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National Coastal Condition Report III
Chapter 6: West Coast Coastal Condition
Part 3 of 3

December 2008

Trends in Coastal Sediment Condition in the Southern California Bight: A Clean Water Act Success Story

The SCB is the most densely populated coastal region in the nation, and its municipalities rely upon coastal waters for the disposal of treated wastewater. Nineteen publicly owned treatment works (POTWs) discharge 1,200 million gallons per day to the SCB. Of these POTWs, the LACSD's Joint Water Pollution Control Plant (JWPCP), which discharges to the Palos Verdes Shelf, is one of the largest in volume and industrialization.

Prior to the Clean Water Act of 1972, the primary goal for treatment systems was public health protection. Following the Clean Water Act, treatment processes and outfall designs were upgraded with the goal of also protecting aquatic life in the ambient environment. During the next 30 years, mass emission rates of effluent-suspended solids and contaminants were reduced as industrial waste source-control measures and treatment plant upgrades were implemented. In addition, receiving-water monitoring programs were instituted to assess the effects of discharge on the condition of the nearshore environment. The monitoring program established along the Palos Verdes Shelf area near the outfall of the JWPCP has the longest consistent record of monitoring receiving waters in the SCB, allowing assessment of the environmental response to effluent quality improvements (LACSD, 2006). This monitoring has been conducted primarily by the LACSD. The location of the outfall and receiving water monitoring sites discussed below are shown in Figure 6-15.

By 1970, the historic discharge had contaminated the seafloor of the Palos Verdes shelf with organic matter and chemicals (e.g., metals and chlorinated hydrocarbons). Organic matter loading resulted in sediment hypoxia and hydrogen sulfide in surface sediment pore waters. Potentially toxic metals and synthetic organic compounds, notably DDT and PCBs, were present in the sediments at levels well above those typically associated with biological effects. These alterations were severe enough to sharply degrade the benthic communities over the entire shelf (Stull, 1995).

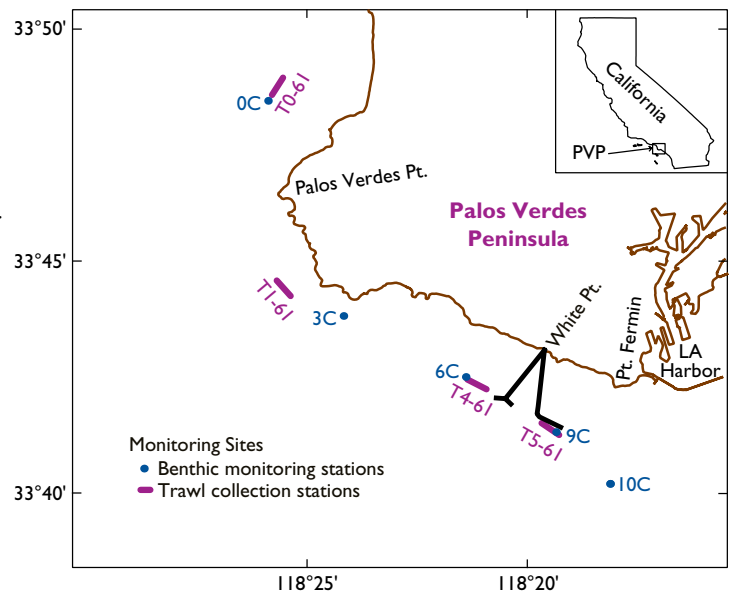


Figure 6-15. JWPCP outfall system and monitoring sites within the SCB. Stations indicated with C in the station ID are benthic monitoring stations, whereas those with T in the station ID are trawl collection stations (courtesy of SCCWRP based on data from LACSD).

As effluent contaminant emissions decreased from 1970 onward, so did the levels of organic matter, metals, chlorinated hydrocarbons, and other contaminants in the upper layers of seafloor sediments. Examples of sediment quality trends are shown in Figure 6-16. Similar reductions have been observed for other contaminants, including numerous metals and other chlorinated hydrocarbons (LACSD, 2006).

The unfavorable sediment conditions that developed over decades degraded benthic communities in much of the Palos Verdes shelf. Impacts were greatest near the outfall, where pollution-tolerant species dominated. Species richness was extremely low, crustaceans and echinoderms were rare, and many benthic species common to reference areas were conspicuously absent. Over time, the severity of biological effects lessened as sediment conditions improved (LACSD, 2006). This pattern of response is summarized by the Benthic Response Index (BRI) (Smith et al., 2001), which is a regional assessment

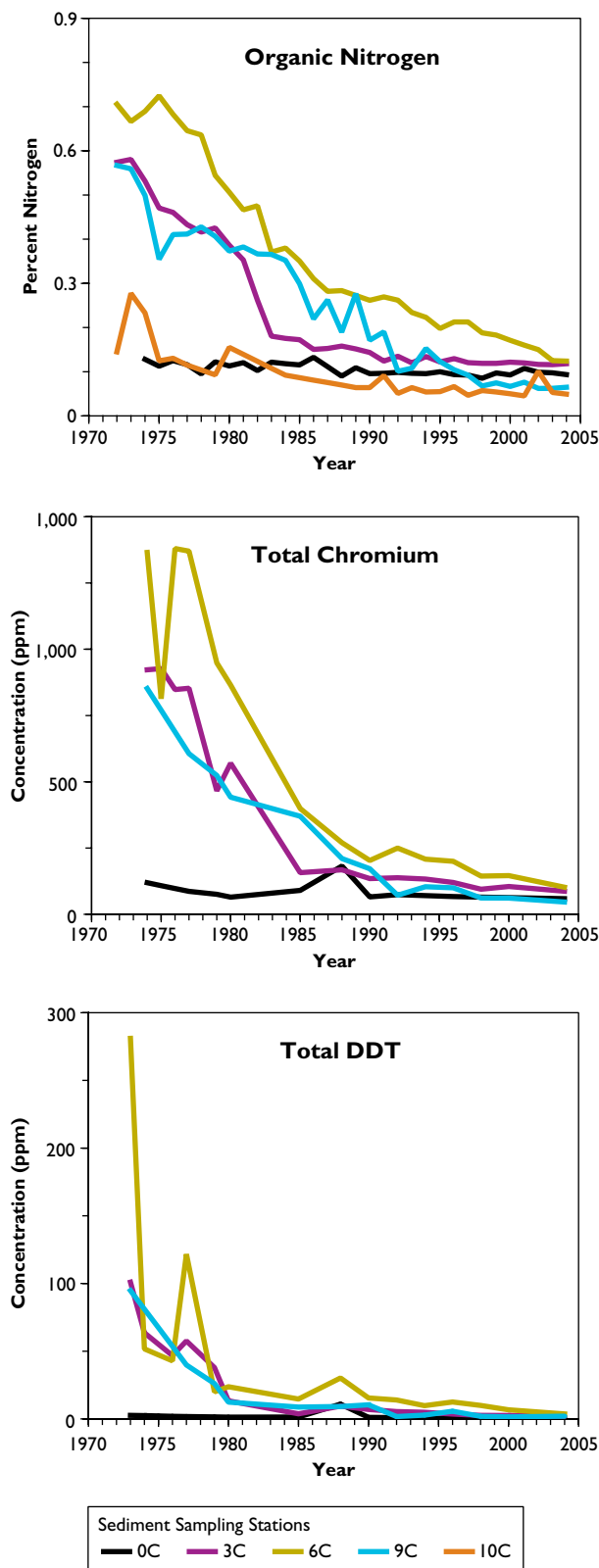


Figure 6-16. Trends in sediment quality represented by changes in concentrations of organic nitrogen, total chromium, and total DDT in sediment samples in the SCB, 1972–2004 (based on data from LACSD, courtesy of SCCWRP).

tool calculated as the abundance of pollution-tolerant species within a sample. Whereas loss in community function, and even loss of the community altogether, was apparent at all sampling stations in the 1970s, even the sites closest to the outfall had only minor deviation from reference condition by the mid-2000s (LACSD, 2006).

As with the benthic communities, the demersal (bottom-dwelling) fish communities on the Palos Verdes shelf exhibited evidence of community-level impacts in the 1970s. Near-outfall sites were characterized by smaller populations, lower biomass, fewer species, and less diversity than sites distant from the discharge. Many species that were rare in the 1970s have become more abundant and widespread in the past two decades. Previously abundant pollution-tolerant species that had been associated with the discharge have declined in population (LACSD, 2006). These trends are summarized by an index of demersal fish biointegrity, the Fish Response Index (FRI) (Allen et al., 2001), with index values below 45 indicating reference biointegrity. The FRI has fallen over time (Figure 6-17), with all sites near the outfall currently within reference condition (LACSD, 2006).

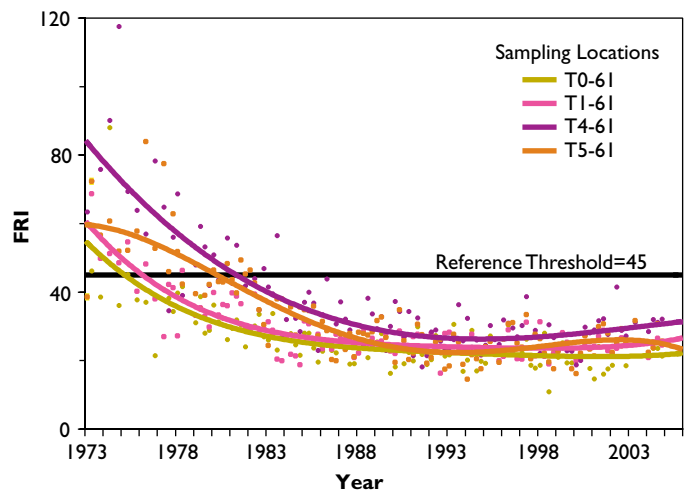


Figure 6-17. Trends in the condition of the demersal fish community in the SCB, 1972–2004, as represented by the Fish Response Index (based on data from LACSD, courtesy of SCCWRP).

Another indicator of pollution-related impacts within demersal fish communities is fin erosion. This disease manifests as the degeneration of fins and is thought to result from a complex set of causes, including contact with contaminated sediments, low dissolved oxygen environments, and secondary bacterial infections. In the past, fin erosion was commonly observed among demersal fish off Palos Verdes. Thirty-one of 69 species collected off the Palos Verdes Peninsula during 1969–1972 trawl surveys exhibited fin erosion, with Dover sole showing the highest incidence. This flatfish species prefers muddy bottoms, where it feeds on benthic organisms. Fin erosion was most commonly found on specimens from near-outfall sampling sites and was rare in specimens from the most distant sampling site. Fin erosion virtually disappeared from Dover sole and all other species of demersal fish collected off Palos Verdes by 1988 (LACSD, 2006).

In the SCB, DDT and PCBs are the persistent synthetic chlorinated hydrocarbons of greatest concern. DDT inputs to the JWPCP sewer system ended in 1971, and other sources of this chlorinated hydrocarbon have been eliminated. Use of PCBs was prohibited in 1979, and this compound has been virtually undetected in effluent since 1986 (Steinberger and Stein, 2004). However, the

persistence of these legacy pollutants in the buried reservoir of historically contaminated sediments results in their continued appearance in the food web and tissues of local sea life. Although tissue burdens in local fish have fallen over time (Figure 6-18), levels in some species are still sufficiently high to justify consumption advisories (LACSD, 2006).

The long-term monitoring results on the Palos Verdes shelf cumulatively provide evidence of the effectiveness of the Clean Water Act. There is clear linkage between reductions in discharge from the POTW and improvements in sediment quality, which in turn has led to improvements in the biological integrity of the system. Although the example provided was for a single facility, similar patterns have been observed at each of the other southern California POTWs that maintain monitoring programs. The JWPCP typifies the successful response by POTWs in the SCB to the challenges presented by the Clean Water Act. Population in the coastal plain is expected to increase substantially over the next 30 years, and pressure on the local marine environment may increase. The requirements of the Clean Water Act will continue to assure that the gains of the past 30 years are sustained, and the monitoring programs associated with those facilities will provide a means of assessing that success.

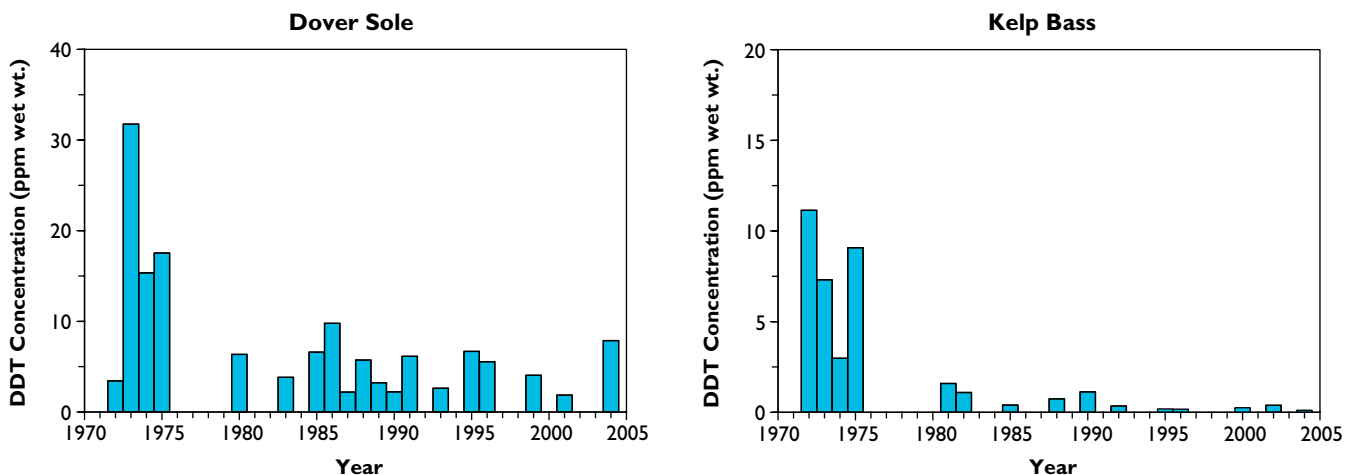


Figure 6-18. Trends in the median concentration of DDT (ppm wet wt.) in muscle tissue of Dover sole and kelp bass in the SCB, 1972–2004 (based on data from LACSD, courtesy of SCCWRP).

Overall Trends

Monitoring of fixed stations over an 11-year period in Puget Sound has shown that the general trend for metals in the sediments has been to decrease over time. Among the 10 priority pollutant metals sampled at 10 stations, a total of 39 cases (single metal at a single location) exhibited statistically significant differences over time. Of these 39 cases, 4 exhibited significant increases, and the rest were significantly decreasing. The Puget Sound PAH data demonstrate that different types of pollutants may have differing temporal trajectories. In contrast to metals, of the 45 cases where a significant temporal trend in PAH concentrations was detected, 41 instances were increases. The Puget Sound benthic monitoring data also strongly suggest that natural environmental variability can have impacts on certain environmental indicators, such as sediment grain size and benthic community composition. Separation of such natural sources of variation from anthropogenic changes remains a significant challenge for the interpretation of long-term monitoring data.

The data from the long-term monitoring programs within San Francisco Bay present a mixed picture of changes over time. As was the case in Puget Sound, sediment copper concentrations have generally declined. PCBs have shown declines in mussel tissue used in a monitoring program since the 1970s, but have shown no decline in the decade since 1994 in samples of various fish tissues. In contrast, DDT and chlordane pesticides have declined in the same fish species over the same time period. Of continued concern in San Francisco Bay is the fact that there is no indication of decreases of mercury over a 30-year period. In contrast, some stations in Puget Sound had significant decreases in sediment concentrations of mercury over only a decade.

The long-term data from the monitoring of fixed stations in the SCB was more focused on the evaluation of system responses near point sources of pollutants from POTWs, in contrast to the more regional assessments reported from Puget Sound and San Francisco Bay; therefore, the trends described tended to be much clearer. Reductions in effluent contaminant levels from the early 1970s onward have reduced the amount of organic matter,

metals, and organic contaminants, such as DDT, in the surface sediments. The demersal fish and benthic communities have both responded favorably to these reductions in pollutant loads. As was the case in San Francisco Bay, the levels of synthetic organic contaminants (e.g., DDT, PCBs) in fish tissues have decreased over time, but in both regions, there is a highly persistent legacy of these pollutants in the sediments that continue to accumulate in fish at levels sufficient to require consumption advisories.

The temporal trends in benthic pollutants within these three large coastal areas of the West Coast demonstrate a number of significant reductions over periods of monitoring, ranging from one to three decades. The increasing trend for PAH concentration with time in Puget Sound is potentially a result of the large increases in human population in the region. Observation of increasing trends for pollutants indicates that there is still a major need for programs that address existing problems, as well as for programs to prevent environmental conditions from getting worse over time.



The sunflower sea star, *Pycnopodia helianthoides*, is found on a variety of subtidal bottoms and in extremely low intertidal zones from Unalaska Island, AK, to Baja California, Mexico (courtesy of NOAA).



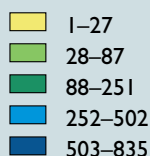
Marine Mammal Strandings Along the West Coast

Seals and sea lions live and breed along the Pacific coasts of Washington, Oregon, and California (King, 1983). These marine mammals share their habitat with humans and consume many of the same fish species. California sea lions (*Zalophus californianus*), Pacific harbor seals (*Phoca vitulina richardsii*), and northern elephant seals (*Mirounga angustirostris*) are the pinniped species that commonly come ashore or “strand” on West Coast beaches when they are ill or in distress. Members of the Southwest and Northwest regions of the National Marine Mammal Health and Stranding Network respond to these strandings when they occur along the California and Oregon–Washington coasts, respectively. The network was formalized by the 1992 Amendments to the Marine Mammal Protection Act and is managed by the NMFS. Live stranded animals are admitted for care to rehabilitation centers, and investigations into cause of death are conducted for animals that die.

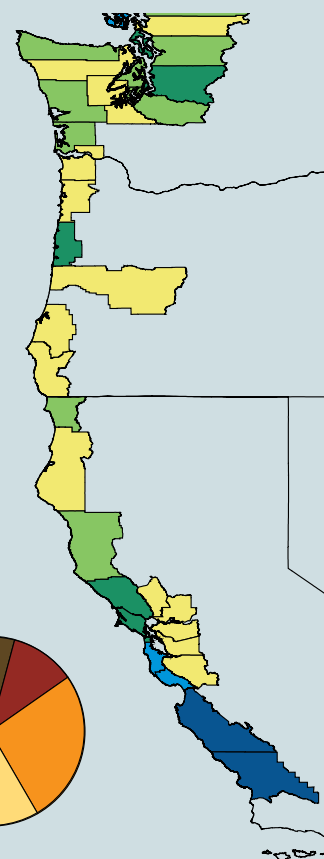
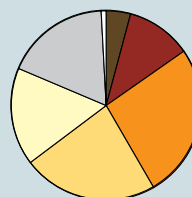
From 2000 to 2004, a total of 4,804 live pinnipeds were stranded along the West Coast. The map shows that the majority of animals were stranded along the California coast (64%), compared to Oregon (7%) and Washington (29%). The highest proportion of animals was stranded in central California, and these animals were most commonly sea lions (75%), followed by elephant seals (18%) and harbor seals (7%).

Major causes of mortality for California sea lions (see pie chart) included the bacterial disease leptospirosis (26%), malnutrition (23%), trauma (18%), domoic acid toxicity (11%), and carcinoma (1%). Domoic acid is a biotoxin produced by some marine algae, especially during HABs. This acid binds to receptors in the brain and is responsible for amnesic shellfish poisoning in humans (Teitelbaum et al., 1990). The first UME associated with domoic acid toxicity was documented along the coast of California in 1998 (Scholin et al., 2000). During that year, approximately 400 sea lions died with clinical signs of domoic acid toxicosis. Since 1998, recurrent toxin-producing events have occurred on a regular basis and have affected hundreds of animals. California sea lions are high-level predators that feed on some of the same species (e.g., anchovies, sardines, hake, rockfish, salmon, market squid) that often enter the human seafood market, and the detection of domoic acid in California sea lions dying along California’s coast is helping to raise public awareness of the presence of this biotoxin in a variety of seafood species. These concerns are exacerbated by increasing reports of HABs that threaten both human and marine life safety (U.S. Commission on Ocean Policy, 2004b).

Number of live pinniped strandings, 2000 to 2004
(courtesy of NOAA)



Causes of Mortality for California Sea Lions
(courtesy of NOAA)





Red sockeye salmon (courtesy of Greg A. Syverson, FWS).

than normal off the coasts of California, Oregon, and Washington. In 2000, the marine plankton assemblages in the Pacific Northwest area shifted from species characteristic of temperate regions to species more characteristic of sub-arctic regions, and baitfish became abundant. Until 2005, marine conditions remained favorable for the growth and survival of all salmon species in the Pacific Northwest; however, California Current LME coho and Chinook salmon landings from the June 2005 surveys were lower than in June 1998, during El Niño (NMFS, In press).

Pacific salmon are particularly vulnerable to habitat degradation because of their dependence on freshwater habitat for spawning and juvenile rearing. Dam construction, logging, agriculture, grazing, urbanization, and pollution have degraded freshwater habitat throughout their range. Water extraction and flow manipulation for hydropower, irrigation, flood control, and municipal needs directly compete with salmon for the freshwater on which they depend. As the human population in the western United States continues to increase, so will the pressures on salmon habitat. The continued existence of salmon in harvestable quantities is a tribute to the resilience of these fish (NMFS, In press).

Pelagic Fisheries

Several stocks of small pelagic fish species support fisheries along the California Current LME. The major species are Pacific sardine, northern anchovy,

jack mackerel, chub (Pacific) mackerel, and Pacific herring. Sardine, anchovy, and the two mackerels are primarily concentrated and harvested off California and Baja California. Pacific herring are harvested along the West Coast from California to Washington. Populations of these small pelagic fish tend to fluctuate widely (NMFS, In press).

Commercial fishing for small pelagic fish species has a long history in the California Current LME, and sardine and anchovy are the most prominent of these fisheries from an historical perspective. California sardines supported the largest fishery in the western hemisphere during the 1930s and early 1940s, when total landings averaged 500,000 t. The sardine abundance index and landings declined after World War II, and the stock finally collapsed in the late 1950s. In the mid-1940s, U.S. processors began canning anchovy as a substitute for sardine; however, consumer demand for canned anchovy was low, and landings from the mid-1940s to mid-1950s averaged only 20,000 t per year. Landings declined and remained low before starting to increase in 1965 after the sardine collapse. Together with landings from Mexico, the total landings from this LME increased to 250,000 t per year during 1975–1980, but declined thereafter due to significant price reductions for fishmeal. The biomass trend for the anchovy resource hit a peak of 1.6 million t in 1973 and declined steadily to 392,000 t by 1994. Northern anchovy landings in California have fluctuated more in response to market conditions than to stock abundance, and low prices and market problems continue to prevent a significant U.S. reduction fishery (i.e., fishery that reduces the fish caught to meal, oil, and soluble protein) for anchovy. Landings by the United States have varied and have been used mostly for live bait and other non-reduction uses. The current yield for the United States is 25,000 t or 30% of the maximum sustainable yield, although recent landings have been much lower (about 8,500 t) due to a lack of commercial markets (NMFS, In press).

All these pelagic fishery resources are currently under management. The well being of ecologically related species in the California Current LME is important in the management of these resources. For example, the endangered brown pelican depends on anchovy as a critical food source,

and so to protect the ecological balance, the FMP (PFMC, 1998) has specified a threshold for determining optimum yield that prevents depletion of the anchovy stock and provides adequate forage for marine fishes, mammals, and birds.

Demersal Fish Fisheries

The demersal fish fishery of the California Current LME is conducted along the entire extent of the coastlines of Washington, Oregon, and California and includes a diverse range of habitats and species. The fishery has four sectors: commercial limited entry, commercial open access, recreational, and tribal (NMFS, In press).

In recent years, a number of dramatic changes have occurred in the California Current LME demersal fish fishery. Between 1999 and 2002, nine stocks were declared overfished, and the implementation of rebuilding plans for these stocks have sharply curtailed fishing opportunities for these species and for associated species throughout nearly all sectors of the fishery. As a result, allowable harvests and landings are at or near historical lows for many species. Two of the overfished stocks (Pacific hake and lingcod) have since been declared rebuilt, but rebuilding for many of the other stocks is expected to take decades. In addition to rebuilding plans for the recovery of overfished stocks, many strides have been made to improve management of the demersal fish fishery. These include the completion of a trawl permit buy-back to reduce fishing capacity, implementation of a coast-wide observer program to monitor bycatch, and expansion of demersal fish resource surveys (NMFS, In press; NWFSC, 2006; PFMC, 2006).

In 2003, U.S. commercial landings of California Current LME demersal fish totaled 168,987 t, generating \$60.2 million in ex-vessel revenue (amount the commercial fishermen receive from the quantity of fish landed). Pacific hake landings dominate the California Current LME demersal fish landings, accounting for 84% of the fishery's total landed weight in 2003; however, with its low unit value, Pacific hake revenue composed only 29% of the demersal fish fishery's revenue in this LME. The demersal fish fishery's most valuable component is the "Dover sole-shortspine thornyhead-longspine thornyhead-sablefish" complex, which accounted

for nearly \$29 million, or 48%, of all demersal fish revenue from this LME in 2003. The trawl fleet (including those aimed at Pacific hake) comprises the largest gear component of the fishery, generating 72% of the ex-vessel revenue (NMFS, In press).

Although traditional management measures such as annual catch quotas have been in place for up to 20 years, some demersal fish stocks have declined during that period to less than 25% of their estimated unfished levels. At least three primary factors have contributed to these declines. First, during the 1980s and into the 1990s, little information was available on the life history and productivity of many demersal fish species, and target harvest rates were based upon knowledge of the productivity of other species. This was a reasonable approach in light of the absence of species-specific information, but it turned out that harvest rates were overly optimistic for most of the long-lived, slow-growing rockfishes. Additionally, resource survey information was insufficient to estimate stock abundance indices with adequate precision, and with no observer program in place, there was no way to verify that the total catch, including bycatch, did not exceed the intended level. Finally, a decline in the basic productivity of the California Current LME from 1977 until the late 1990s (including evidence of the decline in zooplankton abundance mentioned earlier and of ocean warming during the late 1970s) coincided with increases in demersal fish harvests in the late 1970s. This decline in productivity likely contributed to the decline in the overall abundance index and recruitment (addition of new generation of young fish) of demersal fish species (NMFS, In press).



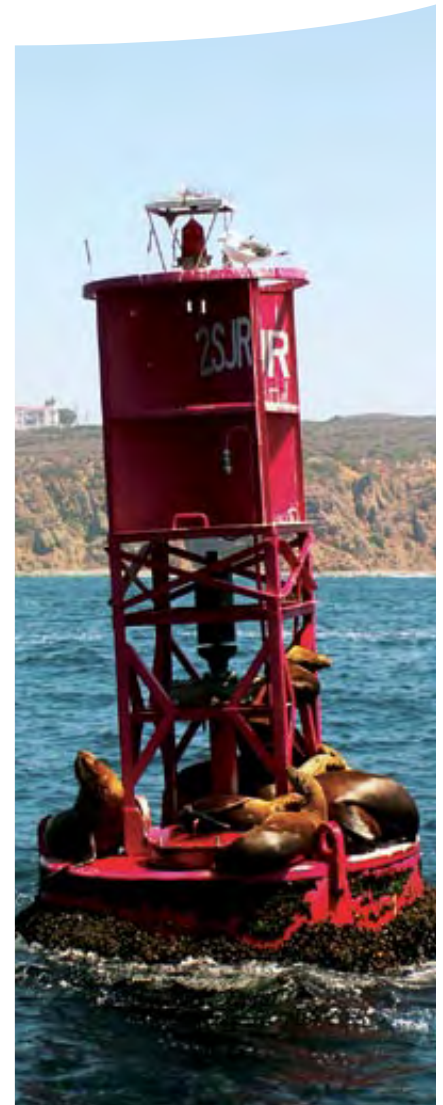
Vermilion rockfish, *Sebastes miniatus*, are caught in West Coast waters and have not been singled out for species management (courtesy of Wayne Davis, U.S. EPA Biological Indicators of Watershed Health Photo Library, <http://www.epa.gov/bioindicators>).

Summary

Based on data from the NCA, the overall condition of West Coast coastal waters is rated fair. Additional benthic community data have become available since the NCCR II and were included in the analysis for this report; other data have been refined. As a result, the overall condition score and the benthic index rating for the West Coast region have changed since the NCCR II, and the percent of coastal area rated good, fair, or poor has been refined for several indices and component indicators.

Currently, NCA data for the West Coast region are only available for 1999 and 2000, and long-term trends in coastal condition cannot be evaluated; however, local monitoring programs have been used to examine long-term trends for several areas of the region. As measured by the PSAMP, no significant changes in the concentrations of most metals and PAHs in the sediments of Puget Sound occurred over time; however, where significant changes were observed, metal concentrations decreased and PAH levels increased. The PSAMP also observed changes in the percent silt over time, and these changes affected Puget Sound's benthic community composition. In San Francisco Bay, levels of DDT in some finfish species have declined over time due to natural environmental variation, although no trends have been observed for PCB or mercury concentrations in finfish. PCB levels in transplanted mussels have decreased in the Bay, and copper concentrations have decreased in water, clams, and sediment. Chlorophyll *a* levels have shown increasing trends in the northern reaches of San Francisco Bay and decreasing trends in the Bay's southern reaches. Since 1970, conditions in the SCB have improved, and levels of organic matter, metals, chlorinated hydrocarbons, and other contaminants have decreased in sediments. Demersal fish and benthic communities have also improved in the region, and DDT and PCB concentrations in fish have decreased.

NOAA's NMFS manages several fisheries in the California Current LME, including salmon, pelagic fish, and demersal fish. Landings of the five species of Pacific salmon within the California Current LME are near or below the maximum sustainable yield, and most of these species are listed as threatened or endangered. Pacific salmon are particularly vulnerable to habitat degradation due to human-induced pressures, such as construction, logging, and urbanization. Ocean conditions in the 1980s and 1990s resulted in decreased abundances of Chinook and coho salmon in this LME. During the same time period, abundances of sockeye, pink, and chum salmon were either stable or increasing. Populations of the small pelagic fish in this LME tend to fluctuate widely, and both anchovy and sardine landings are low due to market constraints. Nine stocks of California Current LME demersal fish were declared overfished between 1999 and 2002, and only two of these stocks are considered rebuilt.



Summary

Contamination in West Coast coastal waters has affected human uses of these waters. In 2003, there were 24 fish consumption advisories in effect along the West Coast, most of which were issued for PCBs contamination. In addition, 33.5% of the region's monitored beaches were closed or under advisory for some period of time during 2003. Elevated bacteria levels in the region's coastal waters were primarily responsible for the beach closures and advisories.

