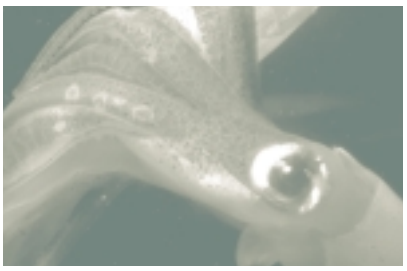
UNDERWATER CENTRAL CALIFORNIA






A GUIDE TO SAVING YOUR OCEAN HERITAGE

The report is the product of a collaborative effort among the West Coast offices of Environmental Defense, The Ocean Conservancy, and the Natural Resources Defense Council. Contributors include Richard Charter, Kaitilin Gaffney, Rod Fujita, Karen Garrison, Karen Reyna, Linda Sheehan, and Kate Wing. The chapter "The Natural History of the Sanctuaries" was written by Michael Bhargava, whose work also informed the rest of this report. Dr. Bhargava was supported by a mini-grant from Environmental Defense's Environmental Science Program. The Ocean Wilderness Network provided partial support for production, as did the David and Lucile Packard Foundation and Rockefeller Brothers Fund.

Environmental Defense is a leading national nonprofit organization representing more than 300,000 members. Since 1967, we have linked science, economics and law to create innovative, equitable and cost-effective solutions to society's most urgent environmental problems.

The Natural Resources Defense Council uses law, science, and the support of more than 500,000 members nationwide to protect the planet's wildlife and wild places and to ensure a safe and healthy environment for all living things.

The Ocean Conservancy's mission is to protect ocean ecosystems and conserve the global abundance and diversity of marine wildlife. Through science-based advocacy, research, and public education, The Ocean Conservancy informs, inspires, and empowers people to speak and act for the oceans.

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Introduction

Standing on a beach in Big Sur, or at the top of a cliff along Point Reyes, the ocean stretches out before you. Our wild coast is part of what defines California, and our relationship with the sea has shaped the state for centuries. Three National Marine Sanctuaries stretch along the coast of central California, yet these Santuaries are not safe havens for the wildlife that inhabits them. In 2002, all three sanctuaries began a review of their management plans, which will guide their actions for the next decade or more. It is through these management plans that each sanctuary takes the essential steps to protect the resources within their borders—the mandate of the National Marine Sanctuaries Act. In this report, we talk about what makes up the sanctuaries, the state of the wildlife and habitats inside the sanctuaries, and identify key threats to the future of California's coast. If you care about what happens beneath the waves off your coast, take action and get involved with the sanctuaries. The oceans are yours, and need your support to stay healthy and to thrive for future generations.

What Is A National Marine Sanctuary?

The National Marine Sanctuaries Act (NMSA) was passed in 1972, giving Congress the right to designate areas as sanctuaries throughout U.S. waters. Today, there are 14 national marine sanctuaries, four of which are in California. The National Oceanic and Atmospheric Administration, or NOAA, has jurisdiction over the National Marine Sanctuary Program, although each sanctuary has a local manager and staff. Sanctuaries have been created for many reasons, including the protection of both biological and historical resources. In California, concerns about oil drilling played a key role in the creation of its marine sanctuaries.

When a sanctuary is created, a "designation document" lays out specific prohibitions and goals that will apply to the area. Almost all of the sanctuaries, for example, prohibit oil exploration in their boundaries as part of their designation. Sanctuaries also write a management plan that governs their general operation. The NMSA contains a broad authority that makes it illegal to destroy or injure any resource under sanctuary management. This makes each sanctuary's management plan very important, because it defines the scope of resources that will be managed by the sanctuary. Although sanctuaries are supposed to review their management plans every five years, those for the three central California sanctuaries are nine to twenty years out of date. During that time, many new activities sprang up in and around the sanctuaries, and threats from oil and gas have not disappeared. Now is the time to determine how best to chart a course that reduces potentially damaging activities inside the sanctuaries and improves protection for the oceans.

Creating the Sanctuaries

In the 1960s, oil development was seen as the biggest threat to the California coast. In 1969, an oil drilling rig blew out near Santa Barbara with disastrous results. The U.S. Department of Interior's plans for oil and gas leasing along California's coast placed many prime drilling targets only 3 miles from shore. During the late 1970s, public opposition to expanding offshore drilling into new areas along the California coast reached a fever pitch. The new NMSA was seen by the people of California as a way to provide a truly permanent "sanctuary" that would protect sensitive coastal areas from offshore oil and gas leasing.

Gulf of the Farallones National Marine Sanctuary: Designated in 1981, the 1,200 square-mile Gulf of the Farallones National Marine Sanctuary (GFNMS) was one of the first in the nation. Sitting just north of the mouth of San Francisco Bay, the biologically productive waters surrounding the Farallon Islands attract hundreds of species, including blue and humpback whales, harbor seals, and great white sharks. The islands also host the largest seabird breeding colonies in the U.S. outside of Hawaii. As seabirds are particularly vulnerable to oil spills, the importance of the islands for seabirds made them a prime target for a sanctuary.

To truly protect the seabirds, the sanctuary needed to include the fishes and nursery areas on which the birds depend. Scientists identified the nearby coastal estuaries of Drakes Bay, Tomales Bay, Estero Americano and Estero de San Antonio as crucial to the sustainability of the seabird populations and to the health of the overall marine environment in this region. In keeping with this broader ecosystem approach to protection, most of the Marin Headlands and the southern Sonoma Coast were incorporated into the final boundary selection—including most, but not all, of the lands of high interest to the oil industry. The protection of the GFNMS was challenged almost immediately. Within a year of their designation, President Ronald Reagan lifted the permanent ban on offshore drilling in both the Farallones and Channel Islands sanctuaries. President Reagan ordered an analysis of the sanctuaries to determine how much the drilling ban would cost the nation's economy. This extensive analysis ultimately placed such a high economic value on the biological resources of the sanctuaries that the drilling prohibition was restored two years later.

Cordell Bank National Marine Sanctuary: Cordell Bank itself is about 43 square miles of granite rising up from the soft seafloor just north of the Farallon Islands. At its shallowest points, pinnacles from the bank rise up to 120 feet below the ocean surface, while deeper regions lie 400 feet beneath the waves. The unusual concentrations and diversity of fishes, anemones, and other marine wildlife at

Cordell Bank, combined with oil industry interest in drilling nearby, made a compelling case for the creation of a new Cordell Bank National Marine Sanctuary (CBNMS). The sanctuary was established in 1989, encompassing 526 square miles of ocean and sharing a boundary with the GFNMS to ensure protection for both areas.

Monterey Bay National Marine Sanctuary: While the Gulf of the Farallones and Channel Islands National Marine sanctuaries were being planned, a third new sanctuary proposal was being evaluated for Monterey Bay. The Monterey Bay National Marine Sanctuary (MBNMS) spans the geographic range of many species, from the warm water Guadalupe fur seal to the northern Steller sea lion. The lush kelp forests in the Bay serve as nurseries for juvenile fish, popular dive sites, and resting places for sea otters. Just offshore, the Monterey Canyon plunges two miles deep underwater. From the time NOAA originally proposed the site it took almost fourteen years to establish the MBNMS. Community support drove the sanctuary's creation, and all the while oil companies continued to press for drilling access. Finally, in 1992, Congress put the MBNMS in place, stretching from the southern boundary of the GFNMS to the Big Sur coast and covering more than 5,300 square miles.

THE NATURAL HISTORY OF THE CENTRAL COAST SANCTUARIES

The marine environmental history of the California coast in the 19th and 20th centuries is a series of stories of resource discovery, followed by rapid and extreme exploitation leading to severe depletion and finally to strict regulation or moratoria followed by slow recovery. Upon arrival in Monterey in 1786, French explorer Jean Francois de la Perourse stated: "No country is more abundant in fish and game of every description."[1] Two centuries later, the Central Coast has been completely transformed by human activities. Marine mammals, birds, fishes and invertebrates have suffered from over-exploitation at the hands of eggers, hunters, whalers, and fishers, as well as from pollution and habitat loss.

Prior to the arrival of Spanish settlers in the 1700s, more than 10,000 Ohlone Indians lived along the Central Coast between Point Sur and the San Francisco Bay.[2] The Esselen lived south of Point Sur and the Coastal Miwok inhabited what is now West Marin. According to historians, the plentiful natural resources of California's land and sea, particularly the abundance of coastal fisheries, supported Indian population densities along the Central Coast that were higher than anywhere on the continent north of central Mexico.[3] In spite of historical evidence that coastal Indians exerted significant pressure on coastal fisheries, especially shellfish and salmon, it appears that coastal Indians were able to sustain fishery yields for centuries.[4]

California's early Spanish settlers were ranchers who paid little attention to, and exerted little pressure on, marine resources.[5] This changed with the arrival of Russian fur hunters just after the turn of the 19th century. The Russians, with the aid of Aleut hunters from Alaska, began harvesting southern sea otters along the central and northern California Coast.[6] By the mid-1800s, the wave of European and Asian settlers to the Monterey Bay and San Francisco Bay had begun. The new immigrants brought about the serial depletion of marine resources, including mammals, fishes and seabirds. Due to human activities, sea otters, common murres, pelicans, rockfishes, sea lions, sardines, gray whales and dozens of other species have experienced a roller coaster of population changes. Only with the passage of protective legislation, such as the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA), did a number of these species begin to recover. Many species, however, remain federally endangered, threatened, or depleted. Only the combination of time, the absence of human exploitation, and habitat restoration can bring their populations back.

Marine Mammals

Early European explorers were uniformly effusive in their descriptions of the abundance of marine mammals they encountered along the California Coast. French explorer Jean Francois de la Perouse noted in the journal of his 1786 arrival in Monterey Bay: "It is impossible to describe either the number of whale with which we were surrounded, or their familiarity. They spouted every half minute within half a pistol shot of our frigates…" Although marine mammals have been hunted in California for centuries for their fur, meat, hides, baleen, and finally, oil, it was not until the 19th and early 20th century that harvest led to severe declines in most of the marine mammal populations off of California. While some marine mammal populations have made impressive recoveries, many others remain at low levels when compared to pre-harvest levels, even though they have not been hunted for decades.

Targeted in an international fur trade, southern sea otter populations that once numbered as high as 20,000 in California were thinned to as few as 100 animals by the dawn of the 20th century. First afforded protection under the 1911 Fur Seal Treaty, in 1977, the southern sea otter was listed as threatened under the Endangered Species Act. The remnant otter population has gradually expanded to just over 2,000 animals in 2002. Numbers peaked in 1995 with 2,377 otters, still only 10 to 15% of their historic highs. Otters continue to die every year from entanglement in fishing gear, gunshot, and diseases linked to human-induced pollution.

Sought for their oil and skins, sea lions, Steller sea lions, northern fur seals, elephant seals, harbor seals, and Guadalupe fur seals were nearly wiped out by Russian and Aleut hunters throughout the 19th century. Remnant populations were protected by treaty in 1911 and populations of sea lions, harbor seals and elephant seals have rebounded significantly in recent decades, recolonizing much of their historical range. Northern elephant seals have made the most spectacular comeback of all. By the early 1900s, only a small colony of as few as 100 elephant seals survived on Guadalupe Island off Baja California. By 1996, this population had grown to more than 84,000 northern elephant seals with breeding colonies from the Channel Islands to the Point Reyes Peninsula.

By the late 18th century, whaling ships were voyaging to California in search of sperm whales and by the 1850s, shore-based whaling stations had been established off of Monterey, targeting primarily gray and humpback whales. In the 1880s, the whaling industry became less profitable as petroleum became a cheaper substitute for whale oil and whale populations were hunted out. Passage of the Marine Mammal Protection Act in 1972, prohibiting the killing of whales in all U.S. waters, occurred just one year after the last whaling station in the United States was closed down. Decades after most whaling efforts ceased, only the gray whales, of all the great whales, has recovered significantly. Populations of gray whales have increased steadily over the last three decades, resulting in the species being delisted under the ESA in 1994. Current populations are estimated at more than 26,000 whales. Humpback whales remain endangered, with a California population estimated at about 1,100 whales, less than 10% of historic levels. The endangered blue whale population is estimated to be approximately 30% of pre-whaling levels.

Marine Birds

Hunting and loss of habitat greatly diminished the bird populations that greeted European explorers. Early visitors to the Monterey Bay area noted the number of geese "would hardly be credit by anyone who had not seen them covering whole acres of ground, or rising in myriads with a clang that may be heard a considerable distance."[7] An 1877 diary entry from a Salinas resident noted that a visitor "killed 126 ducks on ponds east of Salinas in six shots."[8] The seabird colonies of the Farallon Islands came under intense exploitation soon after the Russian settlement of California. The Russians killed off the large populations of seals and sea lions on the islands, then pioneered the egg trade, shipping large numbers of eggs to their California colony at Fort Ross. According to sea captain Benjamin Morrell, Jr., during his 1825 visit to the islands, "aquatic birds in considerable variety resort hither for purposes of laying and incubation; but the Russians seldom give them a chance for the latter process, generally securing the eggs as fast as they are deposited."[9] The explosive growth of the California population after the 1848 gold rush provided an almost unlimited market for Farallon eggs. Eggers preferred the common murre, whose eggs are about twice the size of a chicken egg.

Egg collecting generally ran from May through July, the breeding season of the murres. In order to ensure that the eggs were fresh, eggers would destroy the first lay of the season, which were of unknown age, forcing the birds to lay replacements that the eggers would collect.[10] In 1853, a single boat carried 12,000 eggs from the island, the product of only two days labor.[11] Between 1850 and 1870, perhaps 25,000 dozen eggs were collected per year. The murre populations could not withstand the onslaught and gradually declined. After 1873, an average of about 15,000 dozen eggs were taken, and by 1896, fewer than 8,000 dozen. Writer Otto Emerson visited the Farallones in 1887 and again in 1903, and he commented on the remarkable decline in bird populations over that time. "A walk among the many breeding spots of the southern portions of the island showed an entire absence of birds."[12] Finally, in 1881, the federal government evicted the Pacific Egg Company, replacing the eggers with lighthouse keepers. At the turn of the 20th century, perhaps 60,000 murres remained on the Farallones, a decrease of 85% from the 400,000 that bred on the island only 40 years before.[13]

One hundred years after egging stopped, California's common murres had partially recovered, with population estimates at 100,000 birds, only to again be severely affected by human activities – this time by gill nets and oil spills. Beginning in the late 1970s, a handful of fishing boats casting gillnets set up in Monterey Bay. By 1981, there were thirty gillnet boats operating near Monterey Bay and local residents had begun noticing dead seabirds washing ashore in large numbers. In July 1981, more than 10,000 birds washed ashore on Santa Cruz and Monterey county beaches. In 1982, the day after two gillnetters set nets off of Stinson Beach, two seals, an injured harbor porpoise, and 2,000 birds washed ashore. By 1983, 74 gillnetters were fishing an area from Big Sur to Marin and were estimated to be killing 10% of the murre population annually. Over the next several years, a variety of regulations were put in place to reduce gillnet bycatch that had reduced the common murre population from 100,000 to 45,000 in less than 10 years.

For nearly a hundred years, Central Coast seabird populations have also suffered from pollution. Throughout the 20th century, occasional oil spills from sunken vessels combined with chronic pollution from ballast exchange to repeatedly foul the beaches of central California. Local residents began to complain as early as World War I about the blackened beaches and dead birds that came from oil pollution. Harry Rhodes, superintendent of lighthouses in California, reported during the war that "unless steamers are prohibited from pumping their ballast tanks in the vicinity of the Farallon Islands and thereby discharging large quantities of crude oil, all varieties of diving birds will be exterminated."[14] Samuel Newsom, a resident of the Farallon Islands, reported in 1919 that hundreds of birds had been killed from oil slicks that appeared on average every two weeks. "The destruction of birds was appalling," he wrote. "Hundreds if not thousands of Murres could be seen about the islands trying in vain to free themselves of the oil. Many could be seen splashing in the water, trying to wash the oil from their plumage, while most perched dejectedly on rocks and pecked at their black, oily breasts and wings."[15] A local coastal resident, R.H. Palmer, reported seeing hundreds of dead birds between Monterey and Pacific Grove in March of 1919 and dozens more from Santa Cruz to Half Moon Bay the next year. "It is truly a pitiable sight," he wrote, "to see these handsome and normally immaculate birds standing or sitting up on the beach or out on a rock vainly trying to preen themselves free of this direful clinging mass; and at last, becoming too weak for further attempt, they sit stoically awaiting the end."[16] Dumping of oily bilge water declined significantly when shippers discovered how to economically recover and re-use oil from bilge water. However, illegal dumping of bilge water continues to this day.

On January 18, 1971, two Chevron Corporation oil tankers collided in zero-visibility fog beneath the Golden Gate Bridge, disgorging 840,000 gallons of fuel oil, which covered the coastline from Drake's Bay to Point Año Nuevo.[17] The California Department of Fish and Game estimated that 7,000 birds died and were found on beaches from Tomales Bay to Santa Cruz, but independent researchers showed that a minimum of 20,000 birds died. The birds most affected were western grebes, white-winged scoters, and common murres. The largest and most dramatic spill came in 1984, with the partial sinking of the oil tanker T/V Puerto Rican 12.5 miles outside the Golden Gate, which released 1.47 million gallons of oil into the Gulf of the Farallones National Marine Sanctuary. Overall, the spill killed more than 5,000 seabirds of at least 30 different species, most of them common murres.[18]

California brown pelicans were threatened with extinction by human activities and listed on the federal Endangered Species List in 1970 and the state endangered species list in 1971. Pelicans were harvested for feathers for women's hats in the early 20th century, killed by fishermen who saw them as competitors for fish during the First World War, and finally, and most severely, affected by widespread use of DDT. The pesticide DDT enters the food chain, affecting the pelicans' calcium metabolism and causing the birds to lay thin-shelled eggs that break during incubation.

California Fisheries

An 1868 story in the Santa Cruz Sentinel stated: "herrings and sardines are frequently so abundant in this bay, that boatmen find it difficult to make their way through the shoals." Historian Burton Gordon comments that historical reports of fish numbers from the 1800s, "would seem exaggerated if they were not in general agreement."[19] Although the waters of the Central Coast continue to contain productive fisheries, many of the fish populations off the California coast have been severely depleted from overfishing. Sardines, abalone, Dungeness crabs, large, red sea urchins, rockfishes, and a number of other species have declined dramatically at times because of human exploitation, only to gradually recover when fishers switched to more abundant species or when regulations were finally put in place.

Sardine: The trajectory of boom and bust, so familiar in California history, played itself out famously with the sardine fishery, which grew out of the increased demand for fish during World War I. The sardine fishery expanded tremendously in its first two decades, almost entirely free of state or federal regulation. Proposals to limit sardine catches came as early as 1929, but the industry almost unanimously opposed catch regulations.[20] After a peak catch in 1936-37, landings began to fall. The next year, average monthly catch fell to 30% of that only 3 years earlier, and the fish being caught were significantly smaller. Fishers responded by moving farther offshore and spreading their effort north and south along the California coast. "The declining abundance of this all-important fish," wrote Frances Clark in 1939, "has been evident to the observant student and the alert fisherman for the past eight to ten years, but only in the past two seasons has the fact been forced to the attention of the entire industry. In 1937-38, fishing was so difficult that all admitted the immediate scarcity of fish but many still failed to realize that 1937-38 represented the climax of a decline in abundance that had been going on for some time".[21]

By 1947, it had become obvious to all that the sardine fishery was failing, although the ultimate cause was still a source of debate. The sardine fishery tumbled like dominoes, collapsing first in the north and rapidly moving south. In 1947-48, the fishery failed in British Columbia, then the following year in Oregon and Washington. By the 1951-52 season, the fishery near San Francisco collapsed. Nevertheless, regulators still could not agree on a solution to the crisis, and low-level fishing continued even as most fishers fled to other opportunities. By the 1960s, the sardine catch in central California was negligible, but it was not until 1974 that the California legislature put a complete moratorium on directed fishing for sardines. The moratorium lasted until 1986, when the sardine stock began recovering.[22] By 1999, the sardine catch had returned to 56,747 tons, the highest since the fishery reopened in 1986, but still less than 10% of the peak 726,000 tons landed in 1936-37.[23]

Squid: Fishermen have targeted market squid for bait and food since the early 1900s. The squid fishery took off in the 1980s, beginning a trend eerily similar to the boom and bust pattern of the Pacific sardine fishery. Squid are especially vulnerable to overfishing because they aggregate to spawn, and a major portion of the squid fishery targets these spawning masses. Squid are also sensitive to ocean conditions such as water temperature. The population has been limited by biological factors, mainly during El Niño years, when warmer waters come up the coast. The drop in catch from 1998-2000 immediately followed one of the strongest El Niño conditions in recent decades. Taken together, these characteristics make the squid fishery prone to a collapse. The cost of a collapse in the squid fishery would be substantial for marine ecosystems and fishermen.

Perhaps the most worrisome issue in the squid fishery is the lack of understanding about the resource. Little is known about the present size, structure or status of the squid population. The catch hit a record high in 1999, with markets expanding to Spain, Italy, and the Philippines. However, almost the entire catch came from south of Point Conception. While statewide landings skyrocketed, central California landings remained depressed from 1998-2000.[24] In 2001, the central California catch started to increase to historic levels and in 2002 the fishery boomed, yielding the highest catch for the region in the fishery's 75-year history. The total landings were over 26,000 short tons—an alarming increase of 300% from the average catch of about 8,000 short tons since 1980.[25]

Abalone: Abalone has been targeted by human hunters in California for hundreds of years. The modern abalone fishery began in the 1850s when Chinese immigrants harvested large numbers of abalone in Monterey Bay for export north to San Francisco and to China. After 1900, Japanese hard-hat divers took over the trade, harvesting abalone in deeper waters. Abalone harvest peaked at 3.9 million pounds in 1935 before the Japanese-American internment during World War II temporarily stopped the fishery.

Abalone catch surged again after the war, and as one type of abalone succumbed to excessive fishing pressure, other species took up the slack. The California fishery moved from white to pink to green to black to red to sustain the catch. Each species failed in turn for a variety of reasons. Human fishing pressure remained paramount especially in the north and south, but the recovering sea otter population also put pressure on abalone in central California. Climate change and the emergence of a new disease known as withering foot syndrome also reduced abalone stocks.

Overall, catch fell from 5.4 million pounds in 1957 to less than 125,000 pounds in 1997, a decline of almost 98 percent. Finally, in 1997, the California Department of Fish and Game placed a moratorium on the abalone

fishery and indicated that there was "little hope for recovery of the resource over the next decade."[26] In 1998, the National Marine Fisheries Service (NMFS) proposed white abalone as a candidate for the endangered species list. Three years later, white abalone was listed. While regulations have banned the commercial harvest of abalone, a limited sport fishery is allowed for red abalone north of San Francisco, including some areas within the boundaries of the GFNMS. About 40,000 divers participate in the fishery each year, which requires abalone divers to free-dive, without using scuba gear.

Dungeness crab: The Dungeness crab fishery began with the California gold rush in 1848. Annual crab sales in San Francisco numbered about 300,000 crabs in the 1880s, but catch soon began to diminish and crabs within the San Francisco Bay were found to be too small and too few in number to profitably harvest, forcing fishers to expand their range. New technologies allowed fishers to carry more gear and travel further, substantially increasing the catch, which escalated from less than 1 million crabs in 1888 to almost 3 million in 1892.[27] In 1897, the state placed a ban on catching female crabs to protect spawners, a regulation that continues today. In 1903, closed seasons began to protect the supply, and minimum size limits were instituted two years later. As many as 230 boats cruised the coastal waters off San Francisco in the 1950s, hauling a peak catch of 8.9 million pounds in 1956-57. After that year, the central California fishery collapsed, with catches falling more than 95 percent.

The crash came as a result of a number of factors, including overfishing, loss of spawning grounds due to wetland destruction, an influx of warmer waters, and pollution in San Francisco Bay. The nadir of crab landings came in the 1970s, but populations have grown slowly since then as a result of tighter regulations. Only male crabs with carapaces longer than 6.25 inches may now be taken.[28] In the 1990s, fishers caught an annual catch between 2 and 3 million pounds, a major recovery from 30 years earlier but still only a third of the peak catch of the 1950s.[29]

Rockfish: The name rockfish refers to a group of similar species across three different genera, known as scorpionfishes, thornyheads, and the Sebastes complex. This last category (from the Greek word for "magnificent") includes common species such as Pacific ocean perch, and bocaccio rockfish, which are often sold as "Pacific red snapper." More than 60 species of rockfish occur in the California current. These species are characterized by long life spans, with one rougheye rockfish estimated to have lived to be 147 years old. The rockfish fishery began in the 1860s in Monterey Bay, with shipments of fish directed toward the markets in San Francisco. Fishers using long-line gear brought in an average of about five million pounds of rockfish a year throughout the early 1900s. World War II substantially expanded the supply and the potential market for rockfish. The fishery really took off when foreign vessels appeared in 1963, and within three years, 115 of them trawled the Pacific coast for groundfish, putting noticeable pressure on rockfish populations. In 1968, biologist E.H. Ahlstrom ranked rockfish as "much underutilized" and encouraged fishers to pursue them.[30] When the 1976 Fisheries Conservation and Management Act (Magnuson Act) banned foreign vessels from U.S. waters, the American fleet jumped into the fishery, using public subsidies to increase their technology and catching ability.

As early as 1980, managers began realizing that some rockfish species could not survive the rapidly expanding fishing pressure. In 1982, a fisheries management plan took effect, grouping together the Sebastes complex and setting harvest guidelines designed to keep rockfish populations at 40% of their unexploited populations, although that was reduced to 35% in 1991. By the mid-1990s, scientists began realizing that the low productivity of rockfish made standard exploitation rates unworkable. "With a suddenness that stunned the Pacific council and fishermen alike," Michael Weber wrote, "scientists concluded that several of the species they were able to assess actually were severely overfished."[31] A 1995 study showed that 12 of the 16 major rockfish species had declined in size since the 1960s, a red flag for overfishing.[32] Bocaccio populations now hover around 10% of their historic levels and the species is listed on World Conservation Union's "Red List" of critically endangered species.

Many species of rockfish have now disappeared from around the Golden Gate and Bodega Bay.[33] A study in central California by biologist Mary Yoklavich found that "with the exception of small, isolated rock outcrops that likely serve as natural refuges for these fishes in deep water, we too have found very few large aggregations of these important fishes."[34] Cordell Bank, one of the most productive fishing grounds in central California, has also seen the depletion of rockfish. One marine explorer noted: "By the end of 1984, so many adult rockfish were being taken from Cordell Bank that the old-time fishermen predicted significant reduction of the fish stocks within one or two years. True to the prediction, during [my] expeditions in 1986, far fewer rockfish were seen."[35]

The Sanctuaries today: THE WATERS

According to California's latest assessment of its coastal waters, 98% of the state's estuaries and bays cannot fully support aquatic life, more than 90% carry warnings about eating fish and shellfish, and 86% cannot support recreational uses like swimming and surfing.[36] *The primary contaminants at fault are bacteria and viruses, metals, pesticides, sediments and nutrients. Invasive species are another type of pollution, in the form of non-native wildlife that settles in California and disrupts the native ecosystem. Until the sanctuaries can address their pollution problems, the wildlife and the public will continue to suffer.*

Coastal pollution can come from direct discharges ("point sources") and runoff from land-based activities ("nonpoint source pollution"). Point sources of pollution include municipal treatment plants, power plants, desalination plants, vessel discharges (including from cruise ships), and stormwater outfall pipes. The MBNMS, which stretches along 300 miles of coastline from Marin County in the north to San Luis Obispo County in the south, is particularly vulnerable to both types of pollution. The GFNMS touches fewer miles of coastline than MBNMS but suffers contamination from waters exiting San Francisco Bay and running off Marin County. The CBNMS does not adjoin land but is still susceptible to plumes of contaminated runoff, which can float on top of the heavier seawater and extend 25 or more miles offshore. Oil spills and other pollution from ships pose threats to all three sanctuaries.

Water Treatment and Power Plants

The City of San Francisco has a combined stormwater and sewage system. This aging system can overload during heavy storm events and discharge raw sewage to the Pacific Ocean. Even sewage treatment plants that are not combined systems can release low levels of heavy metals, pesticides and nutrients, as well as high volumes of fresh water. Freshwater discharges dilute the salinity of the receiving environment, impacting and changing coastal habitats. In addition, aging sewage infrastructure regularly leaks and spills sewage into coastal waters, impacting wildlife and causing beach closures. A recent sewage spill into the Salinas River completely depleted the oxygen in one section of the river, killing hundreds of fish, including steelhead trout, an endangered species.

Power plants are another source of pollution. Power plants raise the temperature of sensitive coastal habitats, change water flow, and discharge high levels of suspended solids, which decrease light penetration of the water column and affect adjacent kelp bed production. At 2,500 megawatts, Duke's Moss Landing power plant is authorized to draw 1.2 billion gallons a day from tiny Moss Landing Harbor. The plant draws in 39% of adjacent Elkhorn Slough's volume each day, including larval stages of many fishes and invertebrates that use the slough as a nursery. This affects the overall health of the sanctuary, since loss of fish larvae and plankton results in loss of food for larger creatures in the slough, and a reduced number of fishes that are able to survive into adulthood. The plant's discharge water, which is released only 600 feet offshore, is 28 degrees hotter than the existing water temperature in the discharge area. Just south of the MBNMS, the Morro Bay Power Plant and Diablo Canyon Nuclear Generating Station in San Luis Obispo also circulate vast volumes of cooling water, pulling in creatures in the seawater and increasing temperature in the area of discharge.

Boats & Ships

The cruise ship industry is undergoing unprecedented expansion in California, with a 67% increase in cruise ship traffic between 1990 and 1998, and more than 50 new cruise ships scheduled to come into service over the next four years. Cruise ships can generate up to 37,000 gallons of oily bilge water; 30,000 gallons of sewage; 255,000 gallons of non-sewage wastewater; 15 gallons of toxic chemicals, tens of thousands of gallons of ballast water, and seven tons of garbage per day. At present, no federal regulatory agency is required to monitor the waste or receiving waters to see whether on-board treatment devices meet water quality regulations. Sewage from cruise ships is not regulated to the same standards as on-land sewage treatment facilities. Gray water, which comes from galleys, laundries, baths and showers, can be disposed of anywhere in the ocean. Gray water from cruise ships contains pollutants such as fecal coliforms, food wastes, oil and grease, detergents, shampoos, cleaners,

pesticides, heavy metals, and sometimes medical and dental wastes. Shipboard incinerators burn large volumes of garbage, plastics, and medical waste, producing dioxin, furans, and other toxics.

Oil spills can come from modern-day spills as well as vessels that sank long ago, which decay and release their fuel. The California State Lands Commission is working to map these sunken vessels; their impacts on the sanctuaries will be more evident when that work is completed. Even some chemical compounds commonly thought to be non-toxic can have an adverse effect on wildlife when spilled into an aquatic environment, such as in 1997 when the release of 2,300 gallons of vegetable oil into Monterey Bay killed hundreds of birds.

Marinas represent another source of polluted runoff into the sanctuaries, releasing oily bilge water, detergents from the washing of decks and hulls, paint flakes containing toxic metals, dish detergent and sewage material from boats where people live. Marinas and harbors can also add a significant sediment plume to local waters during dredging activities for channel and basin depth maintenance, as well as associated pollutant and sediment loads from the dumping of these dredged materials into coastal waters. Smaller vehicles, such as jet skis, also can cause significant pollution. A two-hour ride on a jet ski can discharge up to three gallons of unburned gasoline and oil, or the same amount of pollution as driving 139,000 miles in a 1998 passenger car. Jet skis have been prohibited in the GFNMS and regulated in the MBNMS but loopholes in existing regulations allow the use of jet skis even in sensitive areas.

Runoff from Land

Nonpoint sources of pollution along California's Central Coast are dominated by agricultural runoff. Adjacent to the Gulf of the Farallones Sanctuary, 80% of the Tomales Bay watershed is used for agriculture, primarily for grazing dairy and beef cattle. Tomales Bay also receives pathogens from upstream dairies and septic system releases. Walker Creek, which drains to Tomales Bay, adds metals from old mining operations to the agricultural pollutants. A key indication of water-quality problems in Tomales Bay has been the increase in closures on harvesting oysters, caused by high bacteria concentrations in heavy run-off from rainstorms. The mighty Russian River, which drains to the Pacific Ocean just north of the Sanctuary's upper boundary, carries pollutants from agricultural and forest lands upstream, including DDT residues. Nutrient runoff, such as from application of fertilizers, can create toxic algal blooms, or "red tides," in marine waters. One 1998 toxic algal bloom in the MBNMS produced domoic acid, which affects the nervous system in animals and humans. This particular algal bloom resulted in the death of more than 50 California sea lions along California's Central Coast.

Other Sources of Pollution

Over 24 years, the government and private research agencies dumped almost 48,000 fifty-five-gallon drums of radioactive waste just a few miles west of the Golden Gate Bridge inside the GFNMS. While there is little information on the potential extent of the damage, it appears that cleanup will not be practical. Currently, sediment dredged from harbors and ports is dumped just outside the GFNMS. The barge route from San Francisco Bay that carries the material to the deep-ocean disposal site crosses both the MBNMS and GFNMS, and there has been at least one significant spill of dredged material into the MBNMS. The areas adjacent to the dump site and the barge route contain a wide diversity of sensitive habitats as well as endangered and threatened species. In 1995, the first year of operation of the deep-ocean site, a total of 61 scows were towed to the site; while in 1997, a total of 1,173 scows took more than 3 million cubic yards of dredged material to the site, far higher than the "conservative" estimate of 730 annual scows in the site's original environmental impact documents.

Just as loud noises in the air disturb us, underwater noise also disturbs wildlife. Sounds can travel for miles underwater, whether they are the sounds of explosions from oil exploration or the noises whales use to communicate with one another. Underwater noise pollution comes from many sources including the low-frequency noises of ships in transit, the seismic blasts of oil and gas exploration, and marine construction. Marine mammals rely on sound to hunt for food, detect predators, find mates, and keep herds together in the darkness of the sea. Any loud noise has the potential to drown out sounds important to the mammals that are around the same frequency – such as sounds from calves, mates, or predators. A growing body of evidence suggests that intense man-made noises, such as those created by low-frequency active sonar systems, can induce permanent and temporary hearing loss, cause marine mammals to beach themselves, and completely disrupt an animal's behavior. In 1994, researchers associated with the Acoustic Thermometry of Ocean Climate

project requested a permit to place a sound generator in the MBNMS. Due to public outcry, the project was relocated, but only to a spot just outside sanctuary waters, approximately 50 miles west of Half Moon Bay. In late 2002, a federal court temporarily blocked the Navy's effort to deploy a Low Frequency Active Sonar array capable of producing sounds reaching 140 decibels at 300 miles away. As the National Research Council[37] has observed, ocean noise has the potential to affect a wide range of species, including fish, making noise pollution a key issue for the sanctuaries to manage.

Invasive Species

Invasive species are species not native to the California coast that cause economic or environmental harm or harm to human health. Once established, invasive species are extremely difficult if not impossible to eradicate, and the problem is growing. Estuaries are particularly vulnerable to invasion; and large ports, such as San Francisco Bay, can house hundreds of invasive species with significant impacts to native ecosystems. These species often then migrate to other coastal areas. For example, researchers were "astonished" in a recent study to document more than 50 exotic invertebrates in Elkhorn Slough after only 50 person-hours of search effort in the field; many of these species had originally been dumped into San Francisco Bay.

Invasive species may prey upon native species or outcompete them for food. The European green crab, now found in Elkhorn Slough, Tomales Bay, Bodega Bay and Bolinas Lagoon, Estero de San Antonio, and Estero de Americano, both preys on oysters and Dungeness crab and competes with them for resources. Marine biologists in Bodega Bay documented a 90% reduction in local populations of native clams and small shore crabs due to the European green crab in less than 10 years. Invasive species can also dilute native species through cross-breeding and alter community composition or food webs. Finally, they may cause changes in physical habitat structure. For example, burrows caused by the isopod Sphaeroma quoyanum, originally from New Zealand and Australia, are found in banks throughout the Elkhorn Slough, and may exacerbate the high rate of tidal erosion in the Slough.

Ballast water discharged from vessels is currently the number one source of coastal species invasions nationwide, but invaders can also come from other sources. The Japanese mud snail was introduced to the West Coast when Asian oysters were brought over for aquaculture and is now the most abundant animal species in Elkhorn Slough. Invasive cordgrass species were planted in San Francisco Bay as part of marsh restoration projects, and have spread through Tomales Bay, Bolinas Lagoon, and Drakes Estero. Imported live bait, the aquarium trade, and the hulls of boats and ships all offer opportunities for invaders to reach the California coast.

BENEATH THE OCEAN FLOOR: OIL AND GAS DRILLING

Although the sanctuaries currently ban oil and gas drilling, oil and gas activities still pose a threat to sanctuary resources. Development technology has improved significantly since the sanctuaries were created, meaning that areas once thought too expensive or difficult to reach are now affordable and accessible. Tracts of great interest to the oil and gas industry lie just outside sanctuary boundaries: north of the GFNMS along the Sonoma Coast, west of the line where the MBNMS and GFNMS meet, and just below the southern boundary of the MBNMS. As is commonly the case with terrestrial protections such as national parks, the highest development risk often accrues to areas immediately external to the already protected area, due to the transfer of development pressure. Thirty-six active, but undeveloped, offshore oil leases near Pt. Conception remain caught in a legal battle between the current Administration and the State of California. The Department of Interior and the lessees have not given up pursuing eventual oil and gas development on these tracts, where prevailing seasonal ocean currents would carry any significant oil spill northward into the MBNMS and the range of the California sea otter.

In the marine environment, powerful ocean currents drive spill trajectories that create a highly dynamic potential for long-range and enduring pollution events. Experience has shown that accidental oil spills could be readily transported from adjacent unprotected waters into the sanctuaries themselves. In 1984, an oil tanker was inadvertently towed into the GFNMS to a site that was marked on old, pre-sanctuary maps as an ocean dumpsite. The ship then broke in half, spilling a large volume of refined oil into sanctuary waters. A NOAA computer model predicted the oil would float southward, but instead the spill moved northward for several days, impacting the biological

resources of the Marin and Sonoma coastlines. Traces of the spill eventually drifted as far northward as Little River in Mendocino County.

A single spill off the coast of California on the scale of the 1989 Exxon Valdez incident in Alaska's Prince William Sound could inundate at least half of the California coastline with oil. If such a spill originated from an offshore oil rig blowout, the flow could continue for many months before being curtailed. As the long-term biological impacts of the Exxon Valdez oil spill have been studied, data have emerged indicating that contaminants originating from this spill are causing mutations to the eggs of pink salmon at levels of parts per billion. In the Galapagos Islands, 62% of marine iguanas died after eating algae contaminated with oil from a tanker spill a year earlier. Outside of spills, offshore oil development itself can pose hazards. A study sponsored by the Mobile Register newspaper recently found high levels of mercury in fish caught around the offshore drilling rigs in the Gulf of Mexico. The federal government has since created a scientific panel to study the problem of mercury in drilling waste dumped around offshore rigs, and California may follow with a study of its own.

New Energy Sources

The energy industry is moving rapidly toward the commercialization of an entirely new type of energy resource called methane hydrates. Embedded in geologic formations under the deep seafloor, and in shallower pockets under arctic permafrost, are vast deposits of natural gas locked in ice. Commercial production of marine methane hydrates is expected to involve seafloor stripmining techniques, or the pumping of antifreeze solution, methanol, or steam through horizontal boreholes under the seafloor to extract natural gas. Like slant drilling for oil, which avoids the drilling ban in sanctuaries by locating equipment just outside the boundaries, methane hydrates also have the potential to be taken without oversight by the sanctuary.

Another source of contamination comes from Liquefied Natural Gas (LNG), or methane gas that has been converted into a liquid for transport in seagoing tankers. LNG is highly unstable—when spilled it rapidly warms into a vapor that can travel over the surface of water or land for several miles. If the vapor comes into contact with any source of ignition, such as a backfiring car or a cigarette, it can ignite into a giant fire. LNG fires burn incredibly hot, and are very difficult, if not impossible, to extinguish. Thermal radiation from an LNG fire can burn people and property many thousands of feet away. There are currently no LNG terminals along the West Coast of the U.S., but new plans for coastal terminals are being proposed. Near Oxnard, California, local residents recently managed to get property planned for an Occidental Petroleum LNG terminal placed under protective status, denying access to Occidental. Near Rosarita Beach, in Baja California, five large coastal properties have been optioned for three major LNG terminals and gasification facilities, with the natural gas destined for U.S. Sun Belt cities and southern California. Vallejo residents recently opposed a proposal for an LNG terminal at Mare Island in north San Francisco Bay. A number of petroleum companies are also looking into floating single-point moorings and offshore LNG terminals at various locations, including near Eureka and within the Monterey Bay National Marine Sanctuary near Moss Landing. Natural gas pipelines are also being planned for the ocean floor along the U.S. East Coast, from the Scotia Shelf off of Eastern Canada south to New Jersey, and from the Bahamas to Eastern Florida. Similar natural gas pipelines may eventually be proposed off California.

FISHERIES AND WILDLIFE

Many of California's fisheries are in trouble. Declining species include Pacific rockfish, abalone and lingcod. In contrast, other fisheries, such as sardines, herring roe and Dungeness crab, appear sustainable today, in part because fishery managers have tried to avoid the mistakes of the past. Currently, the management plans for these national marine sanctuaries do not regulate or restrict fishing in any way. However, sanctuaries can play an important role in managing fisheries, because fish are part of the mandate of resource protection.

The sanctuaries are expected to look at their resources as an interlocking system, where water quality, fish populations, and underwater habitats all work together. Fishery managers have traditionally looked at each individual species rather than the whole picture. Managers in the past erred on the side of higher catches—a risky gamble in the uncertain ocean. California's ocean environment is subject to a wide variety of sea surface temperatures, tradewinds, ocean circulation patterns, and weather systems. Add relentless fishing pressure to this, along with other environmental factors such as pollution, and you have a recipe for disaster. To help improve both our fisheries and our sanctuaries, the sanctuaries need to take a more active role in protecting the web of life that holds them together.

The Importance of Managing for Humans and for Fish

By the 1960s, Pacific sardines were commercially extinct in California. It would be more than forty years before the fishery recovered enough to reopen. Management moved cautiously in 1986, and today the sardine population is considered recovered. Key to the sardine's current success is a strategy for setting catch levels that takes into account not only the estimated abundance of sardines but also the importance of this species as food for other fish, marine mammals, and birds. This reflects a major shift in fisheries management by recognizing that humans are not the only species that eat sardines--in fact, many marine animals depend on them.

Unfortunately, the same ecological foresight has not yet been taken with another important food fish, the market squid. Market squid, often sold as calamari, collect in the California current in massive numbers, feeding on krill and being fed on by fishes and marine mammals, including some threatened and endangered species. Little is known about the true population size of squid, so there is no way to determine whether or not market squid are being overfished, what levels of harvest will be sustainable in the long-term, and or how to leave enough squid in the water for the birds, mammals and fishes that rely on them. Sanctuaries can help manage squid for the future by creating zones that prohibit some or all fishing, so that a portion of the squid resource remains in the water where seabirds and mammals can feed.

Marine Protected Areas for California

Currently, California is undergoing a process through the Marine Life Protection Act (MLPA) to site areas along the coast to protect marine wildlife. These marine protected areas, or MPAs, will have a variety of levels of protection, some allowing limited fishing and some prohibiting fishing altogether. The sanctuaries contain resources that could also benefit from this extra protection, and with their jurisdiction in federal waters they can complement efforts by the state.

One species that could benefit from MPAs is abalone. By prohibiting the use of SCUBA, the recreational regulations for abalone created a de facto refuge on the north coast. Abalone too deep to be reached by free-divers survive, helping to replenish populations closer to shore.

The commercial black market for abalone is strong, with animals commanding $60 to $80 per pound. Poachers often use scuba gear at night, illuminating their way with light sticks to find their prey.[38] The California Department of Fish and Game estimates that as many as 250,000 red abalone are taken illegally each year, a third of the total catch. Most of those abalone go to seafood restaurants, which pay a premium price for abalone steaks. Only a few enforcement agents survey the entire California coast, so poaching is difficult to prosecute. The state is developing a plan for managing abalone that relies on the use of "no fishing zones" to estimate abalone population sizes. If abalone continue to recover, there will be strong pressure to reopen a commercial fishery. Placing some reserves in the sanctuary now will not only help evaluate abalone in the future, but also allow the sanctuary to offer its enforcement and monitoring resources to the state.

Rockfish are also likely to benefit from MPAs Rockfish tend to mature late, have slow growth rates, and produce fewer offspring relative to other marine fish species. These characteristics make them uniquely vulnerable to overfishing, since they cannot easily recover from a sudden loss in population. Juvenile rockfish rely on small crustaceans for most of their diet, and mature rockfish pursue other fish, including other species of rockfish. Rockfish are themselves prey for a wide variety of species, including the common murre.

Catch restrictions alone have been generally unsuccessful for protecting rockfish, whose populations plummeted during the 1990s. The implementation of a limited-entry system in 1994 did little to reduce fishing pressure. Management of rockfish is complicated by the fact that different species often swim together, making it difficult to avoid overfished species when targeting species whose populations were still healthy. The slow growth of rockfish only adds to the problem. Bocaccio rockfish were once the dominant species caught by trawl fishermen on the Pacific coast. At the height of the fishery, over 7,000 metric tons were landed a year. By 1998, the catch had dropped to 285 metric tons and in 2002, bocaccio was a candidate for the endangered species list. That same year, federal fisheries managers closed much of the Pacific shelf to bottom fishing to help rockfish populations recover. This blanket closure will be reviewed yearly and may be repealed. The sanctuaries have the opportunity to examine their waters to see if strategic MPAs could benefit rockfish populations and protect them permanently.

Fishing and Habitat

Fishing in the national marine sanctuaries off the California coast does not merely affect the species targeted by fisheries; the gear that fishers use can also damage the benthic communities and habitats they encounter. Trawling represents the largest threat to the seabed off the California coast. Trawling refers to dragging a net behind a moving boat, trapping any fishes, sharks, invertebrates, or marine mammals that happen to be in the way. Bottom trawling scrapes across the ocean floor, flushing fish from their hiding places and into waiting nets. Trawling has been a source of controversy since as early as the 14th century, with complaints that it destroys fish habitat and reduces the number of fish for future catches. This equipment can produce significant damage to the ocean floor, destroying underwater structures that provide habitat for a range of species. Trawling has been conducted on the continental shelves for centuries, but the invention of the otter board at the turn of the 20th century expanded its efficiency and therefore its use. In the 1920s, the introduction of diesel engines expanded the range of trawling and increased the size and catching power of fishing vessels and nets. The introduction of rockhopper gear in the 1980s allowed fishers to work in rocky bottoms that were previously inaccessible, eliminating one last refuge for fish.[39] This type of bottom trawling can have a severe effect on productivity of species such as protected rockfish.

Otter trawls have been the dominant form of trawling in the Pacific groundfish fishery since the 1940s. Their use increased after the passage of the 1976 Magnuson Act, since federal subsidies allowed fishers to upgrade their equipment. In 1998, two marine biologists published a scientific study on trawling in the MBNMS. They wanted to compare a heavily trawled area in the sanctuary with one that had not undergone trawling in order to compare the communities that lived there and the disturbance that fishing created. Unfortunately, they could not find any undisturbed areas within the sanctuary. “Because essentially all areas that are suitable for trawl fishing are already fished,” they wrote, “it is virtually impossible to locate adequate treatment and control sites for comparison. As a result, we were forced to take the next best alternative — paired sites representing an uncontrolled gradient of trawling pressure.”[40] Their study showed that areas of high-intensity trawling had lower biodiversity and habitat complexity. In addition, these areas were dominated by opportunistic species that took advantage of the disturbance, as well as those species that were traditionally preyed upon by the commercial species that had been removed by fishers.

Although some species can quickly recover after trawling, many others cannot, and the new assemblage of species remaining after trawling is likely very different from the one that lived there before. Trawling can significantly reduce the number of rocks and mounds that fish use for habitat and protection.[41] According to a site characterization study of the Monterey Bay sanctuary, “trawling occurs year-round and across a large geographic area in MBNMS…[and] has been shown to cause severe disruptions in benthic communities.”[42]

Trawling may not be the only fishing practice that destroys habitat. Fishing activities on Cordell Bank have been a focus of controversy for years. Are fishing activities harming the fragile pinnacles that sprout from the ocean floor, occasionally knocking them off their perches and destroying valuable habitat? The Bank would not be nearly as productive without the pinnacles — “the crown jewels of this sanctuary,” according to one report — since they stretch from the shadowy bottoms toward the surface, where sunlight can provide energy for complex ecosystems. Colonies of hydrocorals, sponges, and anemones crowd onto the top of the pinnacles. In 1978, divers saw little evidence of fishing beyond a piece of a net that had been lost. In the 1980s, more damage appeared, including fragile corals broken off by fishing gear, anchors abandoned at the bottom, and remnants of fishing gear lost from boats at the surface.

This damage may be caused by commercial and recreational fishermen dropping lines with lead weights on the seafloor. Those weights can crash into the ocean floor repeatedly, as fishers lift them up and down to find fish and sound the bottom. This fishing practice can destroy delicate hydrocorals, which recover extremely slowly, and disrupt the communities they support. Since the Bank does not have regular dive monitoring, it is difficult to determine the scale of damage.

Emerging threats in California's Central Coast National Marine Sanctuaries

When the Central Coast sanctuaries were designated, oil development and ocean dumping were considered the most significant threats to the marine environment. Over time, less obvious threats to sanctuary resources, such as increased fishing pressure and non-point source pollution, have become evident. Every year, new activities emerge that must be evaluated to see if they have the potential to damage sanctuary resources. There are clear benefits to identifying emerging threats in order to address them early in their evolution. Regulation becomes more difficult as more and more investments are made in new technologies and activities with the potential to harm marine ecosystems. This chapter addresses some of the new or expanding activities that are likely to threaten sanctuary resources in coming years.

Offshore Aquaculture

Currently, aquaculture operations in the GFNMS and MBNMS are limited to coastal shellfish culturing, such as the oyster farms in Tomales Bay and Drakes Estero of the GFNMS and abalone farming in the MBNMS. However, in 1999, the Department of Commerce released an Aquaculture Policy with the stated objective of increasing aquaculture in U.S. waters by 500% over the next 25 years. To achieve this goal, aquaculture operations would have to move offshore into larger scale and deeper water facilities. Currently, nearly all offshore activities are controlled solely by the Army Corps of Engineers, which reviews projects not on their environmental impacts but to see if they will pose a hazard to navigation.

Development of offshore aquaculture in sanctuary waters raises a number of environmental concerns. Aquaculture operations can introduce exotic species as well as parasites and disease. Cultivated animals can also escape from aquaculture cages anchored in the ocean and compete with closely related indigenous species for resources, habitats, and mates. If interbreeding occurs, the genetic integrity of wild populations can be compromised – especially if the trend toward genetically modifying fish to increase their productivity continues. Escapement can both disrupt natural ecosystems and jeopardize the recovery of endangered species.

Construction of aquaculture facilities may require dredging, drilling and other bottom habitat disturbances that can displace ocean wildlife. The most desirable aquaculture products are high trophic-level species (such as shrimp, salmon, and tuna) that require large amounts of protein, meaning more wild fish must be caught to feed the farmed fish. Aquaculture species are grown at high densities to improve profitability, resulting in concentrated amounts of waste that can lower oxygen levels around the cages, causing localized "dead zones." Water flowing through an offshore pen can carry antibiotics, diseases, and polluting chemicals.

Fiber Optic Cables

In California alone, eight new submarine cables have been approved since April 2000. To date, two commercial fiber optic cable projects have been proposed within the Monterey Bay National Marine Sanctuary, although neither application is currently being pursued. However, according to industry analysts, demand for fiber optic capacity is expected to pick up again in coming years.

Installation of a submarine fiber optic cable requires a miles-long underwater construction project that typically creates a twenty-foot wide zone of disturbance extending 60-70 miles offshore. The process of trench digging and cable burying disrupts the seabed, crushing bottom-dwelling creatures immediately adjacent to the trench and disturbing sediment that smothers marine life in the surrounding area. In areas of rocky bottom habitat, submarine canyons, and in deep water, the cable is laid directly on the seafloor. These exposed cables pose risks to marine mammals. There are documented cases of sperm whales becoming fatally entangled in submarine cables, though no documented entanglements have occurred in recent years. Finally, recent experience in the U.S. Virgin Islands, Florida, Massachusetts, and California demonstrate that cable installations often experience construction problems such as drill fluid leaks and difficulties in achieving burial targets.

Carefully sited and installed correctly, cables installed for scientific research purposes may be consistent with the sanctuaries' mandate and eligible for a special use permit from the National Marine Sanctuary Program. However, large-scale commercial fiber optic cable projects conflict with the sanctuaries' mandate prohibiting commercial development of the seabed within sanctuary boundaries.

Krill Harvesting & Bioprospecting

Krill play a central role in sanctuary ecosystems as the primary prey of most of the fishes, birds and marine mammals that inhabit the sanctuaries. Krill is already commercially fished in fisheries off Japan, Canada, and the Southern Ocean of Antarctica. While there are currently no commercial krill fisheries in the U.S. Exclusive Economic Zone and krill harvest is banned under state law in California waters through the next decade, interest in expanding krill fishing is growing, particularly as feed for large-scale commercial aquaculture. Expansion of the commercial krill fishery has the potential to seriously disrupt the food webs upon which sanctuary species and entire ecosystems depend.

Improved technologies for screening natural products for potential therapeutic uses, coupled with advances in understanding that can help identify useful species, may increase interest in marine bioprospecting. Because sanctuaries include a diverse array of habitats and large numbers of species, and because the sanctuaries host and facilitate scientific research, sanctuaries may become especially attractive to bioprospectors. Because some compounds are present in only small quantities, and because some species are difficult to culture in the laboratory, collections for natural product extraction and purification can sometimes be quite large.

Ocean Energy

The ocean stores vast amounts of energy in tides, waves, and offshore wind. These energy sources have certain advantages over terrestrial renewable energy sources. Offshore winds, tides, and waves tend to be more predictable, more available, and steadier than winds over land, or solar power. Proposals for pilot studies of ocean energy sources, including one in a national marine sanctuary (Olympic Coast) are now being reviewed. Ocean energy projects could result in several kinds of environmental impacts, particularly when scaled-up. These include, among others: the attraction of marine life to artificial structures, rendering them more vulnerable to harvest; changes in circulation affecting migration and the congruence of mixing zones with physical habitats; impacts from the use of anti-fouling chemicals; and impacts to navigation and fishing. Ocean energy projects should be viewed in the context of the larger picture of national energy policy. Renewable ocean energy may become a desirable alternative to offshore oil drilling and increased reliance on fossil fuels. However, sanctuaries are not, in general, suitable areas for large-scale economic activities and should certainly not be where such technologies are tested.

RECOMMENDATIONS

The mandate of the sanctuaries is to protect biodiversity while allowing only uses consistent with the conservation of natural resources. Actions whose impacts are wide-scale and poorly understood should be kept out of sanctuaries, or only allowed in a very limited and controlled manner. This is often called the "precautionary principle" of management because it is a way to take precautions before damage is done. Large-scale commercial enterprises to extract energy, mineral, and biological resources that harm the marine ecosystems of the sanctuaries are clearly incompatible with the mandate. For smaller scale, potentially sustainable activities, the sanctuary should develop programs that allow these activities to be pursued on a trial basis as long as they meet certain standards that protect the resources. The sanctuaries must use all of the tools available to them so they can influence decisions that affect the wildlife and habitats inside their boundaries. The following recommendations should be a part of any sanctuary management plan.

1. **Limit or eliminate discharges from all sources of pollution into the sanctuaries, including point source pollution, polluted runoff, the release of invasive species, and ocean dumping.** Existing law gives the sanctuaries the authority to get involved with the regulation of pollution, as Section 306 of the NMSA states that it is unlawful to "destroy, cause the loss of, or injure any sanctuary resource managed under law or regulations for that sanctuary." Federal regulations require permits for most discharges into the sanctuaries, and allow the sanctuary offices to comment on permits issued by other agencies (such as the Environmental Protection Agency (EPA) or the California Water Resources Control Board).[43] For example, the City of Santa Rosa is considering a wastewater disposal plan that would place an outfall pipe directly above the fragile estuaries within the GFNMS. The sanctuaries should use their right to comment on permits or waivers governing polluted runoff to actively oppose or place conditions on discharges that could impact the sanctuaries. As the coastal population continues to grow, demand for desalination, power, and water treatment plants will continue to grow and it is imperative that the sanctuaries have a say in how these discharges affect sanctuary resources.
2. **Ban all discharges from large passenger vessels in sanctuary waters.** This is the recommendation recently made by the Central Coast Regional Water Quality

Control Board for state waters (to the three mile limit), and the waters of the Monterey Bay and Channel Islands National Marine Sanctuaries. In making this recommendation, the Board stated that "neither industry standards, nor the existing laws are sufficiently conservative to protect our valuable coastal waters." For this reason, the ban should also be applied to the GFNMS and CBNMS. The ban should apply to all cruise ship discharges, including but not limited to: black water; gray water; treated sanitary wastewater; bilge water; ballast water; oily waste; and chemical, medical, hazardous and solid wastes. A ban on ballast water discharge would eliminate this common pathway for invasive species.

3. **Take additional steps to prevent and manage the introduction of aquatic invasive species, with a goal of zero discharge into the sanctuaries**. The sanctuaries should support efforts to identify the number and extent of invasive species present within their coastal estuaries, bays and open coastal areas. Researchers with the Elkhorn Slough National Estuarine Research Reserve have already developed a baseline study of non-native invertebrate species within Elkhorn Slough. The sanctuaries should also develop an early detection program for aquatic invasive species. This can be modeled on the Elkhorn Slough program for selected species that: (1) are not yet present in the Monterey Bay area; (2) have a high potential to be transported there (especially from nearby sources such as San Francisco Bay); (3) are relatively large and easy to identify; and (4) are likely to have a significant ecological impact if they invade. The sanctuaries should also work with appropriate partner agencies, such as Elkhorn Slough and the California Department of Fish and Game, to develop an appropriate response plan to deal with particularly problematic invasive species found within the sanctuary. The sanctuaries should consider a ban on ballast water dumping within sanctuary waters. Finally, the sanctuaries should take steps to prevent the introduction of invasive species through other sources, such as species that stow away on the hulls of commercial and recreational boats.

4. **Create water quality monitoring and outreach programs at CBNMS and GFNMS similar to the one at MBNMS.** A 1992 Memorandum of Agreement signed by eight federal, state and local agencies as part of MBNMS designation created the Sanctuary's Water Quality Protection Program, which has focused on identifying (through monitoring) and beginning to address pollution discharges into the sanctuary, including urban and agricultural runoff and runoff from marinas and boating. A similar effort should be undertaken for the GFNMS and, as appropriate, the CBNMS.

5. **Sanctuary boundaries should be expanded to include key adjacent resources.** Each of the three Sanctuaries serves a different community and includes uniquely special natural wildlife. It is important to maintain local management for each Sanctuary that can be responsive to the needs of both residents and local ocean conditions. Sanctuary boundary changes should be made to add new resources to the Sanctuary, or to give underwater features additional protection. For example, areas close to the GFNMS and the CBNMS remain targets of oil and gas developers. A precautionary expansion would create a new northernmost boundary inclusive of the entire Sonoma Coast. The new boundary should encompass all of the unprotected portions of the underwater feature called the Bodega Basin. The GFNMS and MBNMS should be expanded to include several unprotected oil and gas tracts extending westward beyond sanctuary protection, on the shelf break at the edge of the outer continental shelf. Finally, a feature called the Santa Maria Basin lies south of the MBNMS along the coast of San Luis Obispo County. The Santa Maria geologic basin is considered by the oil industry to be the most promising offshore drilling target remaining undeveloped on the California coastline. For this reason, the MBNMS should be expanded to the south.

6. **Establish fully protected marine reserves within sanctuaries**. The three sanctuaries should offer places of refuge for all wildlife. Some areas within the sanctuaries should have limited or no human disturbance, allowing for natural predator-prey interactions.

7. **Prohibit fishing practices that damage bottom habitat in sanctuary waters, especially in sensitive rocky reef areas.** Currently, alteration of the seabed is forbidden in each of the three sanctuaries, but broad exemptions are given to the fishing industry. This creates the paradox that scientific researchers need permits to place monitors on the seabed to study marine conservation, but fishermen can use destructive fishing gear with no oversight by the sanctuaries. At a minimum, there should not be blanket exceptions to the ban on seabed alterations. Damage to the seabed should be prohibited by banning bottom trawling and other harmful fishing practices unless the damage to bottom habitat is proven to be negligible.

8. **Establish regular, cooperative data-gathering programs that involve the sanctuaries, the state, universities, private researchers and trained volunteers.**

9. **Prohibit outright the following activities in sanctuaries:** offshore aquaculture, krill harvesting, large-scale ocean energy development, commercial fiber optic cables, and extraction of methane and other energy sources, including extraction that is initiated from outside the sanctuary.

10. **Oversee specimen gathering for any purpose including scientific, educational, and bioprospecting.** In state waters, the sanctuary has the opportunity to work with California's Department of Fish & Game to develop a working policy and cooperate on enforcement.

11. **Examine the special use permit process.** Special use permits have the potential to allow small scale projects that would provide benefits to the sanctuary without harming its natural resources. The process needs to have opportunities for public comment and should be carefully managed so that it is not abused. There may be situations in which emerging activities would benefit the sanctuary overall, and the sanctuary should be prepared to deal responsibly with these issues as they arise.

FOR MORE INFORMATION

Joint Management Plan Review
http://www.sanctuaries.nos.noaa.gov/jointplan/

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Monterey Bay National Marine Sanctuary
299 Foam Street, Suite D
Monterey, CA 93940
(831) 647-4201

GLOSSARY

CBNMS, Cordell Bank National Marine Sanctuary

GFNMS, Gulf of the Farallones National Marine Sanctuary

ESA, Endangered Species Act

LNG, Liquified Natural Gas

MBNMS, Monterey Bay National Marine Sanctuary

MMPA, Marine Mammal Protection Act

NOAA, National Oceanic and Atmospheric Administration

NMFS, National Marine Fisheries Service

NMSA, National Marine Sanctuaries Act

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123°W
122°W
38°N
37°N
36°N
Cordell Bank NMS
Gulf of the Farallones NMS
San Francisco
California
Santa Cruz
Monterey Bay NMS
Monterey
Pacific Ocean
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0 5 10 20 30 40 Miles

e
ENVIRONMENTAL DEFENSE
finding the ways that work

NRDC

The Ocean
Conservancy