
Pacific Coast Groundfish Fisheries



NMFS, FRAM Division

Unit 15

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INTRODUCTION

The Pacific Coast groundfish fishery is conducted along the entire coastline of Washington, Oregon, and California, and includes a diverse range of habitats, species, and participants. The Pacific Fishery Management Council's (PFMC) Groundfish Fishery Management Plan (FMP) contains more than 90 species organized into several sub-fisheries, including 1) the Dover sole, thornyheads, and sablefish (DTS) complex; 2) nearshore rockfishes, lingcod, and cabezon; 3) shelf and slope rockfishes; 4) flatfishes; and 5) Pacific hake (whiting). Many of the stocks included in the FMP have geographic ranges that extend beyond the U.S. Exclusive Economic Zone (EEZ) into Canadian or Mexican waters. The fishery has four general sectors: commercial limited-entry, com-

mercial open-access, recreational, and tribal. These sectors use a variety of gears including trawl gear, an array of hook-and-line gears, and pots/traps. Participation in one gear group does not necessarily preclude participation in another. Most vessels targeting groundfish deliver to shoreside processors. However, within the Pacific hake trawl fishery, there are vessels that deliver their catch to motherships as well as to shoreside processors, and there are other vessels that process their own catch at sea.

A number of dramatic changes have occurred in the Pacific Coast groundfish fishery since the last publication of *Our Living Oceans* (NMFS, 1999). Between 1999 and 2002, nine stocks were declared overfished, with spawning estimated to be below 25% of unfished levels. Rebuilding plans were implemented, reducing allowable fishing mortality for overfished and associated species throughout

Photo above:
Yelloweye rockfish.

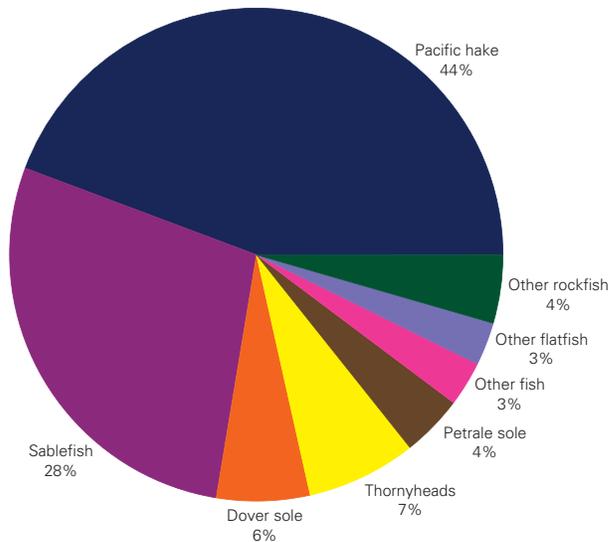


Figure 15-1
Relative components of Pacific Coast groundfish total ex-vessel value in 2006.

all sectors of the groundfish fishery and resulting in historically low allowable harvests. In addition to lower allowable harvest levels for overfished species and co-occurring species, major portions of the Continental Shelf off the U.S. West Coast have been closed to fishing since September 2003. Two of the overfished stocks, Pacific hake and lingcod, have since been rebuilt to target levels. Rebuilding for the overfished rockfish stocks is expected to require longer periods of time due to their relatively low productivity, which limits their ability to recover quickly to B_{MSY} . In addition to rebuilding plans for overfished stocks, many strides have been made toward improving management of the groundfish fishery and research necessary to support management. These include completion of a fixed-gear permit-stacking program and a trawl permit buy-back to reduce fishing capacity, implementation of a coast-wide observer program to monitor bycatch, expansion of groundfish resource surveys, and identification of essential fish habitat and habitats of particular concern.

The recent average yield (2004–06) of Pacific Coast groundfishes in the U.S. was 288,604 metric tons (t; Table 15-1). In 2006, U.S. commercial landings of Pacific coast groundfish totaled 288,990 t, generating \$81 million in ex-vessel revenue. Pacific hake accounted for 91% of the 2006 landed catch and 44% of the associated ex-vessel value. Other important species in 2006 were sablefish (\$23 million), Petrale sole (\$6 million), Dover

sole (\$5 million), and thornyhead rockfish (\$3 million; PSMFC, 2008; Figure 15-1). The trawl fleet (including Pacific hake) is the largest sector of the commercial fishery, generating 75% of the ex-vessel revenue (PSMFC, 2008).

SPECIES AND STATUS

Stock status has been estimated for nearly 30% of the groundfish stocks throughout at least a portion of their Pacific coast range. Of the assessed stocks, more than 70% are near or above target levels. However, many of the assessed stocks, whether currently below target levels or not, experienced declines in biomass throughout much of the 1980's and 1990's. These declines coincided with a period of reduced productivity of the California Current that lasted from 1977 into the late 1990's. It is likely that this decline in ocean productivity contributed to the decline in overall abundance, but the effect appears to have been variable across species and is not well understood at this time. In the most recent period of improved ocean productivity, increases in recruitment and abundance have been observed for many species.

In addition to the role of ocean productivity, harvest levels have contributed to the current status of these species. In the 1980's and 1990's, harvest rates for many Pacific Coast groundfish species were based upon knowledge of the productivity of other, similar species. This was a reasonable approach in the absence of species-specific information and given the paucity of fishery-independent trend information, but many Pacific Coast rockfish species now appear to be less productive than originally thought. As a result, managers set harvest rates for many species at levels that, in hindsight, were too high. Harvest metrics were re-evaluated during the 1990's and again in 2000, resulting in lower harvest rates for most species.

Dover Sole, Thornyheads, and Sablefish Complex

The DTS complex, consisting of Dover sole, longspine and shortspine thornyheads, and sablefish, represents some of the most valuable species in the Pacific Coast groundfish fishery. Dover sole have been targeted along the West Coast since

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PACIFIC COAST GROUND FISH FISHERIES

Species/stock	Recent average yield (RAY) ¹	Current yield (CY) ²	Sustainable yield (MSY) ³	Stock level relative to B_{MSY} ⁴	Harvest rate ⁵	Stock status ⁴
Flatfish						
Arrowtooth flounder	4,160	5,800	5,148	Above	Not overfishing	Not overfished
Dover sole	7,483	8,589	16,505	Above	Not overfishing	Not overfished
English sole	1,262	3,100	3,452	Above	Not overfishing	Not overfished
Petrale sole	2,536	2,762	3,164	Near	Not overfishing	Not overfished
Other flatfishes ⁶	1,939	6,781	Unknown	Unknown		
Subtotal, flatfish	17,380	27,032	35,050			
Rockfish						
Black rockfish (coastwide) ⁶	980	1,276	1,443	Above		
Blackgill rockfish ⁷	130	343	223	Above	Not overfishing	Not overfished
Bocaccio ⁷	81	549	1,974	Below	Not overfishing	Overfished
Canary rockfish	55	270	1,574	Near	Not overfishing	Rebuilding
Chilipepper ⁷	125	2,700	2,155	Above	Not overfishing	Not overfished
Cowcod ⁷	2	24	61	Below	Not overfishing	Overfished
Darkblotched rockfish	186	294	621	Below	Not overfishing	Overfished
Longspine thornyhead	800	2,461	3,687	Above	Not overfishing	Not overfished
Pacific ocean perch ⁸	104	934	1,411	Below	Not overfishing	Rebuilding
Shortbelly rockfish ⁹	11	13,900	Unknown	Above	Not overfishing	Not overfished
Shortspine thornyhead	805	1,077	1,720	Above	Not overfishing	Not overfished
Splitnose rockfish ⁷	262	615	Unknown	Unknown	Not overfishing	Unknown
Widow rockfish	196	3,059	2,000	Near	Not overfishing	Rebuilding
Yelloweye rockfish	15	55	44	Below	Not overfishing	Overfished
Yellowtail rockfish ⁸	840	3,681	4,680	Above	Not overfishing	Not overfished
Other rockfishes ⁶	1,538	6,749	Unknown	Unknown		
Subtotal, rockfish	6,130	37,987	42,857			
Other groundfish						
Cabazon (California)	92	108	137	Near	Not overfishing	Not overfished
Lingcod	821	2,716	3,378	Above	Not overfishing	Not overfished
Pacific cod	898	3,200	Unknown	Unknown	Unknown	Unknown
Pacific hake (whiting) ¹⁰	351,643	364,842	576,688	Near	Not overfishing	Not overfished
Sablefish (blackcod)	6,416	8,175	6,328	Near	Not overfishing	Not overfished
Other groundfishes ^{6,11}	5,023	14,600	Unknown	Unknown		
Subtotal, other groundfish	364,893	393,641	604,331			
Total	388,403	458,660	682,238			
U.S. Subtotal	288,615	390,363	531,607			

Table 15-1

Productivity in metric tons (t) and status of Pacific Coast groundfish fisheries resources.

¹2004–06 average of total mortality including commercial and recreational catch as well as estimated discards.

²2006 allowable biological catch (ABC).

³MSY as calculated in assessment model using management proxies (SSB or SPR) or as estimated by model.

⁴Stock level relative to target and stock status are taken from estimates in most recent stock assessment models.

⁵Overfishing status is based on 2006 total mortality estimates as reported in Hastie and Bellman (2007) compared to 2006 ABC targets.

⁶Harvest rate and stock status are not available for this stock.

⁷The RAY and CY apply to the stock south of 40°10'N latitude. Northern catch and CY are included in the "Other rockfishes" category.

⁸The RAY and CY apply to the stock north of 40°10'N latitude. Southern catch and CY are included in the "Other rockfishes" category.

⁹RAY is based on 2006 catch rather than average of 2004–2006.

¹⁰Values shown are for coastwide stock (U.S. and Canadian portions). The U.S. RAY is 251,844 t, and the U.S. MSY is 426,057 t.

¹¹Category includes sharks, skates, rays, ratfish, morids, grenadier, kelp greenling, and other groundfishes. See Appendix 5 for a complete listing.

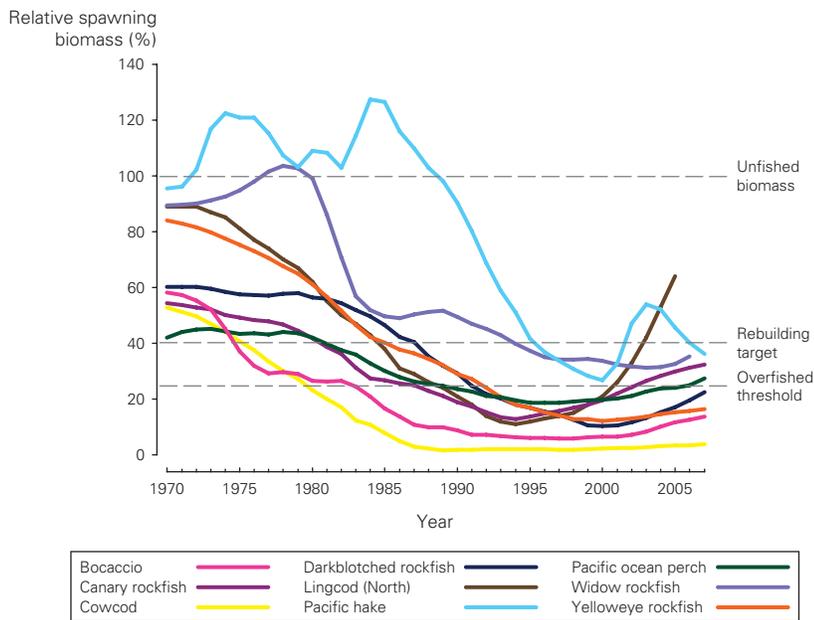


Figure 15-2

Relative spawning biomass or output of Pacific Coast groundfishes declared overfished since 1999 for the period 1970–2007 (if available). The overfished threshold for Pacific Coast groundfish is 25% of the estimated unfished spawning biomass. Lingcod and Pacific hake have been rebuilt to the target level of 40% of the estimated unfished spawning biomass. While previous assessments estimated widow rockfish spawning stock output to be below the overfished threshold, the most recent assessment estimated the stock has not fallen below the overfished threshold. There is considerable uncertainty surrounding these point estimates and the stock is still considered in rebuilding.

World War II, almost exclusively with trawl gear. Annual landings from U.S. waters averaged 18,872 t during the 1980’s, 12,368 t during the 1990’s, and 7,483 t from 2004–06 (Sampson, 2006; PSMFC, 2008). Following a period of decline in the mid 1990’s, Dover sole biomass is steadily increasing; the current estimated spawning stock biomass is 63% of the unexploited level (Sampson, 2006).

Landings of thornyheads peaked in 1990 at 10,082 t and then steadily declined, with recent landings dipping below 2,500 t. An increasing percentage of shortspine thornyhead has been caught with hook-and-line gear (from 7% in 2000 to more than 20% since 2003). Much of this increase is delivered to lucrative live-fish markets. Thornyheads are long-lived and slow growing, with estimated maximum ages of 45 years for longspine



Dover sole.

thornyhead and 100 years or more for shortspine thornyhead (Love et al., 2002). However, recent stock assessments of shortspine and longspine thornyheads estimate spawning biomass to be above their targets, at 63% and 71% of unfished levels, respectively (Hamel, 2006; Fay, 2006).

Sablefish (also known as blackcod) are highly valuable, making up only 2% (6,470 t) of groundfish catch but generating 28% of total groundfish revenues for 2006 (Hastie and Bellman 2007; PSMFC, 2008). Sablefish are harvested by using trawl nets and fixed gear such as hook-and-line and pot gear. Sablefish biomass steadily declined during the 1990’s, but has been increasing in recent years. Current spawning stock biomass is estimated to be 38% of the unfished level (Schirripa, 2008).

Rockfishes

Rockfishes make up the majority of managed species under the Pacific Coast Groundfish FMP, accounting for about \$3.6 million in revenue in 2006 (PSMFC, 2008). They vary greatly in their morphological and behavioral traits, with some species found in mid-water schools and having semi-pelagic behavior, and others leading solitary, sedentary, bottom-dwelling lives (Love et al., 2002). Rockfishes inhabit a wide range of depths, from nearshore kelp forests and rock outcrops to varied deepwater (greater than 150 fathoms) habitats on the Continental Slope. Despite the range of behaviors and habitats, most rockfishes share general life history characteristics, which include slow growth rates, bearing of live young, and large but infrequent recruitment events. These life history characteristics contribute to relatively low average productivity that may reduce their ability to withstand heavy exploitation (Parker et al., 2000), especially during periods of unfavorable environmental conditions. The combination of high historic exploitation, generally low productivity, and changes in oceanic conditions have resulted in the decline of seven rockfish stocks below the overfished threshold (25% of unfished spawning potential, often measured as spawning biomass; Figure 15-2). According to the most recent assessments, three of the species were below the overfished threshold by the mid 1980’s, well before the implementation of fishery management plans.

The overfished species are currently estimated to be between 3.8 and 35% of unfished levels; however, all appear to be increasing in abundance under their respective rebuilding plans.

Not all rockfishes have declined in abundance over the past two decades. A number of species such as chilipepper, yellowtail rockfish, gopher rockfish, and blackgill rockfish are above their target levels, with estimated spawning biomass ranging from 52 to 97% of unfished levels (Figure 15-3). These rockfish inhabit a wide range of habitats which span nearshore, shelf, and slope depths. Although relatively abundant, landings for some of these species are near historical lows as a result of catch restrictions associated with rebuilding species that co-occur with these abundant stocks.

The majority of rockfish landings in shelf and slope depths are made with trawl gear, but there are important commercial and recreational hook-and-line fisheries, especially within nearshore and rocky reef habitats. There is growing concern about local and regional depletions of some rockfishes and other nearshore groundfish species. One source of concern is the concentration of recreational removals from fishing grounds near various ports, while another is the level and concentration of effort in the high-valued live-fish fishery¹ that originated in California, but has gradually moved up the coast into Oregon.

Lingcod and Cabezon

Lingcod and cabezon are important targeted species in both commercial and recreational fisheries. Lingcod is found throughout rocky shelf and nearshore habitats along the entire Pacific Coast. The longer-lived females of the species can reach 20 years in age. The Pacific Coast lingcod stock was designated as overfished in 1999, with a spawning biomass that was less than 20% of its unfished level. However, the stock quickly rebuilt to the coast-wide

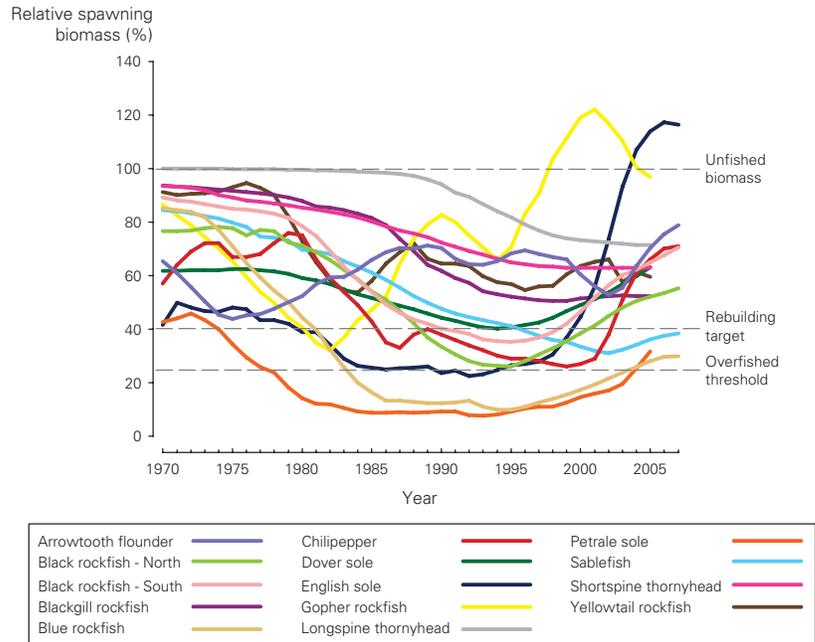


Figure 15-3

Relative spawning biomass or output of selected groundfish stocks for the period 1970–2007. The target MSY-proxy is 40% of the estimated unfished spawning biomass, while the overfished threshold is 25% of the estimated unfished spawning biomass. Many groundfish stocks are near or above target levels.

target level by 2003, following the recruitment of very large year-classes in 1999 and 2000, and was officially declared rebuilt in 2005, which is 4 years earlier than the target rebuilding year established in the rebuilding plan (PFMC, 2008). Annual combined commercial and recreational landings declined from roughly 4,800 t in the mid 1980’s to less than 500 t in 2000–01, but have increased to an average of 821 t between 2004 and 2006 (PSMFC, 2008; Table 15-1).

Cabezon are primarily a nearshore species found intertidally and among jetty rocks (Miller and Lea, 1972). Cabezon are one of the largest species in the Family Cottidae, attaining a length of nearly 1 m and a weight in excess of 11 kg (Feder et al., 1974). Similar to lingcod, males are reported to show nest-guarding behaviors (Garrison and Miller, 1982). The commercial catch of cabezon has increased over the past 10 years and has become a major source of removals because of the developing live-fish fishery off California and Oregon. The stock has only been assessed in California waters because the available data sources remain insufficient to form the basis for a reliable assessment of cabezon in Washington and Oregon. The California stock is estimated to be 38% of unfished levels (Cope and Punt, 2006).

¹This fishery targets smaller-sized fishes from nearshore areas; fish are kept alive and transferred to markets on the same day as capture. Growth of the nearshore live-fish fishery for thornyheads and rockfishes has been propelled by ex-vessel prices that are commonly ten times higher than those for dead fish of the same species. The previously large number of small, open-access boats participating in this fishery has been reduced through the initiation of state permit programs.



Hanuman Singh, WHOI

Groundfishes, including a longnose skate, a Dover sole, an unidentified thornyhead, and a hagfish, observed using the Seabed AUV on Santa Lucia Bank, California.

Flatfishes

Shelf flatfishes such as Petrale sole, English sole and starry flounder are found in low-relief mud, sand, or gravel habitats, and are harvested primarily with commercial trawl gear. Arrowtooth flounder are an abundant flatfish commonly found in depths from 50 to 800 m. Some flatfish species can attain ages of 15–27 years, while other flatfishes are unlikely to live beyond 10 years. Petrale and English sole experienced protracted periods of generally poor recruitments from the mid 1970's through the mid 1990's that left the stocks near historically low levels. Higher recruitments since the mid 1990's have produced substantial increases in both populations.

Current spawning stock biomass is estimated to be above target levels for English sole, arrowtooth flounder, and starry flounder (116%, 79%, and 50%, respectively) while Petrale sole is near target levels at 32% of unfished spawning biomass (Figure 15-3; Stewart, 2008; Kaplan and Helser, 2008; Ralston, 2006; Lai et al., 2006). The increasing trends in spawning stock biomass estimated in assessments for these species are mirrored by increasing trawl survey catch per unit of effort (CPUE) for several unassessed flatfish species. Combined landings of shelf flatfish in recent years are roughly half of what they were around 1990. These declines have

resulted from changes in markets, as well as from restrictions imposed on flatfish catch to reduce rockfish bycatch in the flatfish fishery.

Pacific Hake

The coastal stock of Pacific hake (whiting) is the most abundant groundfish population in the California Current system (Helser and Martell, 2008). The stock is characterized by highly variable recruitment patterns and a relatively short lifespan when compared to other groundfish stocks. Pacific hake was declared overfished in 2002 following many years of poor recruitments. However, similar to lingcod, a strong year-class in 1999 led to substantial spawning biomass increases as this year-class reached maturity. The 2007 stock assessment shows the stock had declined to historically low levels in 2000 (although not below the overfished threshold as previously thought), and had increased to target levels by 2002. The volatility of this stock is reflected in the doubling of the spawning biomass between 2000 and 2003 due to the recruitment of a single strong year-class. The stock is now considered rebuilt, and the 2007 spawning biomass was estimated to be 36.2% of unfished levels (Figure 15-2; Helser and Martell, 2008). Coastwide (United States and Canada) landings of Pacific hake peaked at 360,000 t in 2005 and 2006 but are expected to decline as the 1999 year-class makes its way through the population. A recent treaty between the United States and Canada (2003) establishes an annual assessment and management process, a research commitment, and a harvest-sharing agreement providing 73.9% of the coastwide allowable catch for U.S. fisheries and 26.1% for Canadian fisheries. The treaty is expected to be ratified by the end of 2008, with implementation of the agreement starting for the 2009 fishing season.

Other Groundfish

The Pacific Coast Groundfish FMP also includes species such as sharks, skates, rays, ratfish, codlings, grenadiers, kelp greenling, and other species that are neither common nor targeted by commercial and recreational fisheries. Two of these stocks, kelp greenling (Oregon substock)

and longnose skate (coastwide) were assessed for the first time in 2005 and 2007, respectively. Both kelp greenling and longnose skate are estimated to be above target levels, at 49% and 66% of unfished levels, respectively (Cope and MacCall, 2006; Gertseva and Schirripa, 2008).

ISSUES AND PROGRESS

Recent years have brought sweeping changes to the Pacific Coast groundfish fishery and the research and science supporting the management of this fishery. Many important issues cited in prior editions of *Our Living Oceans* have been addressed. For example, a comprehensive observer program to monitor total catch in at-sea hake fisheries and discards in the remaining groundfish fisheries has been implemented coastwide. In addition, an allocation scheme between the United States and Canada for Pacific hake has been formalized, although it is still awaiting ratification. Furthermore, additional progress has been made in several other areas to continue to improve management of groundfish.

Resource Surveys and Stock Assessments

Scientific surveys to collect vital information on the distribution, relative abundance, and age structure of Pacific Coast groundfish populations are conducted along the West Coast using bottom trawls, fixed-gear, and acoustic technology. Many of these surveys have been expanded in spatial and depth coverage as well as an increase in frequency of occurrence. For example, in 1998 an annual cooperative research² bottom trawl survey of slope groundfish resources was implemented along the West Coast using locally chartered commercial fishing vessels. In 2003, the survey's coverage was expanded to include the area south of Point Conception, California, and shallow depths on the Continental Shelf (Keller et. al., 2007). Likewise, a mid-water trawl survey to estimate relative abundance of pelagic juvenile rockfish and Pacific hake was expanded from a core area off central California

²Research in which industry and other stakeholders partner with NMFS, state agencies, and university scientists in the collection of fundamental fisheries information to support the development and evaluation of management options.



Flag rockfish as seen from an ROV.

to a coastwide survey in 1999. Additionally, the integrated acoustic and trawl survey used to assess the distribution and abundance of coastal Pacific hake is now conducted on a biennial instead of triennial basis, in collaboration with Canada's Department of Fisheries and Oceans. These expanded surveys have provided additional information to improve the precision of groundfish assessments.

Habitat surveys are being conducted using sidescan and multibeam sonar, human-occupied submersibles, and remotely operated vehicles (ROV's). With these surveys, scientists are exploring, mapping, and documenting the interactions between groundfishes, other demersal fishes, invertebrates, and benthic habitats. Of particular importance in the future will be the determination of the distribution and abundance of biogenic species³ including deep water corals and their role and importance to the groundfish ecosystem (Whitmire and Clarke, 2007).

Great strides have also been made in standardizing and improving the integrated age/length modeling framework used for many of these assessments, as well as reporting the scientific uncertainty associated with the assessment results. There are, however, remaining challenges, particularly to develop survey and assessment methods for data-poor and data-limited species, especially those occurring in rocky, untrawlable habitats. Non-extractive

³Plants and animals that create physical structures that may be used as habitat by other species.



Longspine thornyhead.

surveys utilizing ROV's, autonomous underwater vehicles (AUV's), and acoustic methods are being tested as appropriate tools for surveying in rocky habitats and are needed to develop fishery-independent indices of abundance in order to assess many of the data-poor species.

Bycatch

In addition to understanding the status and trends of groundfish populations, it is crucial to document and quantify total fisheries removals, including landed catch and discards. Groundfish landings have long been documented by state fishery agencies. However, until 2001, at-sea discard had not been systematically monitored outside of the at-sea processing hake fleet and isolated research projects. This lack of discard information contributed to greater uncertainty in stock assessments and in evaluating management performance relative to harvest benchmarks. An observer program was initiated in 2001 to collect information on the magnitude and composition of discard within the groundfish industry. These data are used to document total mortality to assess whether overfishing has occurred, and are also used to study patterns of co-occurrence among target and bycatch species, identify gear-specific bycatch and discard activity, and note changes in fishing behavior as vessels approach limits for target species. Many of the observers are assigned to permit-holders within

the trawl fleet, with the remainder accompanying permitted fixed-gear vessels or open-access boats.

Harvest Policy

Harvest rates for most assessed groundfish stocks have been reduced in recent years, and allowed harvests of unassessed and data-poor species have been set with greater precaution. Assessed species are generally managed with a constant proportional rate of harvest such that the expected level of spawning potential (egg production or female spawning biomass) per recruit will be reduced to some fraction of the estimated unfished level. In circumstances where the maximum sustainable yield (MSY) harvest rate is not reliably estimated, the PFMC's harvest policy uses spawning potential values of 50% for rockfishes and thornyheads, 40% for flatfishes and Pacific hake, and 45% for other species including sablefish and lingcod (Ralston et al., 2000). These rates are now believed to be more sustainable than the 35–40% rates used for most assessed stocks during the 1990's because research has since shown rockfishes and thornyheads have less resilient spawner–recruit relationships than previously believed. Allowable harvests for unassessed species and complexes that were set based on historical levels are now reduced by 50%.

In addition to a reduction in harvest rates, Pacific Coast groundfish are managed under the 40–10 Rule, where species with abundance levels between $SB_{25\%}$ and $SB_{40\%}$ are designated as being within a precautionary zone. Under this policy, yield is reduced linearly from the amount available when the stock is at 40% of the unfished level ($SB_{40\%}$) to zero catch when the stock is at 10% of the unfished level. In practice, stocks are designated as overfished when spawning biomass falls below 25% of the unfished level ($SB_{25\%}$), and a rebuilding plan, including a species-specific rebuilding harvest rate, must be developed.

Gear Changes

Prior to 2000, trawl vessels were able to use gear with very large footropes—including some configurations with large truck tires—in order to fish in rocky shelf and slope habitat areas. Beginning in 2000, measures were adopted to restrict the

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Pink rockfish.

use of gear in shelf depths to footropes no larger than 8 inches in diameter. This greatly limited the ability of the trawl fleet to fish in habitats that are believed to be the most critical for rockfish recovery. Since then, additional research and experimental fisheries have been conducted on modified trawl net designs that provide greater opportunity for rockfish to escape, while preserving CPUE for targeted flatfish species. In particular, research conducted off the northern part of the U.S. West Coast developed a more flatfish-selective trawl gear design to reduce bycatch of co-occurring rockfish (King et al., 2004; Hannah et al., 2005). This gear is now required in nearshore waters north of Cape Mendocino, California.

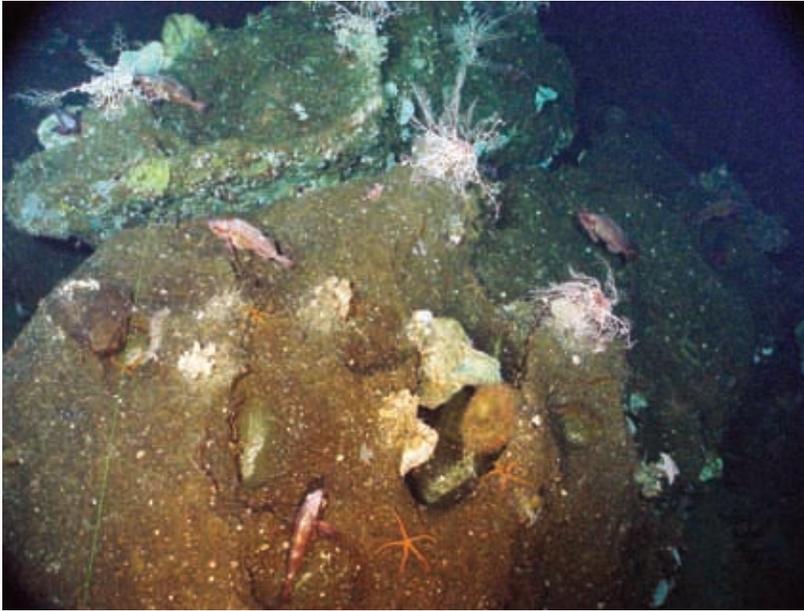
Groundfish Fishing Capacity Reduction Programs

In 2001, the National Marine Fisheries Service (NMFS) implemented a permit stacking program for the limited-entry, fixed-gear sablefish fishery. This program allows eligible permit owners to stack up to three permits on a single vessel in order to ac-

cess the sablefish limits associated with each of those permits. This simplified individual quota program has reduced the number of vessels participating in the primary sablefish fishery by about 50%.

A trawl permit buy-back program was implemented in 2003 to reduce the capacity of the groundfish fishery. The program removed 91 groundfish trawl permits (about 35% of then-existing trawl permits) and many state crab and shrimp permits owned by the same operators. Coast Guard fishing endorsements were removed from each vessel actively using these permits, meaning that they can never again be used for commercial fishing in U.S. waters. Remaining permit holders are responsible for repaying roughly \$30 million in Federal loans that enabled the buy-back.

The PFMC is now midway through the development of a trawl rationalization program that will implement, depending on the fishery, either individual transferable quotas or co-operatives. The Council is also seeking to convert the open-access portion of the groundfish fishery into a limited-entry fishery.



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A diversity of rockfish and megafauna invertebrates associated with a rock outcrop located off Cherry Bank in Southern California's borderlands region.

Closed Areas and Essential Fish Habitat

West Coast groundfish fisheries are managed with a variety of closed areas intended to either minimize the bycatch of overfished groundfish species or to protect sensitive habitats. Many of the closed areas are gear-specific, meaning that they are closed to some particular gear types, but not others.

The rockfish conservation areas (RCA's) are large-scale closed areas that extend along the entire length of the U.S. West Coast and are intended to protect a complex of species, such as the overfished shelf and slope rockfish stocks. The RCA's differ between gear types (e.g. trawl, non-trawl, and recreational RCA's), and have boundaries that may be seasonally adjusted to facilitate harvest of abundant stocks in seasons and areas with the least impact on overfished stocks. Although both the eastern and western RCA boundaries have changed over time for all of the gear groups, a 5,500 mi² area between the trawl RCA boundary lines approximating the 100- and 150-fathom (fm) depth contours has remained closed since January 2003. The Cowcod Conservation Areas are two areas in southern California that have been closed to most commercial and recreational fishing since January 2001.

Essential fish habitat (EFH) along the West

Coast is described as all water and substrates in areas with a water depth less than or equal to 3,500 m, as well as seamounts in depths greater than 3,500 m (NMFS, 2005). In 2006, 51 areas encompassing over 130,000 mi² were closed to protect sensitive habitats associated with EFH or habitat areas of particular concern (HAPC's) (Whitmire and Clarke, 2007). The closed areas are fully protected from bottom trawl impacts; in addition, some sensitive areas are closed to all fishing gears that contact the bottom. The largest of these closures prohibits the use of bottom trawls deeper than 1,280 m (700 fm) and out to the extent of EFH (i.e. 3,500 m), essentially freezing the footprint of recent bottom trawl activity.

In addition to closures implemented by the PPMC and NMFS, the States of California, Oregon, and Washington are developing and implementing protected areas within their waters. California has implemented a network of marine protected areas as part of the Marine Life Protection Act (MLPA) and anticipates expanding the network. Oregon is engaged in an ongoing process to designate a system of marine reserves in Oregon's territorial sea, and Washington is initiating a process to update its inventory of state marine protected areas as well as identify criteria for the potential creation of additional marine protected areas in the future.

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