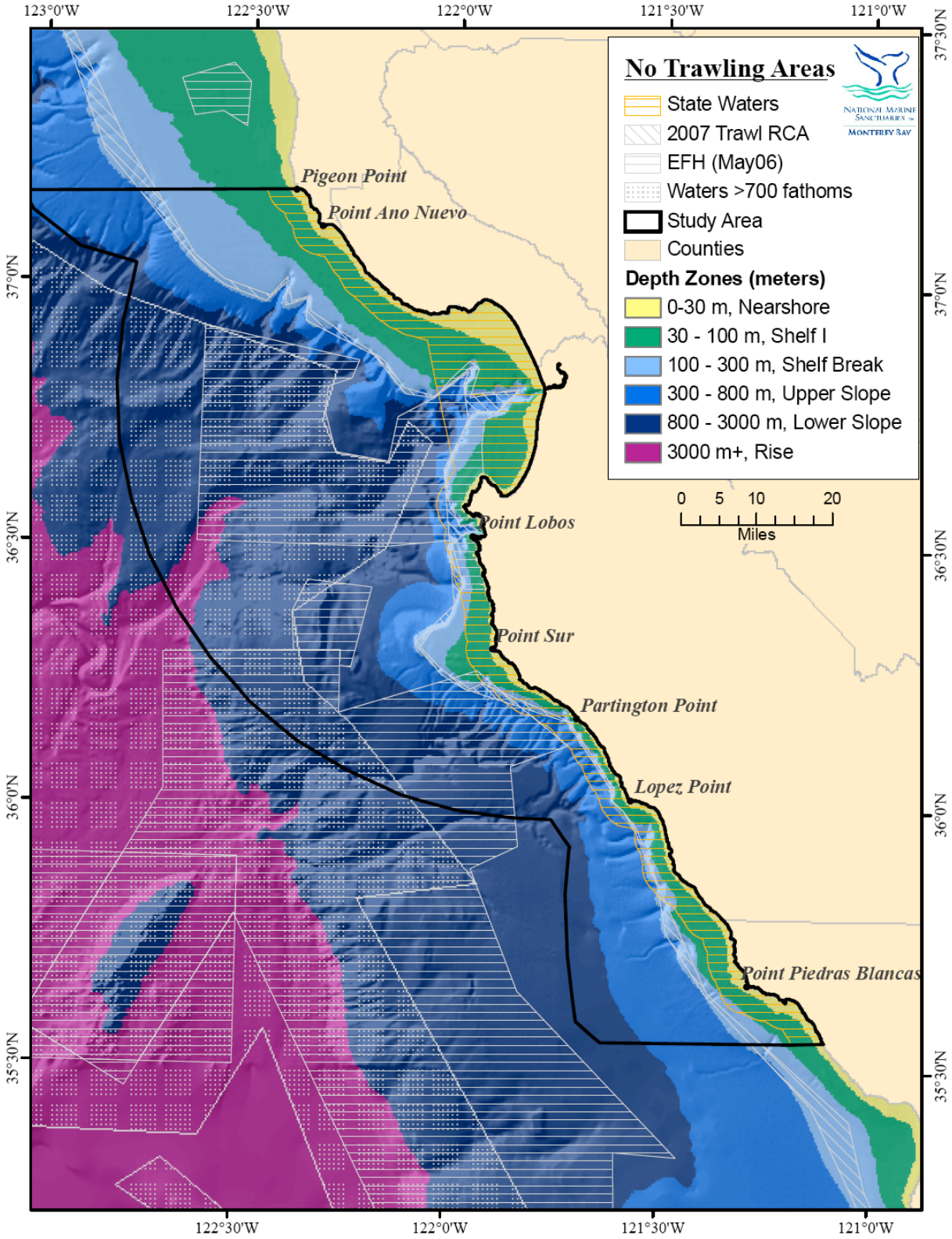

Figure 1. Marine Protected Areas in the MBNMS. (Figure provided by MBNMS.)

Overview of area-based regulations by depth zone

Epipelagic, mesopelagic, bathypelagic, migratory and highly mobile species are poorly protected by MPAs of the size likely to be placed in the MBNMS study area, therefore protection levels are assessed primarily for benthic, resident and low to moderate mobility species. Trawling was the principal fishing gear used in the fisheries of the several overfished groundfish species off of California, and this gear can cause alterations in bottom habitats; therefore, this gear type is the most important to be assessed. Gillnet, trap, pot and hook and line fisheries also have the potential to cause overfishing of some resident species and therefore a second class of protection, no fishing for bottom fishes is evaluated. The information on areas closed by depth zone was derived from the MBNMS GIS database and was provided by Sophie De Beukelaer (MBNMS).

The MBNMS MPA stakeholder group divided the habitats of the MBNMS study area into 6 depth zones (Table 4) that differ from the habitats definitions and depth zones used in the State of California MLPA process. Each of the 6 depth zones could be divided into hard and soft bottom habitat areas if adequate habitat mapping were available. The adjacent Davidson Seamount contains only the two deeper zones; due to its importance in protection of the central California deep waters habitats calculations for this area are also listed.

Trawling in the study area is prohibited in five different types of area closures and there is considerable overlap between the areas:

- Trawling is prohibited in all State of California Waters
- Trawling is prohibited in all State of California MPAs
- Trawling is prohibited in all Federal EFH areas
- Trawling is prohibited in waters deeper than 100 fathoms and shallower than -150 fathoms (183-274 m) in the trawl Rockfish Conservation Zone
- Trawling is prohibited in waters deeper than 700 fathoms and shallower than 3500 fathoms (1280-6400 m) in the entire EEZ.
- Trawling is also prohibited in the Davidson Seamount Area

When combined the many sources of no trawling areas dominate the ocean off of central California (Figure 2). The areas where trawling in the study area is allowed include 3 areas on the upper and lower slope and one large and 2 very small areas on the inner shelf break and outer shelf (i.e. between state waters and the RCA).

Trawling is presently extremely tightly regulated in the study area; 64% of the study area is closed to trawling (Table 4, Figure 2). Trawling is presently prohibited in 99% of the nearshore habitat and 74% of the shelf habitat. Trawling is prohibited in 37% of the shelf break and 22% of the upper slope habitats. Nearly all of the lower slope (81%) and rise area (100%) is closed to trawling. Except for the shelf break habitat, which will go from 37% to 23%, the percent area closed to trawling will remain essentially unchanged when the Rockfish Conservation Area is eventually opened to fishing.

All fishing for bottomfishes is prohibited in the trawl RCA, in the portion of the non-trawl RCA that lies within State waters and in the majority of the State of California MPAs (Table 4 Figure 3). There is no commercial fishing for groundfishes in any of the State MPAs; however, some of the MPAs allow recreational fishing for groundfishes. The MPAs that allow fishing for bottom fishing by recreational fishers (and the estuarine MPAs) were not included in the calculations presented in figure 4. Presently there is no fishing for bottomfishes in 12% of the study area and this will go to 3% when the RCA is eventually re-opened to fishing. In addition, 100% of the Davidson Seamount is closed to all take of sea life living on or near the bottom. The three shallower depth zones have 18-48% of their area closed to bottomfishing, 7% of the upper slope is closed and essentially none of the deeper zones are closed to bottomfishing in the study area. However, the adjacent Davidson Seamount has very large areas within the lower slope and rise habitats that are closed to bottomfishing. When the Rockfish Conservation Area is again opened to fishing the only areas in the study area that will have no fishing for bottomfishes will be the State of California MPAs. The nearshore (17%) will remain virtually unchanged; however, the shelf area will decline from 48% to 12% the shelf break area will decline from 36% to 5% and the upper slope will decline from 7% to 2% when the RCA is eventually re-opened to fishing.

Table 4. Area and percentage of area by depth zone with no trawling and no take of bottomfish. The percentage that will occur when the Rockfish Conservation Area is opened to fishing is indicated by –RCA. (Data provided by MBNMS).

	Depth Range		Area	No Trawling			No Bottomfish Take		
	meters	fathoms	sq. mi.	sq. mi.	RCA	-RCA	sq. mi.	RCA	-RCA
MBNMS									
Nearshore	0-30	0-16	164.7	163.6	99%	99%	28.18	18%	17%
Shelf	30-100	16-55	542.4	398.8	74%	73%	65.32	48%	12%
Shelf break	100-300	55-164	399.6	148.8	37%	23%	90.00	36%	5%
Upper slope	300-800	164-437	897.4	193.8	22%	20%	62.80	7%	2%
Lower slope	800-3000	437-1640	2141.2	1729.2	81%	81%	1.21	0%	0%
Rise	3000+	1640+	70.3	70.3	100%	100%	0.00	0%	0%
TOTAL			4215.7	2704.4	64%	62%	247.51	12%	3%
Davidson Seamount									
Lower slope	800-3000	437-1640	113.5	113.5		100%	113.5		100%
Rise	3000+	1640+	662.0	662.0		100%	662.0		100%
TOTAL			775.5	775.5		100%	775.5		100%

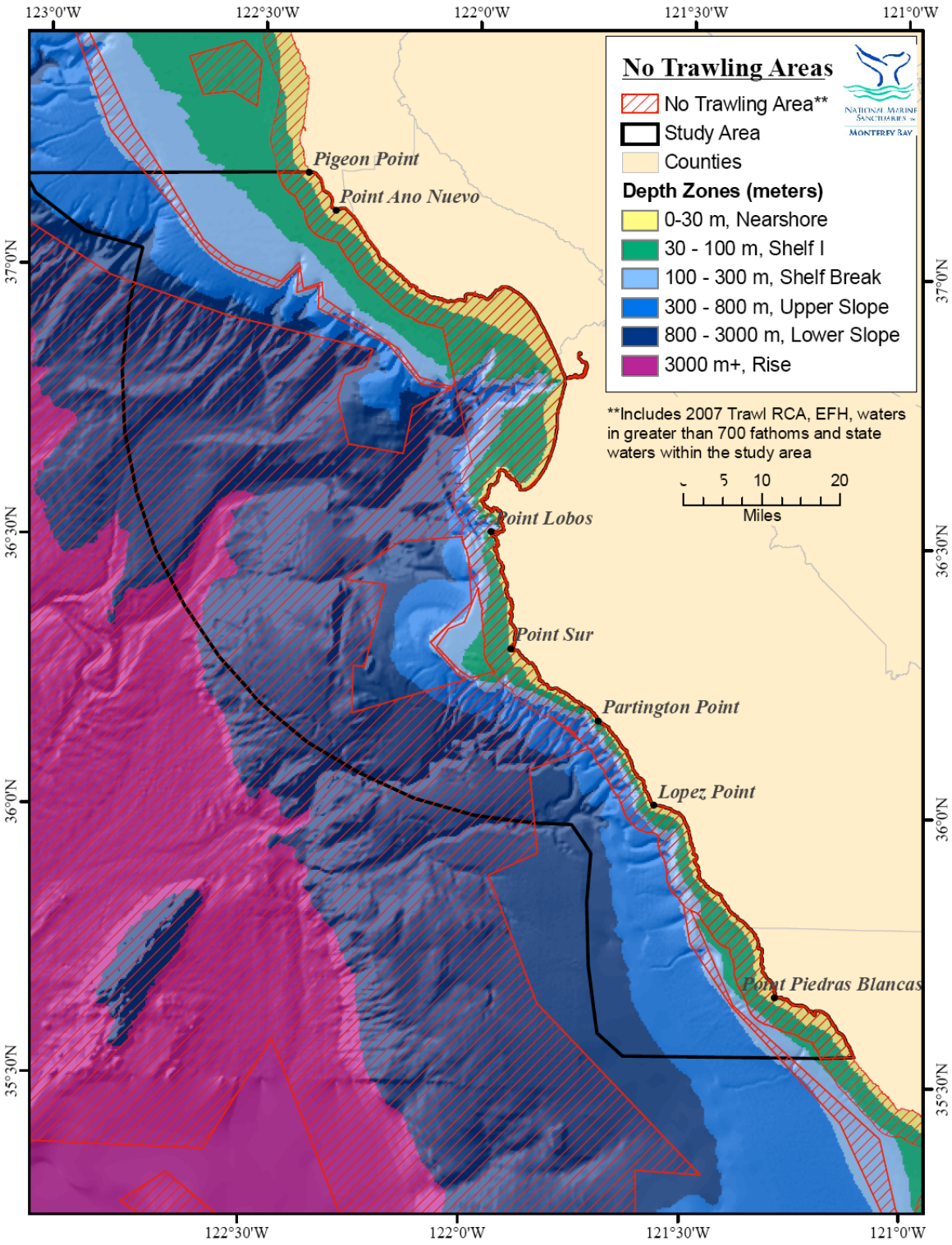

Figure 2 No trawling areas in the Monterey Bay National Marine Sanctuary (Figure provided by the MBNMS).

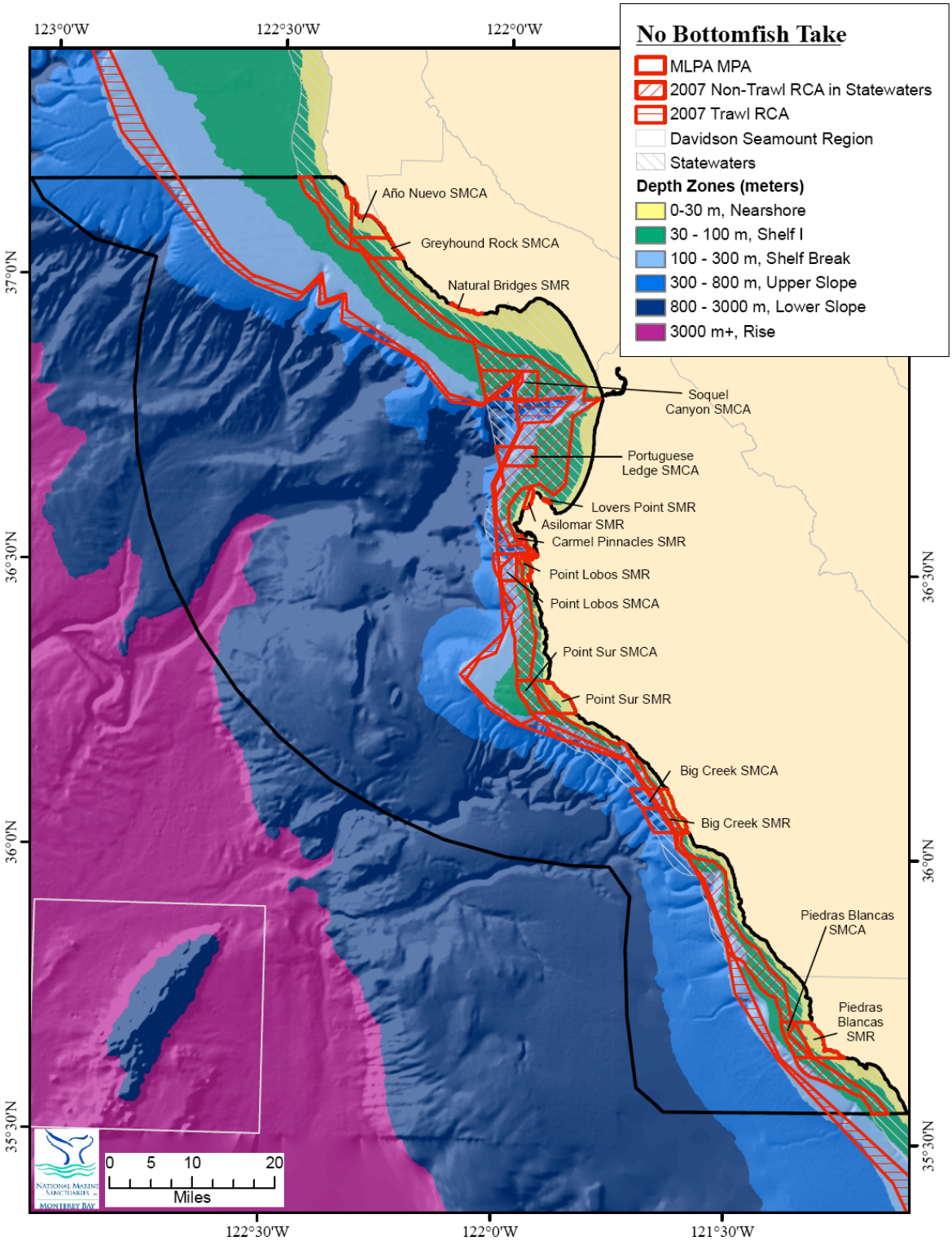

Figure 3. No bottomfish take areas in the MBNMS (Figure provided by the MBNMS).

It should be noted that the vast majority of bottomfishes that have been caught on the shelf, shelf break, upper slope and lower slope habitats were taken by trawl gear. In addition simplifying the area closures into only two categories, no trawling and no fishing for bottomfishes, covers up much of the complexity of area based closures for other commercial and recreational fishing gear types. All of the other gear types used to take bottomfishes are tightly regulated and the regulations include extensive area closures. For example, non-trawl commercial fishers cannot fish for bottomfishes in waters deeper than 30 fathoms (54 m.) and shallower than 150 fathoms (274 m) under the RCA. This is the majority of both the nearshore and shelf habitats. Recreational fishers cannot fish for bottomfish in waters deeper than 30 fathoms under the RCA. Note that the RCA area closed to recreational and non-trawl commercial fishers is much larger than that closed to trawling (i.e. the area in Table 4). Many efficient fishing gears are completely illegal in California (i.e. beach seines and Danish seines). In addition, the study area has a very complicated set of depth regulations which prevent the use of gillnets in waters between the shore and as deep as 100 fathoms (183 m) and these regulations will remain in effect after the RCA is re-opened. Also the Davidson Seamount area offshore of the MBNMS, adds a very large area in the lower slope and rise habitats where no take of bottom organisms is allowed.

METHODS LIKELY TO PRODUCE SUSTAINABLE FISHERIES

Biomass-based Quotas

Over the last two decades the management of the fisheries in the EEZ of California, Oregon and Washington has had very significant changes in the principal methods used to protect the resources. As information on the populations of exploited fishes has increased population assessments using stock synthesis models have been used to estimate the population sizes, exploitation rates and productivity of a wide range of important commercial species. It should be noted that these species represent the majority of the biomass of exploited species in the California Current System. These models have been used to calculate the expected size of an unfished population, and this allows estimation of the relative size, or depletion, of the exploited species. With the development of this information, management centered on establishing annual quotas designed to maintain populations at or near the levels that would produce maximum sustainable yield and maximum productivity, and allocation of the available yield among different user groups.

Over the last decade, area-based fishing regulations including area-based annual quotas and monthly or bi-monthly species (and species groups) trip limits have become standard management for most species managed by the PFMC (Appendix 1 : 2007-8 trip limits). The PFMC is actively involved in adaptive management and is constantly changing regulations to insure that annual quotas are based on current stock assessments, that annual quotas are not exceeded, that trip limits spread the available quotas over the geographical range of the species and the most advantageous seasonal distribution of landings and to reduce the bycatch of overfished species. The stock assessments revealed the low productivity of most west coast groundfish species, and this prompted the PFMC to reduce the number of fishing vessels chasing the fish so that the fishery would remain profitable with reduced catch levels.

Presently there is a NOAA mandate for ecosystem-based management, and it is expected that as information, analyses and ecosystem models become available further changes in management will occur. At this stage it is impossible to predict the basis of future ecosystem based management; however it is likely that trophic level and regional scale spatial considerations will be of major importance.

Overfishing has been a major factor in the determination of our present regulatory strategies. The PFMC uses the following definitions to describe overfishing and overfished:

> Overfishing occurs when the catch exceeds the fishing mortality rate needed to produce the maximum sustained yield F_{MSY} on a continual basis. The default F MSY proxy used for setting acceptable biological catches (ABCs) is $F_{45\%}$ for other groundfish such as lingcod and sablefish. $F_{50\%}$ is the default value for rockfishes and $F_{40\%}$ is the default for flatfishes.
>
> A stock is overfished if its current biomass is less than 25% of the unfished biomass level or if the current biomass is less than 50% of the biomass that would produce the maximum sustainable yield (MSY)

Thus overfishing depends on the annual harvest rate that produces MSY, and the overfished status depends on the relative size of the population in relation to the biomass that produces MSY. However, in practice overfishing has depended on the annual rate that produces 50%, 45% or 40% of the annual fecundity of the average fish in an unfished population and the overfished status has depended on a population falling below 25% of its unfished level.

Presently the PFMC manages groundfish fisheries with annual quotas based on a control rule where stock assessments are available. Quotas for the rest of the stocks are set at some fraction of historical average catch, often on a species group basis. The control rule uses a base harvest rate which is defined as the fishing mortality rate (F_{MSY}) or exploitation rate (E_{MSY}) that produces the maximum sustain yield; in practice the above MSY proxies are used. The exploitation rate is the percentage of the population that is taken by the fishery. This base exploitation rate is altered when the biomass drops below two population thresholds. The first threshold is the biomass that produces MSY; where this level is not known the proxy is 40% of the expected average unfished spawning biomass (this is now called the 40% depletion level). When a species stock assessment shows that the biomass is less than the 40% threshold, the exploitation rate is decreased linearly going from (E_{MSY}) at 40% of the unfished biomass to E=0.0 at 10% of the unfished biomass. The second threshold is the population level that defines an overfished species (i.e. in practice 25% of unfished biomass) and falling below this threshold triggers management into a rebuilding mode where fishing rates must be sharply reduced to allow rapid population rebuilding. Note that when a population is at 25% of its unfished biomass the exploitation rate would be exactly half of the (E_{MSY}) rate. For example if the exploitation rate that produces the proxy maximum sustained yield is 5% (i.e. E=0.05) the exploitation rate would be 2.5% when the population was at the 25% overfishing threshold.

When a species declines below the overfished threshold the PFMC has taken drastic measures to reduce the catch of that species both from fisheries targeting the species and fisheries which may take the species as bycatch. This has included closing down all groundfish fisheries over most of the core habitat of the overfished species (i.e. the RCA and the Cowcod closures in Southern California).

STATUS OF LIVING RESOURCES - STOCK ASSESSMENT

Generally speaking quantitative stock assessments are most accurate for groundfish species that have both relatively large populations and a history of commercial exploitation; and they are generally lacking for species without a history of commercial landings, nearshore species and species with small populations. There are many exploited species, including those taken in recreational fisheries, for which we do not have population assessments and only one population assessment is available for an unexploited species. Un-assessed species that are most likely to be at low population levels include species that live in habitats where extensive fishing (especially trawling) has occurred in the past, in nearshore habitats possibly affected by pollution (or other man induced environmental changes) and cold water species adversely affected by the warm water regime that has largely persisted since 1976-77.

The groundfish stock assessments used in this report are the most recent available assessments (August 2007) available from the Pacific Fisheries Management Commission's website. Regional assessments that do not include the central California area (i.e. cowcod), and species that are not common in central California (i.e. Pacific Ocean perch) were not included. Where several regional assessments were available the assessment covering the central California area was used (i.e. lingcod). The great majority of species for which quantitative information is available are presently being harvested at less than maximum sustainable levels and presently there is no overfishing occurring on PFMC managed stocks. This was not the case in the 1980s and early 1990s.

The term depletion has recently been used to describe the status of a population in relation to its unfished level. For example, a species that has a depletion of 40 % has a population that is 40% of the estimated average size of the unfished population. For some species the population size at the start of exploitation (i.e. the virgin population level) is taken to be the unfished biomass used to establish depletion. However, increasingly the unfished biomass is calculated within the species stock assessment model. The population fluctuations of the unexploited shortbelly rockfish provide a good example of the problem of establishing the unfished population level (Figure 4). The species was virtually unfished for the entire 1950-2005 time-period; therefore the average population size for the entire period would be the best estimate of the unfished biomass. If the beginning biomass (381,000 mt) were used to determine the species' unfished biomass the 2005 "depletion" would be 16.8%. Therefore, the stock would have to be classified as overfished and a rebuilding plan would have to be established; despite the fact that it has essentially not been fished.

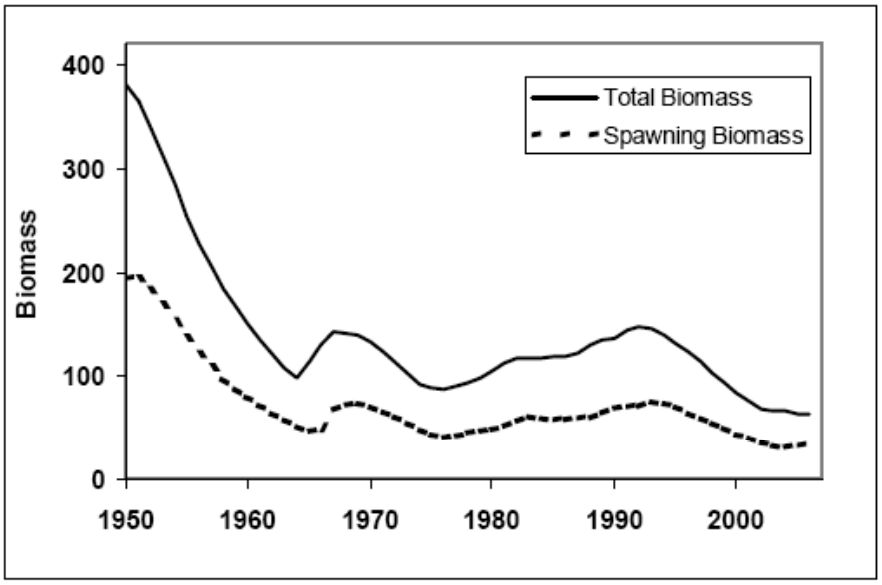

Figure 4. Population estimates of shortbelly rockfish in thousands of metric tons.
Figure from 2007 stock assessment (John Field, Edward Dick and Alec MacCall)

Stock assessments are available for 23 species in the central California area; to simplify the complex array that would result from trying to visualize the fluctuations of 23 species, the population levels relative to the individual species' unfished population levels (i.e. depletions) are listed at 10 year intervals starting in 1965. (Table 5). Several stock assessments do not go back as far as 1965 and the most recent year in the individual assessments is placed in the 2005 column. The definition of an overfished species used by the PFMC is a depletion of 25%; any stock falling to below this level requires sharply reduced exploitation rates and a rebuilding plan

Table 5. Depletion as a percentage of unfished biomass at ten-year intervals.
(Stocks below the 25% overfished threshold are in bold type)

	Year of assessment	1965	1975	1985	1995	2005*
Bank rockfish	2000	NA %	NA %	61.7%	52.2 %	45.1 %
Black rockfish	2003	84.7	70.2	38.7	41.2	54.8
Blackgill rockfish	2005	96.6	91.2	78.8	51.5	52.3
Bocaccio	2005	52.6	42.8	**18.0**	**7.1**	**11.6**
Cabezon (north)	2005	81.4	78.4	54.3	41.0	52.2
Canary rockfish	2005	55.9	46.1	**24.0**	**6.9**	**5.7**
Chilipepper	1998	NA	85.0	47.5	53.1	51.5
Darkblotched rockfish	2005	89.2	52.7	50.0	**18.6**	33.6
Dover sole	2005	62.1	63.4	50.8	42.0	62.8

English sole	2007	46.0	48.0	26.0	27.0	116.0
Gopher	2005	95.3	60.6	68.4	100.1	100.0
Lingcod (south)	2005	98.0	76.0	33.0	**12.0**	**24.0**
Longnose skate	2007	83.0	84.0	71.0	75.0	66.0
Longspine thornyhead	2005	100.0	99.8	98.7	82.7	71.6
Petrale sole (south)	2004	31.0	**19.0**	**7.0**	**8.0**	29.0
Sablefish	2005	57.3	59.9	45.5	34.1	27.9
Sablefish	2007	87.1	55.8	61.1	41.0	38.3
Shortbelly rockfish	2005	95.0	89.0	118.0	144.0	67.0
Shortspine thornyhead	2005	96.3	89.2	80.1	64.8	62.7
Starry flounder (south)	2005	NA	48.0	71.0	39.0	62.0
Whiting	2006	NA	118.5	120.1	38.6	30.9
Widow rockfish	2007	94.5	95.0	49.5	37.1	35.8
Yelloweye rockfish	2005	91.4	82.5	55.1	29.4	**23.0**
AVERAGE		79.2	71.3	58.0	45.9	49.6

(* 2005 or the most recent year available)

The west coast trawl fishery began prior to 1900 primarily as a fishery for flatfish, after about 1950 technological improvements, increased knowledge of the behavior of rockfishes and probably the decline in flatfish populations resulted in the trawl fishery concentrating more on rockfishes. The development of the fishery for other species (i.e. thornyheads, Pacific whiting, sablefish ect.) was more gradual. This pattern is seen when the stock assessment information is grouped into flatfishes, rockfishes and other species (Figure 5). The flatfish group was fished to below 50% of their unfished level by 1965 and the group declined to well below the 40% level by 1995; the group then rebounded to the 67% level following the introduction of restrictive quotas in the mid-1990s. The rockfish and other species groups were at quite high population levels in 1965. The rockfish group declined faster than the other species group and by 2005 both groups had population levels between 40-50% of the unfished level. While group levels are well within management guidelines individual species in each of the three groups had depletion levels that fell below the 40% target threshold. Presently the canary rockfish, bocaccio, yelloweye rockfishes and lingcod (in the southern assessment area) are below the 25% level (Table 5) and widow rockfish is in a rebuilding plan with biomass expected to reach the target level (40% depletion) in 2009. Due to the coastwide increase in its population lingcod has recently been removed from the overfished status; however, most of the recent increase in the lingcod has occurred in the north (64% depletion) and its status in the southern assessment area is considerably less (depletion 24%). Although the cowcod assessment does not include the area north of Point Conception, this species occurs in the MBNMS and it's population level in southern California is only 7.1% of the unfished level. Rebuilding plans with greatly reduced exploitation rates are currently in place for canary, bocaccio, cowcod, widow and yelloweye rockfishes.

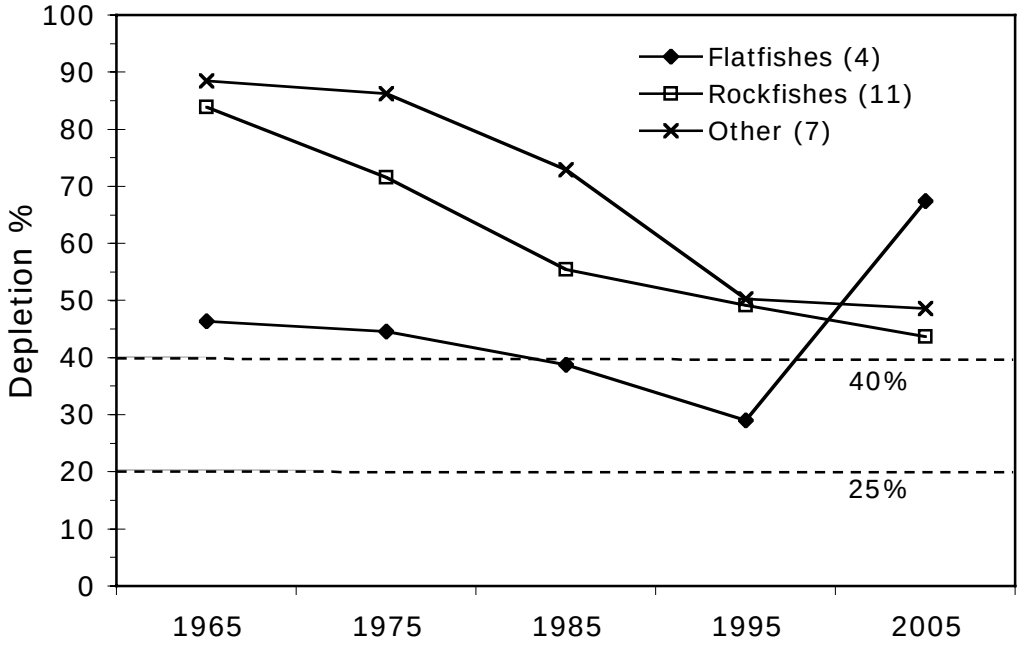

Figure 5. Summary of biomass trends at 10-year intervals of taxonomic groups of bottomfishes, depletion refers to the biomass of the species group in relation to its unfished (100%) state.

The stock assessment models showed that some of the groundfish stocks have relatively stable population growth rates (i.e. surplus production rates) that are in the 2-4% per year range. Some of the more productive stocks have average rates in the 6-12% range; however, most of the higher productivity species appear to have highly volatile, environmental-dependent rates with some years having negative growth rates and other years occasionally producing rates that are far above the average for the species. In other words the stocks that have stable production are relatively unproductive and the stocks with high productivity are relative unstable. Sablefish is an example of a stable, low productivity species and Pacific whiting is an example of species with high productivity, unstable production (Figure 6).

Shortbelly rockfish, the single unexploited species with a stock assessment, is a good example of a species whose population fluctuations have been primarily determined by environmental variation (Figure 4). Shortbelly rockfish had a total biomass of about 381,000 metric tons (mt) in 1950; by 1958 the population had fallen to less than half of the 1950 level and it to date it has not again attained the 1958 level. Between 1960 and the present the biomass has slowly fluctuated between 150,000 and 64,000 mt with minimum biomass occurring in 2005 (the last year of the assessment. Note that the foreign fleet that fished whiting off of Washington, Oregon and central California took small amounts of shortbelly rockfish from the mid-1960 to the mid-1970s (i.e. about 1% of the population per year and 6% in 1967).

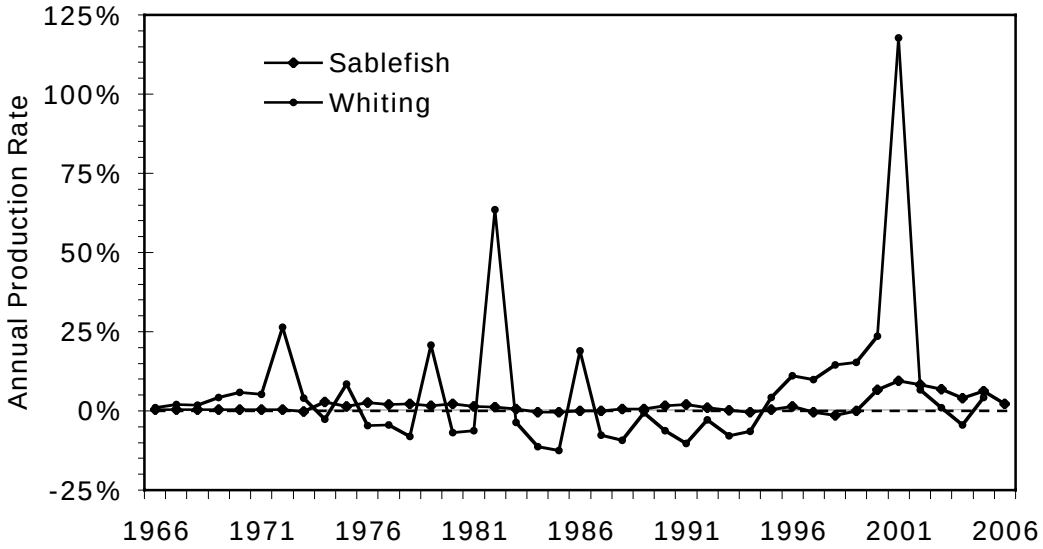

Figure 6. Annual production rates of sablefish and Pacific whiting. Data derived from the 2007 sablefish (Michael Schirripa) and 2006 whiting(Thomas Helser. Ian Stewart, Guy Fleisher and Steve Martell) stock assessments

Stock assessments show some variability in estimates as the models evolve. To demonstrate the type of variation that occurs, estimates of depletion levels from two sablefish stock assessments are listed in Table 5. The depletion estimate for the last year of the 2005 assessment (i.e. 2004) is 27.91% the corresponding estimate from the 2007 assessment is 34.2%.

OVERVIEW OF THE TOTAL AFFECT OF REGULATIONS ON FISHERIES

Sustainable fisheries require two components: (1) that there will be plenty of fish around in the future to sustain the fishery, and (2) that the fishing gear has to be sufficiently efficient that it is economical to fish a particular species. Ecosystem management adds two additional components: (3) that there should be plenty of non-fished species around, and (4) that physical habitat alteration should be minimized. If fisheries are to continue the tradeoffs between these four, often contradictory, components have to be evaluated. For example some hook and line fisheries have low by-catch rates and near zero habitat damage, but hook and line fisheries are not economically feasible for many species. In contrast, trawling on hard bottom, with large rollers, may be the economical superior mode of fishing for some species, but this type of trawling has large habitat impacts. The overview below suggests that there has been little attention paid to evaluation of the tradeoffs between four components. I note that the evaluation that follows is primarily focused on only half of the story; a description present fisheries regulations and the effect of the regulations on fisheries.

Nearshore (0-30 m or 0-16 fathoms) soft bottom habitat could be efficiently harvested with beach seines, demersal seines, various types of trawls, gillnets, and crab pots. The shelf (30-

100 m or 16-55 fathoms) soft bottom habitat has essentially the same array of effective gear types except for beach seines. Very few of the resident soft bottom species can be effectively fished with hook and line gear. Nearly all of the effective fishing gear for this habitat has been prohibited in the MBNMS area. Only crab pots, small mesh gillnets (that cannot be used to take rockfishes or lingcod) in the area between Yankee Point and Point Sal, and trawl gear (in 27% of the shelf habitat) are allowed. Therefore economically sustainable fisheries are impossible in the MBNMS for the vast majority of nearshore and shelf bottomfishes that dwell on soft bottom (i.e. surf perches, soles, flounders, turbots, skates, osmerid and antherinid smelts and white croaker).

Nearshore and shelf hard bottom habitats could be efficiently fished with gillnets, fish traps, various types of hook and line gear and low relief hard bottom could be trawled with some types of trawl gear. Gillnets and trawls are presently illegal over the entire nearshore habitat and the great majority of the shelf habitat; but other types of gear are adequate to achieve and exceed sustainable fisheries for many of the resident fishes in these habitats. Presently these other gear types cannot be used in the non-trawl RCA (54-274 m or 30-150 fathoms) so presently the hard bottom shelf habitat from 54-100 m is virtually unfished for bottomfishes.

When the non-trawl Rockfish Conservation Area is re-opened to fishing the shelf area in the MBNMS will remain closed to gillnetting as gillnets generally cannot be used in water shallower than 60 fathoms (109 m) between Point Reyes and Point Arguello. However, between Yankee Point and Point Sal gillnets less than 3 1/2 inches can be used; but rockfish and lingcod cannot be taken. All commercial fishing and recreational fishing for groundfish will remain prohibited in the State MPAs (17% of the nearshore and 12% of the shelf). The principal reasons for prohibition of gillnets in shallower water was their bycatch of protected species (marine birds and to a lesser degree marine mammals). This bycatch would not be expected in the shelf-break habitat due to increased depth; as past gillnetting was concentrated in the nearshore and shelf habitats it is presently unknown if this gear could be effectively used in the shelf-break or deeper habitats. Presently there is essentially no gillnet fishery in the MBNMS study area although it is legal fishing gear at depths deeper than the RCA.

The strong contrast between the potential exploitation levels in the hard and soft bottom habitats is the principal reason that the State of California MLPA process emphasized protection on nearshore and shelf hard bottom habitats and why they developed no MPAs specifically for soft bottom nearshore or shelf habitats. Presently there is no fishing for bottomfishes in 18% of the nearshore and 48% of the shelf habitats. When the RCA is re-opened to fishing 17% of the nearshore and 12% of the shelf habitats will have no fishing for bottomfish (i.e. the State MPAs): however, the percentage of hard bottom habitat protected by the State MPAs is about twice that of the soft bottom habitat. Trawling is presently prohibited in 99 % of the nearshore habitat and 74% of the shelf habitat in the study area; this will remain virtually unchanged when the RCA is re-opened.

Shelf break (100-300 m or 55-164 fathoms) fisheries have at times been the most significant fisheries in the MBNMS, the otter trawl fishery has traditionally dominated the fisheries exploiting this very rich habitat and most of the species that have been overfished on the west coast are trawl groundfish species with high concentrations of biomass at shelf break depths.

Including the RCA, which is a long-term but temporary closure, 37% of this habitat has recently been closed to trawling and when the RCA is reopened 23% of this area will remain closed to trawling. Presently all fishing for bottomfishes is prohibited in 36% of the shelf break habitat; this will decline to 5% when the RCA re-opens. In keeping with its traditional importance this habitat has the largest number of species with stock assessments and when the RCA is reopened the principal protection of this habitat will be provided by PMFC trip limits, PMFC EFH areas, State no trawl areas, State MPAs, limited entry and a complicated series of State of California area closures to gillnets.

The upper slope habitat (300-800 m or 164-437 fathoms) extends from the shelf break habitat to the approximate depth of the oxygen minimum (i.e. dissolved oxygen below about 0.5 mL/L). The great majority of shelf break species have individuals that go deeper than 300 meters, but their abundance drops off quickly below this depth. Essentially diversity drops off rapidly as the depth increases and the oxygen level decreases. At 400 meters depth (219 fathoms) dissolved oxygen varies between about 0.7 to 1.5 mL/L and few fishes or invertebrates are able to tolerate oxygen concentrations this low. On average oxygen levels drop below 1 mL/L at a depth of about 475 meters (260 fathoms) in the study area and it remains below this level to about 1500 meters (820 fathoms). The upper slope habitat has a few rockfish species (i.e. splitnose, bank and blackgill) whose core habitat is on the shallow edge of the upper slope but these species are not abundant below about 450 meters (246 fathoms). The fisheries of the upper slope are primarily dependent upon 4 species that are able to exist at the low oxygen levels existing over the habitat (Dover sole, shortspine thornyhead, longspine thornyhead and sablefish also known as the DTS group). In the MBNMS these four species, and the three rockfish species, are primarily caught with trawls but sablefish, which is a high mobility species, and to a lesser extent blackgill rockfish are also caught with bottom longlines and traps. Presently 22% of the upper slope habitat is closed to trawling and this will go to 20% when the RCA re-opens. Fishing for bottomfishes is prohibited in 7% of this habitat and this will decline to 2% when the RCA is reopened. Stock assessments are presently made for Dover sole, sablefish, shortspine thornyhead, longspine thornyhead and blackgill rockfish.

The lower slope (800 to 3000 m or 437 to 1640 fathoms) habitat occupies more than 50% of the MBNMS area. The fisheries in the lower slope have been dominated by the same DTS group that dominates the landings from the upper slope. In addition, a number of species of grenadiers can be effectively fished with the same longline gear used to fish sablefish and significant landings were made in the MBNMS in 1996. Grenadiers are uncommon in the oxygen minimum zone; therefore they are less common on the shallower portion of the lower slope habitat. Presently trawling is not allowed in 81% of the study area's lower slope; therefore, it could be said that the only species that could be expected to achieve economically sustainable fisheries in this habitat are sablefish, grenadier and possibly blackgill rockfish. However, the DTS species dominate both the upper and lower slope habitats so from a biological perspective the separation of the slope into two habitats at the oxygen minimum (i.e. 800 m) is not particularly helpful. Note that there is also a large area (113 sq mi) of lower slope habitat in the Davidson Seamount and fishing for bottomfishes is prohibited in this area.

The upper and lower slope habitats, due to their low diversity fauna and fisheries, are a good example of the combined effects of PFMC regulatory actions. There were no trawl or other closures in effect in the study area slope habitats during the 1996 to 2005 period; however, there were extensive reductions in annual quotas, limited entry was introduced and there were several vessel buyouts reducing the number of trawlers operating in the study area. These factors reduced the 2006 landings of the slope species to 1/4 of the 1996 landings (Table 1). It should be noted that since 2006 trawling has been prohibited in 23% of the study area upper slope habitat.

No bottomfishing occurs in the study area rise habitat (3000+ m or 1640+ fathoms) and trawling is not permitted in 100% of this area. There is only 70.3 sq. miles of this habitat in the study area; however, the Davidson Seamount Closure contains 662 sq miles of this habitat and no bottomfishing is allowed on any of this area.

Unfortunately the various MPAs and other area based trawl closures were developed independently by the different management agencies and no attempt was made to integrate, co-ordinate or evaluate the combined effects of the many area closures. The lack of co-ordination has resulted in considerable overlap between the protected areas with some areas being protected by a federal EFH area, a State MPA and a State no-trawling area. Adaptive management with this type of layering of regulations will be extremely difficult.

This lack of co-ordination will also greatly hinder research to evaluate the effects of MPAs. For example, the great majority of groundfish taken in the shelf, shelf break and slope habitats have been taken by trawl gear and some species, especially flatfishes, are taken in only very minor quantities by other fishing gear. The alongshore areas adjacent to all of the State MPAs are closed to trawling, and due to the combination of the RCA and the State of California trawl closure at present all of the area in state waters between 30 and 150 fathoms are no bottomfish take areas. With the area outside of a State MPA as protected as the area inside of the MPA how can the effect of the MPA possibly be evaluated?

The lack of co-ordination and evaluation of the combined effects of different types of regulations is also apparent when the Pacific Council's quota/bimonthly catch limit management is compared with MPA based management. For example the sablefish population (a species with high mobility and a low exploitation rate, an average of only 3.0% per year from 1950-2006) has continued to decline due to the fact that it is an extremely unproductive stock (its surplus production averaged only 1.4% per year from 1950-2006). The 2007 sablefish bimonthly catch limit for limited fixed gear vessels is 5,000 pounds (Appendix A). The enactment of the State MPAs and federal EFH areas did not alter this allocation. Therefore, unless the total closed area is so large that a vessel cannot catch its allocation the same amount of sablefish will be landed by a Monterey Bay vessel after the MPAs were enacted as was landed before they were enacted. The MPAs primary affect on sablefish will be to cause a relative increase in sablefish density inside the MPAs and a relative decrease outside the MPAs; there will be very little net difference in the density of sablefish in the entire study area. Note that this is not the case for species that are not managed by catch limits (i.e. the spot prawn or Dungeness crab).

Presently there are no known species in the federal water portion of the study area that are being exploited at rates greater than the calculated maximum sustainable yield (MSY) for the species. Note that population assessments are only available for exploited species with a history of significant landings, a taxonomic based proxy F_{MSY} is used for many species, and that rates are generally not available for nearshore species. Within the study area there are a small number of species in each depth zone that are currently being exploited at rates above about half their MSY rate (Table 6).

Table 6. Species with exploitation rates in the federal portion of the MBNMS study area estimated to be in excess of about half the species MSY rate (note there are no current biomass estimates for anchovy, squid, Chinook salmon, Dungeness crab, California halibut or spot prawn).

Pelagic Species	Shelf Species	Shelf Break Species	Upper Slope Species	Lower Slope Species
Sardine	Petrale sole	Petrale sole	Petrale sole	
Anchovy	California halibut	Sablefish	Sablefish	Sablefish
Squid	Dungeness crab	Spot prawn	Dover sole	Dover sole
Chinook salmon			Thornyheads	Thornyheads
			Splitnose rockfish	
			Blackgill rockfish	
			Bank rockfish	

In summary the MBNMS study area appears to be heavily protected from overfishing and the many layers of regulations from the different management agencies prevent a large number of exploitable species from being fished at any appreciable level. This is particularly true of species in soft bottom areas of the nearshore and shelf habitats, the shelf break habitat, the deep slope habitat and the rise habitat. In federal waters a small number of species are presently being fished at moderate or higher exploitation levels and the species that were overfished in the past are now in rebuilding plans and their habitat has been heavily protected by the RCA. The most recent available landings (2006) show that the ports in or near the MBNMS have had large to extreme declines in the value of their landings over the previous 10 years. These declines were primarily due to increased management measures, particularly reduced catch limits and the RCA, and not due to declines in the populations of the dominant exploited species. Numerous stock assessments show that the populations are responding to these management measures with total groundfish biomass rising substantially since about 1999. Thus management measures made prior to the establishment of the many MPAs in the MBNMS study area is preserving and enhancing ecosystem function and biodiversity. The ports of Santa Cruz, Monterey and Morro Bay are presently in severe decline and the loss of fishing infrastructure is a real threat to the fishing industry in these ports. Further declines in the value of the fisheries in the MBNMS should be expected as the very extensive areas that are now protected by the federal EFHs, State MPAs and state waters trawl closures were open to fishing in 2006. It appears that the several agencies that have designated areas in the MBNMS as MPAs have acted in an un-coordinated manner resulting in the present situation with 74% of the shelf and 64% of the MBNMS study area in no trawling MPAs, little

deepwater habitat (other than the Davidson Seamount Area) in no bottomfishing MPAs, no analyses of the combined affects of MPAs and previous management actions and no coherent overall strategy for ecosystem management.

Appendix A. Pacific Fishery Management Council's groundfish trip limits for 2007-8.

Table 3 (South) to Part 660, Subpart G -- 2007-2008 Trip Limits for Limited Entry Trawl Gear South of 40°10' N. Lat.

Other Limits and Requirements Apply -- Read § 660.301 - § 660.399 before using this table 032007

		JAN-FEB	MAR-APR	MAY-JUN	JUL-AUG	SEP-OCT	NOV-DEC
	Rockfish Conservation Area (RCA)[6/]:						
	40°10' - 38° N. lat.	100 fm - modified 200 fm [7/]	100 fm - 150 fm				100 fm - modified 200 fm [7/]
	38° - 34°27' N. lat.	100 fm - 150 fm					
	South of 34°27' N. lat.	100 fm - 150 fm along the mainland coast; shoreline - 150 fm around islands					
	All trawl gear (large footrope, selective flatfish trawl, and small footrope trawl gear) is permitted seaward of the RCA. Large footrope trawl gear is prohibited shoreward of the RCA. Midwater trawl gear is permitted only for vessels participating in the primary whiting season.						
	See § 660.370 and § 660.381 for Additional Gear, Trip Limit, and Conservation Area Requirements and Restrictions. See §§ 660.390-660.394 and §§ 660.396-660.399 for Conservation Area Descriptions and Coordinates (including RCAs, YRCA, CCAs, Farallon Islands, Cordell Banks, and EFHCAs).						
	State trip limits and seasons may be more restrictive than federal trip limits, particularly in waters off Oregon and California.						
1	**Minor slope rockfish[2/] & Darkblotched rockfish**						
2	40°10' - 38° N. lat.	15,000 lb/ 2 months			10,000 lb/ 2 months		15,000 lb/ 2 months
3	South of 38° N. lat.	40,000 lb/ 2 months					
4	**Splitnose**						
5	40°10' - 38° N. lat.	15,000 lb/ 2 months			10,000 lb/ 2 months		15,000 lb/ 2 months
6	South of 38° N. lat.	40,000 lb/ 2 months					
7	**DTS complex**						
8	Sablefish	14,000 lb/ 2 months					
9	Longspine thornyhead	22,000 lb/ 2 months					
10	Shortspine thornyhead	7,500 lb/ 2 months					
11	Dover sole	70,000 lb/ 2 months			80,000 lb/ 2 months		
12	**Flatfish** (except Dover sole)						
13	Other flatfish[3/], English sole, & starry flounder						
14	40°10' - 38° N. lat.	110,000 lb/ 2 months	Other flatfish, English sole, starry flounder & Petrale sole: 110,000 lb/ 2 months, no more than 30,000 lb/ 2 months of which may be petrale sole.	Other flatfish, English sole, starry flounder, arrowtooth flounder & Petrale sole: 110,000 lb/ 2 months, no more than 25,000 lb/ 2 months of which may be petrale sole.			110,000 lb/ 2 months (including arrowtooth)
15	South of 38° N. lat.						
16	Petrale sole	50,000 lb/ 2 months					50,000 lb/ 2 months
17	Arrowtooth flounder						
18	40°10' - 38° N. lat.	10,000 lb/ 2 months		Arrowtooth included within other flatfish limits - - see above			
19	South of 38° N. lat.						
20	**Whiting**						
21	midwater trawl	Before the primary whiting season: CLOSED. -- During the primary season: mid-water trawl permitted in the RCA. See §660.373 for season and trip limit details. -- After the primary whiting season: CLOSED.					
22	large & small footrope gear	Before the primary whiting season: 20,000 lb/trip. -- During the primary season: 10,000 lb/trip. -- After the primary whiting season: 10,000 lb/trip.					

TABLE 3 (South)

*** Effective August 1, 2007 ***

Table 3 (South). Continued

23	**Minor shelf rockfish[1/], Chilipepper, Shortbelly, Widow, & Yelloweye rockfish**				
24	large footrope or midwater trawl for Minor shelf rockfish & Shortbelly	300 lb/ month			
25	large footrope or midwater trawl for Chilipepper	2,000 lb/ 2 months	12,000 lb/ 2 months	8,000 lb/ 2 months	
26	large footrope or midwater trawl for Widow & Yelloweye	CLOSED			
27	small footrope trawl for Minor Shelf, Shortbelly, Widow & Yelloweye	300 lb/ month			
28	small footrope trawl for Chilipepper	500 lb/ month		800 lb/ month	
29	**Bocaccio**				
30	large footrope or midwater trawl	300 lb/ 2 months			
31	small footrope trawl	CLOSED			
32	**Canary rockfish**				
33	large footrope or midwater trawl				
34	small footrope trawl	100 lb/ month			
35	**Cowcod**				
36	**Minor nearshore rockfish & Black rockfish**				
37	large footrope or midwater trawl				
38	small footrope trawl				
39	**Lingcod[4/]**				
40	large footrope or midwater trawl	1,200 lb/ 2 months	4,000 lb/ 2 months		
41	small footrope trawl		1,200 lb/ 2 months		
42	**Pacific cod**	30,000 lb/ 2 months	70,000 lb/ 2 months		30,000 lb/ 2 months
43	**Spiny dogfish**	200,000 lb/ 2 months	150,000 lb/ 2 months	100,000 lb/ 2 months	
44	**Other Fish[5/] & Cabezon**				

TABLE 3 (South) con't

1/ Yellowtail is included in the trip limits for minor shelf rockfish.
2/ POP is included in the trip limits for minor slope rockfish
3/ "Other flatfish" are defined at § 660.302 and include butter sole, curlfin sole, flathead sole, Pacific sanddab, rex sole, rock sole, and sand sole.
4/ The minimum size limit for lingcod is 24 inches (61 cm) total length.
5/ Other fish are defined at § 660.302 and include sharks, skates, ratfish, morids, grenadiers, and kelp greenling.
6/ The Rockfish Conservation Area is a gear and/or sector specific closed area generally described by depth contours but specifically defined by lat/long coordinates set out at §§ 660.391-660.394.
7/ The "modified 200 fm" line is modified to exclude certain petrale sole areas from the RCA.
To convert pounds to kilograms, divide by 2.20462, the number of pounds in one kilogram.

*** Effective August 1, 2007 ***

Table 4 (South) to Part 660, Subpart G -- 2007-2008 Trip Limits for Limited Entry Fixed Gear South of 40°10' N. Lat.

Other Limits and Requirements Apply -- Read § 660.301 - § 660.399 before using this table 062007

		JAN-FEB	MAR-APR	MAY-JUN	JUL-AUG	SEP-OCT	NOV-DEC
	Rockfish Conservation Area (RCA)[5/]:						
	40°10' - 34°27' N. lat.	30 fm - 150 fm					
	South of 34°27' N. lat.	60 fm - 150 fm (also applies around islands)					
	See § 660.370 and § 660.382 for Additional Gear, Trip Limit, and Conservation Area Requirements and Restrictions. See §§ 660.390-660.394 and §§ 660.396-660.399 for Conservation Area Descriptions and Coordinates (including RCAs, YRCA, CCAs, Farallon Islands, Cordell Banks, and EFHCAs).						
	State trip limits and seasons may be more restrictive than federal trip limits, particularly in waters off Oregon and California.						
1	**Minor slope rockfish[2/] & Darkblotched rockfish**	40,000 lb/ 2 months					
2	**Splitnose**	40,000 lb/ 2 months					
3	**Sablefish**						
4	40°10' - 36° N. lat.	300 lb/ day, or 1 landing per week of up to 1,000 lb, not to exceed 5,000 lb/ 2 months					
5	South of 36° N. lat.	350 lb/ day, or 1 landing per week of up to 1,050 lb					
6	**Longspine thornyhead**	10,000 lb / 2 months					
7	**Shortspine thornyhead**						
	40°10' - 34°27' N. lat.	2,000 lb/ 2 months					
	South of 34°27' N. lat.	2,000 lb/ 2 months			3,000 lb/ 2 months	2,000 lb/ 2 months	
8	**Dover sole**	5,000 lb/ month South of 42° N. lat., when fishing for "other flatfish," vessels using hook-and-line gear with no more than 12 hooks per line, using hooks no larger than "Number 2" hooks, which measure 11 mm (0.44 inches) point to shank, and up to two 1 lb (0.45 kg) weights per line are not subject to the RCAs.					
9	**Arrowtooth flounder**						
10	**Petrale sole**						
11	**English sole**						
12	**Starry flounder**						
13	**Other flatfish[1/]**						
14	**Whiting**	10,000 lb/ trip					
15	**Minor shelf rockfish[2/], Shortbelly, Widow rockfish, and after August 31, Bocaccio**						
16	40°10' - 34°27' N. lat.	300 lb/ 2 months	CLOSED	200 lb/ 2 months		500 lb/ 2 months (including Bocaccio)	
	South of 34°27' N. lat.	3,000 lb/ 2 months		3,000 lb/ 2 months			
18	**Chilipepper rockfish**	2,000 lb/ 2 months, this opportunity only available seaward of the nontrawl RCA					
19	**Canary rockfish**	CLOSED					
20	**Yelloweye rockfish**	CLOSED					
21	**Cowcod**	CLOSED					
22	**Bocaccio**						
23	40°10' - 34°27' N. lat.	200 lb/ 2 months	CLOSED	100 lb/ 2 months	300 lb/ 2 months	Bocaccio included under Minor shelf rockfish, shortbelly, & widow limits -- See above	
24	South of 34°27' N. lat.	300 lb/ 2 months		300 lb/ 2 months			

TABLE 4 (South)

*** Effective August 1, 2007 ***

Table 4 (South). Continued

25	**Minor nearshore rockfish & Black rockfish**							
26	Shallow nearshore	600 lb/ 2 months	CLOSED	800 lb/ 2 months	900 lb/ 2 months	800 lb/ 2 months	600 lb/ 2 months	
27	Deeper nearshore							
28	40°10' - 34°27' N. lat.	700 lb/ 2 months	CLOSED	700 lb/ 2 months		600 lb/ 2 months	700 lb/ 2 months	
29	South of 34°27' N. lat.	500 lb/ 2 months		600 lb/ 2 months				
30	California scorpionfish	600 lb/ 2 months	CLOSED	600 lb/ 2 months	800 lb/ 2 months		600 lb/ 2 months	
31	**Lingcod**[3/]	CLOSED		800 lb/ 2 months			400 lb/ month	CLOSED
32	**Pacific cod**	1,000 lb/ 2 months						
33	**Spiny dogfish**	200,000 lb/ 2 months		150,000 lb/ 2 months	100,000 lb/ 2 months			
34	**Other fish**[4/] **& Cabezon**	Not limited						

TABLE 4 (South)

1/ "Other flatfish" are defined at § 660.302 and include butter sole, curlfin sole, flathead sole, Pacific sanddab, rex sole, rock sole, and sand sole.
2/ POP is included in the trip limits for minor slope rockfish. Yellowtail is included in the trip limits for minor shelf rockfish.
3/ The minimum size limit for lingcod is 24 inches (61 cm) total length.
4/ "Other fish" are defined at § 660.302 and include sharks, skates, ratfish, morids, grenadiers, and kelp greenling.
5/ The Rockfish Conservation Area is a gear and/or sector specific closed area generally described by depth contours but specifically defined by lat/long coordinates set out at §§ 660.391-660.394, except that the 20-fm depth contour off California is defined by the depth contour and not coordinates.

To convert pounds to kilograms, divide by 2.20462, the number of pounds in one kilogram.

*** Effective August 1, 2007 ***

Table 5 (South) to Part 660, Subpart G -- 2007-2008 Trip Limits for Open Access Gears South of 40°10' N. Lat.

Other Limits and Requirements Apply -- Read § 660.301 - § 660.399 before using this table 062007

		JAN-FEB	MAR-APR	MAY-JUN	JUL-AUG	SEP-OCT	NOV-DEC
	Rockfish Conservation Area (RCA)[6/]: 40°10' - 34°27' N. lat.	30 fm - 150 fm					
	South of 34°27' N. lat.	60 fm - 150 fm (also applies around islands)					
	See § 660.370 and § 660.383 for Additional Gear, Trip Limit, and Conservation Area Requirements and Restrictions. See §§ 660.390-660.394 and §§ 660.396-660.399 for Conservation Area Descriptions and Coordinates (including RCAs, YRCA, CCAs, Farallon Islands, Cordell Banks, and EFHCAs).						
	State trip limits and seasons may be more restrictive than federal trip limits, particularly in waters off Oregon and California.						
1	**Minor slope rockfish[1/] & Darkblotched rockfish**						
2	40°10' - 38° N. lat.	Per trip, no more than 25% of weight of the sablefish landed					
3	South of 38° N. lat.	10,000 lb/ 2 months					
4	**Splitnose**	200 lb/ month					
5	**Sablefish**						
6	40°10' - 36° N. lat.	300 lb/ day, or 1 landing per week of up to 700 lb, not to exceed 2,100 lb/ 2 months					
7	South of 36° N. lat.	300 lb/ day, or 1 landing per week of up to 700 lb				350 lb/ day, or 1 landing per week of up to 1,050 lb	
8	**Thornyheads**						
9	40°10' - 34°27' N. lat.	CLOSED					
10	South of 34°27' N. lat.	50 lb/ day, no more than 1,000 lb/ 2 months					
11	**Dover sole**	3,000 lb/month, no more than 300 lb of which may be species other than Pacific sanddabs. South of 42° N. lat., when fishing for "other flatfish," vessels using hook-and-line gear with no more than 12 hooks per line, using hooks no larger than "Number 2" hooks, which measure 11 mm (0.44 inches) point to shank, and up to two 1 lb (0.45 kg) weights per line are not subject to the RCAs.					
12	**Arrowtooth flounder**						
13	**Petrale sole**						
14	**English sole**						
15	**Starry flounder**						
16	**Other flatfish[3/]**						
17	**Whiting**	300 lb/ month					
18	**Minor shelf rockfish[1/], Shortbelly, Widow & Chilipepper rockfish**						
19	40°10' - 34°27' N. lat.	300 lb/ 2 months	CLOSED	200 lb/ 2 months		300 lb/ 2 months	
20	South of 34°27' N. lat.	750 lb/ 2 months		750 lb/ 2 months			
21	**Canary rockfish**	CLOSED					
22	**Yelloweye rockfish**	CLOSED					
23	**Cowcod**	CLOSED					
24	**Bocaccio**						
		200 lb/ 2					

TABLE 5 (South)