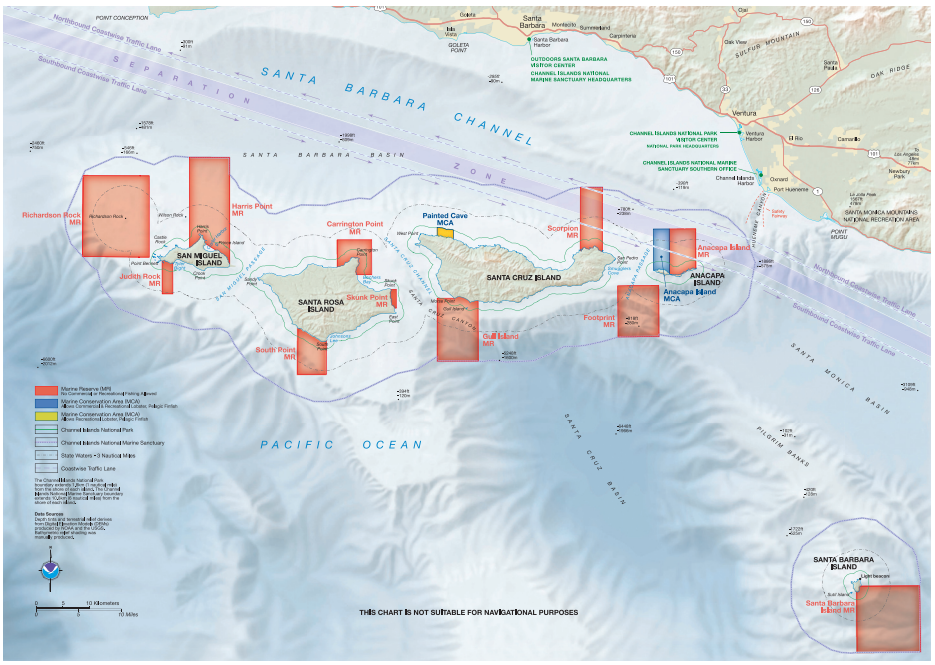
Channel Islands
National Marine Sanctuary

CONDITION REPORT 2009



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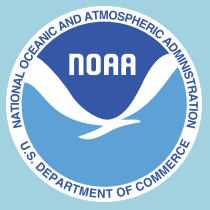
NATIONAL MARINE SANCTUARIES



Map:
Bathymetric Grids provided by NOAA's NGDC Coastal Relief Model
Divins, D.L., and D. Metzger, NGDC Coastal Relief Model, Vol. 6,
http://www.ngdc.noaa.gov/mgg/coastal/coastal.html

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- *The Chumash were the first people to inhabit the Channel Islands.*
- *The islands were first visited by Europeans in 1542.*
- *In the 1800s the islands served as a location for sea otter, seal, and sea lion hunting. Subsequently, the land was cultivated for ranching and farming purposes.*
- *The sanctuary was designated on Sept. 22, 1980, and encompasses 1,470 square statute miles (1,110 square nautical miles).*
- *In 2003, 12 marine protected areas were designated by the California Department of Fish and Game Commission.*
- *In 2007 several of the marine protected areas were extended to the federal boundary and one new area was created.*
- *Numerous shipwrecks are located in waters surrounding the islands.*
- *The sanctuary is an important area for recreational and commercial use, including diving, kayaking, fishing, boating, wildlife viewing, shipping transit, and research.*

About this Report

This "condition report" provides a summary of the status of resources in the National Oceanic and Atmospheric Administration's Channel Islands National Marine Sanctuary, pressures on those resources, current condition and trends, and management responses to the pressures that threaten the integrity of the marine environment. Specifically, the document includes information on the status and trends of water quality, habitat, living resources and maritime archaeological resources and the human activities that affect them. It presents responses to a set of questions posed to all sanctuaries (Appendix A). Resource status of the Channel Islands is rated on a scale from good to poor, and the timelines used for comparison vary from topic to topic. Trends in the status of resources are also reported, and are generally based on observed changes in status over the past five years, unless otherwise specified.

Sanctuary staff consulted with a working group of outside experts familiar with the resources and with knowledge of previous and current scientific investigations. Evaluations of status and trends are based on interpretation of quantitative and, when necessary, non-quantitative assessments, and the observations of scientists, managers and users. The ratings reflect the collective interpretation of the status of local issues of concern among sanctuary program staff and outside experts based on their knowledge and perception of local problems. The final ratings were determined by sanctuary staff. This report has been peer reviewed and complies with the White House Office of Management and Budget's peer review standards as outlined in the Final Information Quality Bulletin for Peer Review.

This is the first attempt to describe comprehensively the status, pressures and trends of resources at the Channel Islands National Marine Sanctuary. Additionally, the report helps identify gaps in current monitoring efforts, as well as causal factors that may require monitoring and potential remediation in the years to come. The data discussed will enable us to not only acknowledge prior changes in resource status, but will provide guidance for future management as we face challenges imposed by such potential threats as increasing coastal populations, shipping, and climate change.

Summary and Findings

Channel Islands National Marine Sanctuary contains spectacularly rich and diverse marine life. With a variety of habitats including kelp forests, sandy bottom, and open ocean, it is home to diverse fish and invertebrate communities, serves as part of the migratory route of whales, and as feeding and breeding grounds for seabirds and marine mammals. Located offshore of Southern California, the sanctuary is adjacent to the growing counties of Ventura and Santa Barbara, and not far from the heavily populated Los Angeles metropolitan area, bringing

Photo: Robert Schwemmer, NOAA

The Anacapa Island lighthouse was constructed in 1932 and continues to exist to this day.

to it a variety of recreational and commercial human activities, including diving, kayaking, fishing, boating, wildlife viewing, and shipping.

Despite this setting, most water quality parameters at the Channel Islands sanctuary appear to suggest relatively good conditions. For example, though numerous contaminants have been identified, they appear at levels much lower than that of mainland metropolitan areas. Habitat quality and living resource conditions have been degraded somewhat by a variety of human activities, including fishing and boating, as well as changing ocean conditions and disease. The principal threat to maritime archaeological resources in the sanctuary is looting, natural degradation, and the threat of damage from fishing gear or anchors. An additional concern with these historical sites is the fact that once damaged, there is no potential for recovery, as there is for water, habitat, and living resources.

The sanctuary contains a network of marine zones established in state waters in 2003 and extended to the federal boundary in 2007 that will help protect these valuable resources. These marine zones now include 11 no-take zones (also called marine reserves) and two marine conservation areas where some fishing is allowed. In addition, a new management plan for the Channel Islands sanctuary was released in 2009; it recommends a number of management actions that will address concerns of resource protection and management. The plan stresses an ecosystem-based approach to management that requires consideration of ecological interrelationships not only within the sanctuary, but within the larger context of the Santa Barbara Channel. Specific management recommendations include an improved water quality monitoring program, actions to reduce vessel discharges, and directed research on emerging issues.

National Marine Sanctuary System and System-Wide Monitoring

The National Marine Sanctuary System manages marine areas in both nearshore and open ocean waters that range in size from less than one to almost 140,000 square miles. Each area has its own concerns and requirements for environmental monitoring, but ecosystem structure and function in all these areas have similarities and are influenced by common factors that interact in comparable ways. Furthermore, the human influences that affect the structure and function of these sites are similar in a number of ways. For these reasons, in 2001 the program began to implement System-Wide Monitoring (SWiM). The monitoring framework (NMSP 2004) facilitates the development of effective, ecosystem-based monitoring programs that address management information needs using a design process that can be applied in a consistent way at multiple spatial scales and to multiple resource types. It identifies four primary components common among marine ecosystems: water, habitats, living resources and maritime archaeological resources.

By assuming that a common marine ecosystem framework can be applied to all places, the National Marine Sanctuary System developed a series of questions that are posed to every sanctuary and used as evaluation criteria to assess resource condition and trends. The questions, which are shown on the following page and explained in Appendix A, are derived from both a generalized ecosystem framework and from the National Marine Sanctuary System's mission. They are widely applicable across the system of areas managed by the sanctuary program and provide a tool with which the program can measure its progress toward maintaining and improving natural and archaeological resource quality throughout the system.

Similar reports summarizing resource status and trends will be prepared for each marine sanctuary approximately every five years and updated as new information allows. The information in this report is intended to help set the stage for the management plan review process. The report also helps sanctuary staff identify monitoring, characterization and research priorities to address gaps, day-to-day information needs and new threats.

Channel Islands National Marine Sanctuary Condition Summary Table

The following table summarizes the "State of Sanctuary Resources" section of this report. The first two columns list 17 questions used to rate the condition and trends for qualities of water, habitat, living resources, and maritime archaeological resources. The Rating column consists of a color, indicating resource condition, and a symbol, indicating trend (see key for definitions). The Basis for Judgment column provides a short statement or list of criteria used to justify the rating. The Description of Findings column presents the statement that best characterizes resource status, and corresponds to the assigned color rating. The Description of Findings statements are customized for all possible ratings for each question. Please see Appendix A for further clarification of the questions and the Description of Findings statements.

Status: Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

Trends:
- Conditions appear to be improving ..... ▲
- Conditions do not appear to be changing ..... –
- Conditions appear to be declining ..... ▼
- Undetermined trend. ..... ?
- Question not applicable ..... N/A

#	Questions/Resources	Rating	Basis for Judgment	Description of Findings	Sanctuary Response
WATER					
1	Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?	?	Distance from the mainland and regulations limit impacts; sampling generally indicates water quality is better at the islands than the mainland. However, there is concern about an apparent increase in the frequency and extent of diatom blooms. Also, the effects of ocean acidification, although not currently well understood, are expected to have significant impacts.	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.	Current efforts include partnerships with researchers who sample bacteria levels and water characteristics. The sanctuary also participates in the Southern California Bight-wide surveys that take place every five years (1998, 2003, 2008) to study water quality and contaminants. The sanctuary is working to develop a water quality program that will include a more comprehensive monitoring and reporting effort.
2	What is the eutrophic condition of sanctuary waters and how is it changing?	–	Mainland runoff does not reach the island in significant amounts and lack of development on the islands means there is little local land-based nutrient inputs; island runoff is minimal. However, there may be localized inputs from marine mammals and possibly vessel discharge.	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.	
3	Do sanctuary waters pose risks to human health?	–	There are no known occurrences of risks resulting from water contact or seafood consumption at the islands. However, there are known vectors for shellfish poisoning through *Pseudo-nitzschial*domoic acid blooms although shellfish poisoning has not been reported in the sanctuary.	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.	
4	What are the levels of human activities that may influence water quality and how are they changing?	–	Many activities are present that have the potential to harm water quality: shipping traffic, vessel discharges, DDT, and mainland land use runoff. However, they are not causing significant damage at this time.	Few or no activities occur that are likely to negatively affect water quality.	
HABITAT					
5	What is the abundance and distribution of major habitat types and how is it changing?	?	Past trawling, lost fishing gear, and marine debris have harmed habitats, although little is known about deepwater habitats. Recent trawl bans and other regulations may improve conditions.	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources or water quality.	Recent restrictions including bans on bottom fishing and the establishment of marine reserves may help habitats to recover over time.
6	What is the condition of biologically structured habitats and how is it changing?	–	Long-term loss of giant kelp and understory habitat-forming algae, trawling damage to hard-bottom coral communities, anchor damage to eelgrass and kelp, declines in eelgrass as a result of white urchin increases, decline in mussel bed community diversity, biomass, and bed thickness. Short term increases in kelp, an eelgrass restoration project, reserves, and trawl regulations may help habitats recover.	Selected habitat loss or alteration may inhibit the development of living resources, and may cause measurable but not severe declines in living resources or water quality.	
7	What are the contaminant concentrations in sanctuary habitats and how are they changing?	▲	Distance from mainland reduces impacts from mainland discharges, DDT still detectable but some species recovering, vessel discharges are present but regulations have kept contamination at low levels.	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.	
8	What are the levels of human activities that may influence habitat quality and how are they changing?	▲	Impacts to habitat quality may have resulted from historic or current direct or incidental extraction of biogenic species, marine debris, vessel discharges, and anchoring; creation of reserves and other fishing regulations may improve conditions.	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized, not widespread.	

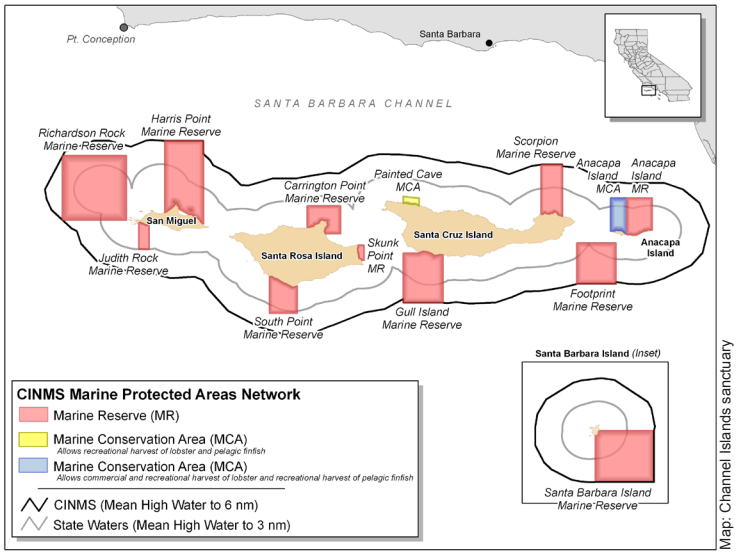
Table is continued on the following page.

Channel Islands National Marine Sanctuary Condition Summary Table (Continued)

#	Questions/Resources	Rating	Basis for Judgment	Description of Findings	Sanctuary Response
LIVING RESOURCES					
9	What is the status of biodiversity and how is it changing?	?	Extraction of fish (e.g., sheephead, kelp bass, rockfish) and invertebrate (e.g., lobster and abalone) species has decreased biodiversity and simplified community structures (e.g., dominance of urchins and brittlestars).	Selected biodiversity loss may inhibit full community development and function, and may cause measurable but not severe degradation of ecosystem integrity.	Marine reserves and other regulations have recently been established which are expected to help some species recover over time. Early indications are that reserves will increase biomass, species numbers, and will allow parts of system to recover to a more resilient state. Monitoring programs record presence of non-indigenous species if they are observed.
10	What is the status of environmentally sustainable fishing and how is it changing?	▲	Declines have occurred in several species of sharks, giant sea bass, swordfish, various rockfish, and abalone populations; recent implementation of marine reserves may improve conditions.	Extraction has caused or is likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.	
11	What is the status of non-indigenous species and how is it changing?	▼	No problematic species have become established; there is concern that invasive algae from mainland harbors and Santa Catalina Island could reach the islands.	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).	
12	What is the status of key species and how is it changing?	—	Removal of key species, including sea otters, led to an increase in urchins and urchin barrens. Some species (black sea bass and lobsters) have shown recent increases, but do not approach historic levels.	The reduced abundance of selected keystone species may inhibit full community development and function, and may cause measurable but not severe degradation of ecosystem integrity; or selected key species are at reduced levels, but recovery is possible.	
13	What is the condition or health of key species and how is it changing?	?	Withering foot syndrome in abalone, small size of fished species, low fecundity in sea birds; although some birds have shown recent recovery from reproductive impairment from high levels of DDT.	The diminished condition of selected key resources may cause a measurable but not severe reduction in ecological function, but recovery is possible.	
14	What are the levels of human activities that may influence living resource quality and how are they changing?	▼	Increased visitation and potential disturbance along with expected climate change offset gains made in resource protection.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.	
MARITIME ARCHAEOLOGICAL RESOURCES					
15	What is the integrity of known maritime archaeological resources and how is it changing?	▼	Past looting of some shallow sites, natural deterioration of all sites contribute to declining integrity; integrity of deeper wrecks is unknown, but some accidental fouling by fishing gear may have occurred.	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific or educational value and may affect the eligibility of some sites for listing in the National Register of Historic Places.	Education, outreach, enforcement efforts, and regulations have helped decrease looting and destruction. Increased efforts to catalog and monitor wrecks that may pose an environmental hazard.
16	Do known maritime archaeological resources pose an environmental hazard and is this threat changing?	▲	Sites just outside sanctuary boundaries pose a greater threat from leaching chemicals such as bunker fuels and cargos.	Selected maritime archaeological resources may pose isolated or limited environmental threats, but substantial or persistent impacts are not expected.	
17	What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?	▲	Impacts to maritime archaeological resources may result from site looting, injury by divers, and vessel activity. Increases in education, enforcement, and trawling closures may allow for improvement.	Selected activities have resulted in measurable impacts to maritime archaeological resources, but evidence suggests effects are localized, not widespread.	

Site History and Resources

Channel Islands National Marine Sanctuary (Channel Islands sanctuary) is located off the coast of Santa Barbara and Ventura counties in Southern California, 350 miles south of San Francisco and 95 miles north of Los Angeles. The sanctuary was designated in 1980 because of its national significance as an area of exceptional natural beauty and resources; it is administered by the National Oceanic and Atmospheric Administration (NOAA), within the U.S. Department of Commerce. The sanctuary encompasses 1,470 square statute miles (1,110 square nautical miles) of water from mean high tide to 6 nautical miles offshore of Anacapa, San Miguel, Santa Barbara, Santa Cruz, and Santa Rosa Islands (Figure 1). The sanctuary is a special place for species, sensitive habitats, shipwrecks, and maritime archaeological artifacts. Many valuable commercial and recreational activities, such as fishing, shipping, and tourism occur in the sanctuary. A comprehensive ecosystem management approach is used to promote long-term conservation of sanctuary water, wildlife, habitats, and maritime archaeological resources, while allowing compatible human uses.



Map: Channel Islands sanctuary

Figure 1. The Channel Islands sanctuary encompasses the waters surrounding Anacapa, San Miguel, Santa Barbara, Santa Cruz, and Santa Rosa Islands and including special marine zoning areas.

Photo: Robert Schwemmer, NOAA

Figure 2. East end of Santa Cruz Island.

The Channel Islands sanctuary is characterized by a unique combination of features including: complex oceanography, varied bathymetry, diverse habitats, remarkable biodiversity, rich maritime heritage, a remote yet accessible location, and relative lack of development (Figure 2). The combined physical, biological and cultural characteristics of the sanctuary provide outstanding opportunities for scientific research, education, recreation, and commerce. Such activities include commercial and recreational fisheries, marine wildlife viewing, sailing, boating, kayaking, and other recreational activities, maritime shipping, and nearby offshore oil and gas industry.

History

Human History of the Channel Islands

The Channel Islands and the surrounding waters have a very rich history. The Chumash, or island people, are the indigenous people of the Santa Barbara Channel and inhabited the Channel Islands and adjacent mainland dating back thousands of years. A vibrant Chumash community remains in Southern California today. Cultural resources found in the sanctuary represent Chumash Native American and other pre-European cultures and date to the end of the Pleistocene, approximately 13,000 years before present. This date is associated with the early human remains discovered at Arlington Springs on Santa Rosa Island (Johnson et al. 1999). Arlington Springs and Daisy Cave on San Miguel Island are two of the earliest archaeological sites in North America (Watts et al. 2008). Recent findings of additional early Holocene sites on San Miguel provide further evidence that the western Northern Channel Islands were a particularly attractive area for early Americans (Watts et al. 2008). For hundreds of years the Chumash traveled the Santa Barbara Channel in plank canoes called *tomols* to trade with the mainland community.

Channel Islands National Park

Within the boundary of the sanctuary lies the Channel Islands National Park, a special terrestrial and marine protected area of national and global significance. It is administered by the National Park Service, a component of the Department of the Interior. The park consists of 250,000 acres of land and ocean environment encompassing Anacapa, San Miguel, Santa Barbara, Santa Cruz (Figure 2), and Santa Rosa Islands, their submerged lands, and the waters within one nautical mile of each island. Channel Islands National Park monitors and protects threatened and endangered species, restores ecosystems, and preserves the natural and cultural resources for current and future generations.

Juan Rodriguez Cabrillo, believed to be a Portuguese navigator in service to Spain, entered the Santa Barbara Channel in 1542 and is believed to be the first European to land on the islands. Subsequent explorers included Sebastian Vizcaino, Gaspar de Portola, and English captain George Vancouver, who in 1793 assigned the present names of the islands on nautical charts. Beginning in the late 1700s and continuing into the 1800s, Russian, British, and American fur traders hunted sea otters for their valuable furs. Once the sea otters were hunted to near-extinction, traders focused their efforts on hunting seals and sea lions for their fur and oil.

In the early 1800s the Chumash people were relocated from the islands to the mainland missions. Soon after, hunters, settlers, fishers, and ranchers began to populate the islands. By the mid-1800s, ranching was the predominant occupation on the islands which resulted in heavy grazing and cultivation of the land for livestock. Despite the events of the last 200 years, today the Chumash culture remains closely tied to the islands, as demonstrated during annual Chumash *tomol* crossings to *Limuw* (Santa Cruz Island) (Figure 3).

In 1912 the U.S. Lighthouse Service (later the U.S. Coast Guard) began its stay on Anacapa Island and in 1932 constructed the Anacapa Island lighthouse that exists to this day. The U.S. Navy assumed control of San Miguel Island just before World War II and subsequently the islands served an important role in Southern California's coastal defenses.

Photo: Robert Schwemmer, NOAA

Figure 3. Chumash paddlers reenact the historic channel crossing in traditional plank canoes called *tomols*.

Designation of the Sanctuary

Federal efforts to protect the islands began in 1938 when President Franklin D. Roosevelt proclaimed Santa Barbara and Anacapa Islands as the Channel Islands National Monument. In 1976, a U.S. Navy and National Park Service agreement allowed supervised visitation of San Miguel Island. In 1978, continued protection, research, and educational use of the mostly privately owned Santa Cruz Island was granted through a partnership between the Nature Conservancy and the Santa Cruz Island Company. Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara Islands, their submerged lands, and the waters within one nautical mile of each island were designated as the nation's 40th national park in 1980. Later that same year, the ocean waters surrounding six nautical miles out of the islands were designated as a national marine sanctuary.

Commerce

Since the days of the early coastal Chumash inhabitants, coastal waterways along Southern California have been a main route of travel and supply. Ocean-based commerce and industry (e.g., fisheries and coastal shipping) are important to the maritime history, the modern economy, and the social character of this region. The expansion of the global economy has resulted in a substantial increase in international vessel traffic through the Santa Barbara Channel. Much of this traffic is related to the Port of Long Beach-Los Angeles, the second busiest port in North America (Port of Long Beach 2005). The Channel Islands sanctuary is located about 70 miles northwest of the port and about 40 miles northwest of Port Hueneme, a smaller deepwater international port. These ports generate extensive commercial shipping traffic that transits the Santa Barbara Channel using shipping lanes that pass through the sanctuary at its northeast boundary (Figure 4). Approximately 75 percent of the departing vessel traffic leaves northbound and 65 percent of arriving vessel traffic comes southbound, passing through the Santa Barbara Channel (U.S. Department of Commerce 2007).

Regional oil and gas facilities represent another significant source of commercial vessel traffic near the sanctuary. Combined, the total commercial vessel traffic in the Santa Barbara Channel in 2005 was over 7,000 vessels per year (Santa Barbara County Air Pollution Control District 2006).

Fishing is another important industry in the sanctuary. The waters surrounding the Channel Islands include rich fishing grounds that support important commercial and recreational fisheries. Key target species for commercial fishing in the Channel Islands sanctuary include squid, sea urchin, spiny lobster, prawn, nearshore and offshore finfishes (e.g., rockfishes and California sheephead), coastal pelagic species (e.g., anchovy, sardine and mackerel), flatfishes (e.g., California halibut, starry flounder and sanddabs), rock crab, and sea cucumber. Squid is California's largest fishery by economic value

Photo: Robert Schwemmer, NOAA

Figure 4. Cargo vessels pass through sanctuary waters near Anacapa Island.

Photo: Fred Benko

Figure 5. A blue whale visits a commercial whale watching vessel.

and tonnage (CDFG 2005) and the urchin fishery landings from the Channel Islands were the highest in the state in 2005 (CDFG 2006). Recreational (sport) fishing is also very popular in the sanctuary. Recreational fisheries in the sanctuary access both nearshore and offshore areas, and target both bottom fish and pelagic fish species. Types of fish landed by recreational fishers include kelp bass, mackerel, California sheephead, halfmoon, and ocean whitefish. Species commonly targeted by consumptive divers include many rockfish species, kelp bass, halibut, yellowtail and white seabass, as well as lobster and rock scallops. Offshore recreational fishing focuses on mobile species such as yellowtail, tuna, white seabass, barracuda, broadbill swordfish, marlin, and mako shark.

Fish and fishers are not alone in seeking out the productive waters of the sanctuary. The waters surrounding the Channel Islands are a destination feeding ground for seabirds, pinnipeds, and a variety of cetaceans including humpback and blue whales (Figure 5). Foraging wildlife frequent sanctuary waters, and many charter vessels from Ventura and Santa Barbara make regular wildlife viewing trips to the sanctuary. Other popular non-consumptive recreational activities occurring in the sanctuary include snorkeling, diving, boating (motor and sailing), kayaking, swimming, and wildlife and scenic viewing.

Geology

The Channel Islands are located within a unique geological region off the Southern California Coast. Over millions of years, large plates of the earth's crust moved along fault lines, pushing against the coastline of Mexico and California, creating the coastal geography that is seen today. During this shifting, part of the Southern California coast was rotated, resulting in the unusual east-west axis of the California coast just south of Point Conception, termed the Transverse Ranges, and the formation of the Channel Island chain along this coast. The Continental Borderland is the offshore section of the underwater geology that forms a wide continental shelf (Norris and Webb 1990). Unlike most wide continental shelves that consist of gently sloping platforms interrupted by low banks and occasional canyons, the Continental Borderland is a region of basins and elevated ridges (Norris and Webb 1990) (Figure 6). The Channel Islands are the portions of the ridges that rise above sea level. The Santa Barbara Basin is a deep (1650 feet, 500 meters) submerged geological feature within the Santa Barbara Channel (the body of water between the islands and the mainland).

More than 20 oil fields and several natural gas fields lie beneath the Santa Barbara Channel in the Santa Barbara Basin. Natural oil seeps in the area are known to have one of the highest rates of seepage in the world. For example, seeps at Coal Oil Point near Santa Barbara are estimated to discharge approximately 150-170 barrels (6,300-7140 gallons) of oil per day (Hornafius et al. 1999).

Oceanography

Water circulation around the Channel Islands is complex and highly dynamic, resulting from the interaction of large-scale ocean currents, local geography, and the unique basin and ridge topography of the ocean bottom in the Southern California Bight. The major ocean current moving through the area is the south-flowing California Current, which brings cold water from the Gulf of Alaska down the coast of California. This current generally flows at the western edge of the islands (Hendershot and Winant 1996). As it flows south towards the equator, it mixes with the north-flowing Southern California Countercurrent, which brings warm water northwestward up the coast (Hendershott and Winant 1996). Between the islands and the mainland these currents create a localized cyclonic gyre that can vary in intensity seasonally based on current and wind speed (Hendershot and Winant 1996, Harms and Winant 1998, Winant et al. 2003). These varying conditions create alternate states of upwelling, where cool nutrient-rich water is brought from deeper areas to the photic zone at the surface, and relaxation, when upwelling ceases (Winant et al. 2003). Regional upwelling is wind-driven and provides the nutrients and conditions for seaweeds, phytoplankton, and zooplankton to thrive, with effects seen throughout the food chain.

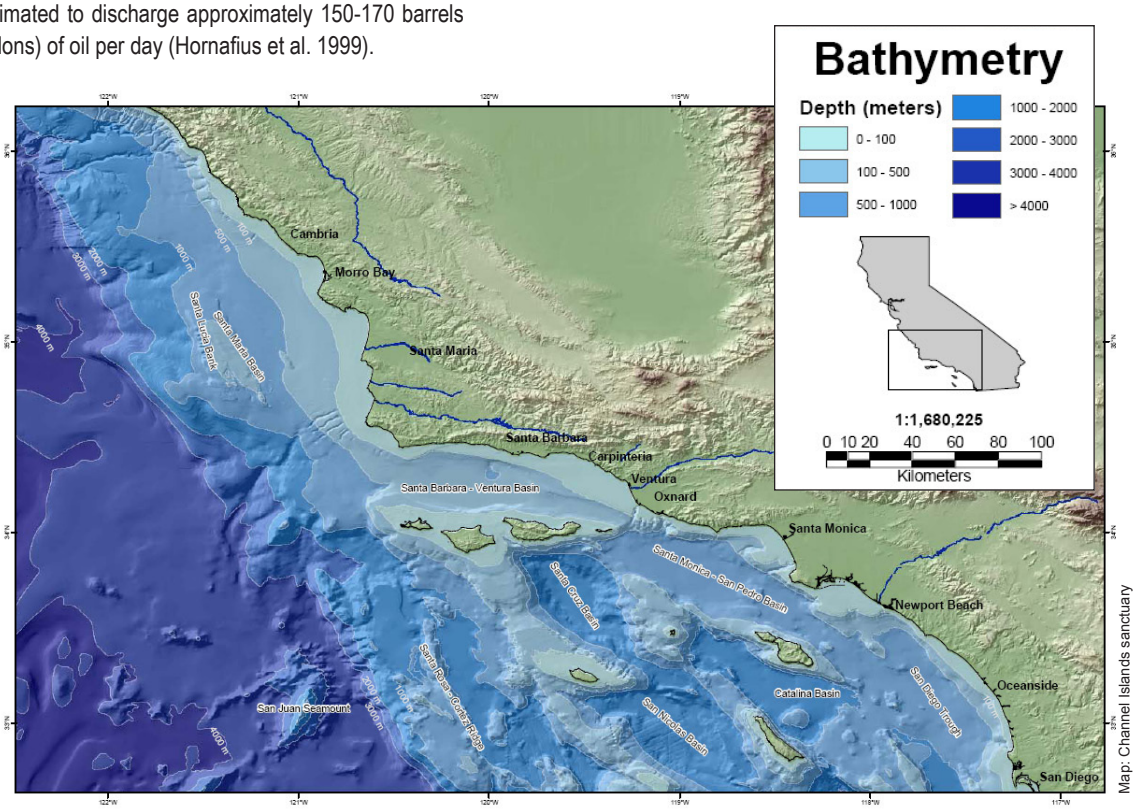


Figure 6. Bathymetric features of Southern California.

Habitat

There are a wide variety of important habitats within the Channel Islands sanctuary including intertidal, hard and soft bottom subtidal, deep water, water column, kelp forest, eelgrass, and surf grass. Each of these habitats supports a diverse group of invertebrates, fish, algae, and plants.

Intertidal Zone Habitat

Intertidal zones are composed of a variety of coastal habitats that are periodically covered and uncovered by waves and tides. Therefore, these habitats vary in the type of substrate and degree of exposure to surf. The vertical extent of the tidal change within the Channel Islands can be as much as 10 feet (3 meters). Bottom types in the intertidal zones include fine muds, sand, gravel, cobble, boulders, and bedrock. Sedentary and mobile invertebrates, fish, algae, seabirds, and pinnipeds use the intertidal zone surrounding the Channel Islands.

Hard and Soft Bottom Subtidal Habitat

Subtidal habitats include those ranging from the lower limit of the intertidal zone down to deepwater offshore. Nearshore subtidal habitats include mud, sand, gravel, cobble, and bedrock substrates. These shallow-water habitats are subject to dynamic physical processes, including wave exposures, along-shore currents, upwelling, temperature, salinity, and nutrient differentials, and suspended sediment loads.

Soft bottom habitats are extensive in the sanctuary, especially in deeper water. These habitats support a community living above the sand, including sea pens, sand crabs, sand dollars, sand stars, bottom-dwelling sharks, rays, and flatfishes (Figure 7). In addition, a diverse assemblage also dwells within the soft sediment, including worms, crustaceans, snails, and clams.

Rocky subtidal habitats are widespread around the sanctuary, and include high-relief volcanic reefs with walls, ledges, caves, and pinnacles. Low-relief sedimentary reefs exist as well. These rocky subtidal environments are capable of supporting thousands of algal, invertebrate, and fish species, depending on the extent of habitat heterogeneity and influence of physical factors such as turbulence, currents, light, temperature, nutrients, sedimentation, and biological interactions such as competition and predation.

Deep Water Habitat

The deep water habitats around the Channel Islands extend from 30 to greater than 200 meters deep over the continental shelf and slope and well over 1000 meters in canyons. Well over 90 percent of deepwater benthic habitats in the Southern California Bight consist of soft bottom habitat (Thompson et al. 1993). Most of the deepwater hard bottom substrates are low-relief reefs less than 1 meter in height; some reefs have 1- to 5-meter-high features. Boulders and bedrock outcroppings are features of these reefs in the deep waters

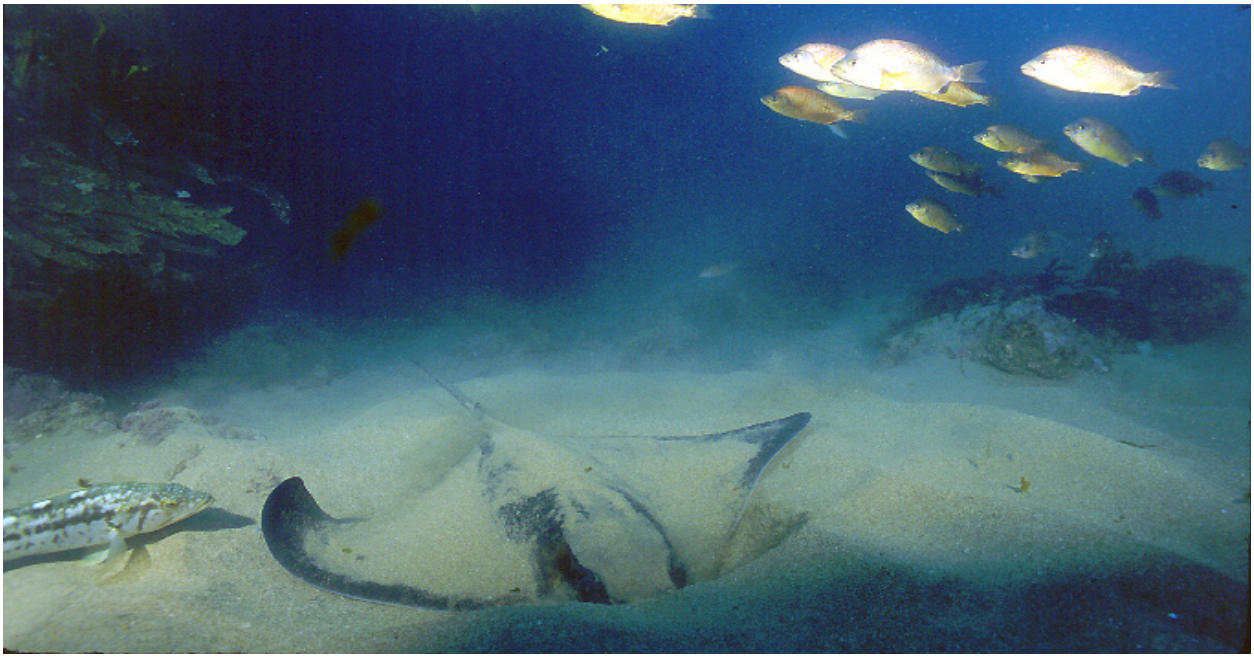


Photo: Ralph Clevenger

Figure 7. Bat ray and kelp bass on soft bottom habitat in Channel Islands National Marine Sanctuary.

around the Channel Islands. Higher relief pinnacles and ridges occur in some areas such as off the northwest end of San Miguel Island. Because of the difficulty in studying very deep habitats, little is known about these areas in the Channel Islands sanctuary. However, recent submersible studies have revealed deep sea corals, including a new species, and associated diverse fish and invertebrate communities (Tissot et al. 2006).

Pelagic Habitat

Pelagic habitat includes the offshore oceanic water around the islands. This is the most extensive habitat in the sanctuary and is divided into subhabitats based on depth, each of which has varying degrees of light penetration, temperature, oxygen concentration, and density. A variety of animals occupy the pelagic habitat. Phytoplankton and other pelagic organisms occupy the epipelagic zone (0-200 meters) which includes the photic (light penetrating) zone. Large migratory fish and marine mammals occupy the mesoplagic zone, from 200 to 1000m (U.S. Department of Commerce 2007) and their wide ranges and long distance migrations make them difficult to study.

Macroalgae and Plants

Macroalgae and marine plants (seagrasses) are habitat-forming organisms that grow in intertidal and shallow subtidal waters, generally less than 30 meters deep, where enough light penetrates for photosynthesis. The islands support a rich array of benthic macroalgae and seagrasses. In the Southern California Bight, there are at least 492 species of algae and four species of seagrasses known to occur of the 673 species described for California (Abbott and Hollensberg 1976, Murray and Bray 1993). These algae and marine plants are critical to the life history of many of the invertebrates, fishes, seabirds, and marine mammals found in the sanctuary. Giant kelp (*Macrocystis pyrifera*) forms extensive underwater forests on rocky substrates at shallow subtidal depths (Figure 8). These impressive kelp forests are characteristic features of Southern California nearshore marine environments, including the sanctuary, and are important not only ecologically, but also for recreational and commercial activities including fishing, diving, and tourism. Kelp beds are highly productive habitats and serve as important nursery habitat for juvenile fishes in the upper canopy (Carr 1994), as well as providing food, attachment sites, and shelter for a diverse assemblage of invertebrates and other species of algae on the benthos through the water column and in the root-like structure called the hold fast (Dayton 1985, Graham 2004).

The two types of marine flowering plants found in the sanctuary form dense beds on different substrate and in different conditions. Surfgrass (*Phyllospadix* sp.), found in rocky intertidal and shallow subtidal areas, and eelgrass (*Zostera marina*), found in soft bottom

Photo Robert Schwemmer, NOAA

Figure 8. Giant kelp in Channel Islands National Marine Sanctuary.

Photo Robert Schwemmer, NOAA

Figure 9. Eelgrass at Santa Cruz Island.

subtidal areas, form productive and complex habitats that provide food and refuge for a wide variety of marine species, including fish and invertebrates that are recreationally and commercially fished (den Hartog 1970, Orth et al. 1984, Hemminga and Duarte 2000) (Figure 9). Seagrass beds provide nursery habitat (reviewed in Heck et al. 2003) and are important for nutrient cycling (Costanza et al. 1997) and substrate stabilization (Fonseca and Fisher 1986).

Living Resources

The abundance and distribution of living resources in the sanctuary is driven on a large scale by the oceanographic conditions around the islands, specifically the mixing of the warm northerly current and

Photo: Ralph A. Clevenger

Figure 10. The spiny lobster can be found in the Channel Islands sanctuary. It is a key target species for commercial and recreational fishing.

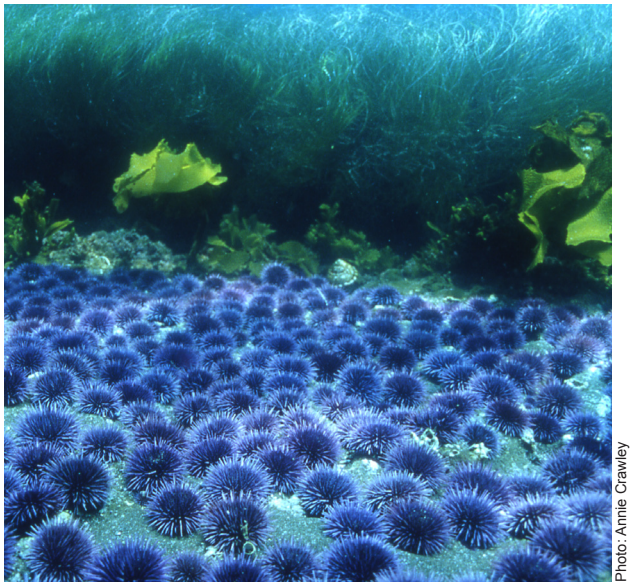


Photo: Annie Crawley

Figure 11. Purple sea urchins.

the cooler southerly current and localized gyres. The Channel Islands are transitional; the islands have a gradient of southern versus northern species. Santa Barbara Island, the most southern island, is inhabited mainly by southern species, Anacapa and Santa Cruz Islands are intermediate with both southern and northern components, while Santa Rosa and San Miguel Islands to the north are populated with a greater portion of northern species. For example, garibaldi (*Hypsypops rubicunda*) is found mainly in warm water regions while blue rockfish (*Sebastes mystinus*) are more abundant in the colder water regions. The varied oceanographic conditions and the transition between them, the diversity of habitats, ranging from sheltered embayments to exposed open coasts, and the relatively undisturbed location support a wide variety of invertebrates, fish, macroalgae, marine plants, marine mammals, and seabirds.

At the base of the food web in the Southern California Bight is a diverse planktonic community. The abundance and species richness of plankton varies greatly both spatially and temporally and is dependent upon such environmental factors as nutrients and temperature. Short-term blooms of phytoplankton often occur in association with upwelling events and subsequently support zooplankton populations. Zooplankton, in turn, are preyed upon by small schooling fish, which support larger fish and marine mammals, including pelagic migratory species.

The total number of benthic invertebrate species in the Southern California Bight may be in excess of 5,000, not including microinvertebrates (Smith and Carlton 1975, Straughan and Klink 1980). Select invertebrates in the sanctuary include multiple species of corals, prawns, spiny lobster (Figure 10), crabs, sea urchins (Figure 11), sea cucumbers, sea stars, abalone, nudibranchs, scallops, mussels, squid, clams, barnacles, snails, salps, tunicates, jellyfish, sea slugs, worms, and anemones. Species that deserve special consideration because of their importance as keystone dominants, harvested species, or species particularly sensitive to environmental disturbance include: California hydrocoral (*Stylaster californicus*); ridgeback prawn (*Sicyonia ingentis*); spot prawn (*Pandalus platyceros*); spiny lobster (*Panulirus argus*); rock crab (*Cancer antennarius*) (brown, yellow and red); abalone (black (*Haliotis cracherodii*), green (*H. fulgens*), pink (*H. corrugate*), red (*H. rufescens*), white (*H. sorenseni)*, flat (*H. walallensis*), northern (threaded (*H. assimilis*)) (Geiger 1999); mussels; clams; scallops; market squid; sea urchins (red (*Stronglyocentrotus franciscanus*), purple (*S. purpuratus*), and white (*Lytechinus anamesus*)); sea cucumbers (*Holothuroidea*); and sea stars (Leet et al. 2001). Several of these species are harvested commercially, and represent significant fisheries in the Southern California Bight.

More than 400 species of fish have been documented in the sanctuary, a greater species richness than at nearby coastal regions of the Southern California mainland. Fish diversity on nearshore reefs is related to the presence or absence of kelp and substrate topography. Hard substrate is the least common habitat type in the Channel Islands, but it is among the most important fish habitat because it supports kelp. Some of the common nearshore epipelagic fishes in the sanctuary include the California barracuda (*Sphyraena argentea*), Pacific bonito (*Sarda chiliensis*), white seabass (*Atractoscion nobilis*) and yellowtail (*Sebastes flavidus*). Common groundfish found within sanctuary include bocaccio (*Sebastes paucispinis*), cowcod (*S. levis*), chilipepper (*S. goodie*), widow rockfish (*S. entomelas*), bank rockfish (*S. rufus*), dover sole (*Solea solea*), English sole (*Pleuronectes vetulus*), and sablefish (*Anoplopoma fimbria*). Coastal pelagics and highly migratory species include Pacific sardine (*Sardinops sagax*),

Northern anchovy (*Engraulis mordax*), Pacific mackerel (*Scomber japonicas*), jack mackerel (*Trachurus symmetricus*), albacore (*Thunnus alalunga*), swordfish (*Xiphias gladius*), Pacific northern bluefin tuna (*T. orientalis*), skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*T. albacores*), striped marlin (*Tetrapturus audax*), shortfin mako shark (*Isurus oxyrinchus*), thresher shark (*Alopias vulpinus*), blue shark (*Prionace glauca*) and opah (*Lampris regius*).

The Channel Islands sanctuary is located along the Pacific Flyway, a major migratory route for birds, and acts as a stopover during both north (April through May) and south (September through December) migrations. In addition, the diversity of habitats on the Channel Islands provide breeding and nesting sites for many species and large numbers of seabirds, which then forage in sanctuary waters. Sandy beaches provide foraging and resting habitat for a number of shorebirds including Black-Bellied Plover (*Pluvialis squatarola*), Willet (*Catoptrophorus semipalmatus*), Whimbrel (*Numenius phaeopus*), Long-billed Curlew (*N. americanus*), gulls, and sanderlings (*Calidris alba*). The upland portions of the beach provide kelp deposits that attract invertebrates where Black and Ruddy Turnstones (Arenaria melanocephala and A. *interpres*), dowitchers, and other shorebird species forage. Caves and crevices provide nest habitat for Xantus's Murrelets (*Synthliboramphus hypoleucus*) and Ashy Storm-Petrels (*Oceanodroma homochroa*), while Cassin's Auklets (*Ptychoramphus aleuticus*) dig burrows in seaside cliffs. Nineteen seabird species breed in the Channel Islands, eight of which have been granted special status under federal or California state law: Ashy Storm-Petrel, Black Storm-Petrel (*O. melania*), California Brown Pelican (*Pelecanus occidentalis*), California Least Tern (*Sternula antillarumi*), Double-crested Cormorant (*Phalacrocorax auritus*), Rhinoceros Auklet (*Cerorhinca monocerata*), Western Snowy Plover (*Charadrius alexandrinus*), and Xantus's Murrelet (*Synthliboramphus hypoleucus*).

Four species of sea turtles have been reported in the offshore Southern California region: green (*Chelonia mydas*), loggerhead (*Caretta caretta*), olive-Ridley (*Lepidochelys olivacea*) and leatherback (*Dermochelys coriacea*). All species of sea turtles are federally endangered and these four species are rarely sighted at the Channel Islands because of range limits, decreased populations, and their highly migratory and pelagic habits.

The Channel Islands and surrounding waters support a great diversity of marine mammals, including whales, pinnipeds, and otters. As in the case of the seabirds, because of their dependence on a large volume of seasonal food resources, the abundance and distribution of marine mammals is an indication of the general heath and ecological integrity of the marine ecosystems of the Channel Islands sanctuary.

At least 33 species of cetaceans have been reported in sanctuary waters (Leatherwood et al. 1982, Leatherwood et al. 1987). Common cetaceans include: short-beaked (*Delphinus delphis*) and long-beaked common (*Delphinus capensis*), bottlenose (*Tursiops trunca-*

Photo: L. Gordon

Figure 12. Humpback whales lunge feeding in the sanctuary.

tus), Pacific white-sided (*Lagenorhynchus obliquidens*), and Risso's dolphins (*Grampus griseus*); and California gray (*Eschrichtius robustus*), blue (*Balaenoptera musculus*), and humpback (*Megaptera novaeangliae*) whales (Figure 12).

The sanctuary provides vital habitat for pinnipeds, offering important feeding areas, breeding sites, and haul outs. Six species of pinnipeds have historically occurred in the Northern Channel Islands: northern fur seal (*Callorhinus ursinus*), Guadalupe fur seal (*Arctocephalus townsendi*), northern elephant seals (*Mirounga angustirostris*), Pacific harbor seal (*Phoca vitulina*), Steller sea lion (*Eumetopias jubatus*), and California sea lion (*Zalophus californianus*). The most common pinniped in the northern Channel Islands is the California sea lion and the least common is the Steller sea lion, which has declined throughout its range and is now extremely rare throughout Southern California.

Finally, the southern sea otter (*Enhydra lutris*) also can be found in the Channel Islands. The southern sea otter is listed as threatened under the federal Endangered Species Act and is considered depleted and protected under the Marine Mammal Protection Act. In general, the California population has been slowly increasing in recent years.

Maritime Archaeological Resources

There are many documented shipwrecks in the waters of the Channel Islands sanctuary such as the passenger steamer *Cuba*, which stranded off of San Miguel Island in 1923, and the California Gold Rush passenger steamer *Winfield Scott*, which stranded in 1853 on Anacapa Island and is listed in the National Register of Historic Places (Figure 13). The significant number of shipwrecks within the sanctuary can largely be attributed to prevailing currents and weather conditions, combined with natural hazards.

The shipwreck remains reflect the diverse range of activities and nationalities that traversed the Santa Barbara Channel. European sailing and steam vessels, California-built ships of Chinese design called "junks," American coastal traders, vessels engaged in island commerce, and a Gold-Rush-era side-wheel steamer have all been lost in sanctuary waters. Each has a story to tell about the history, technology, and society of earlier times.

Between the years 1853 to 1980, an inventory of over 140 historic ship and aircraft wrecks were documented in the Channel Islands sanctuary and National Park. To date, about 30 sites have been located and surveyed. The sanctuary's shipwreck Reconnaissance Program contributes to scientific knowledge and enhancement of management practices related to underwater archaeological resources by encouraging research and monitoring efforts. Federally certified scuba divers provide year-round monitoring of submerged sites through cooperative partnerships with the Channel Islands National Park, California State Lands Commission and Coastal Maritime Archaeology Resource organization.

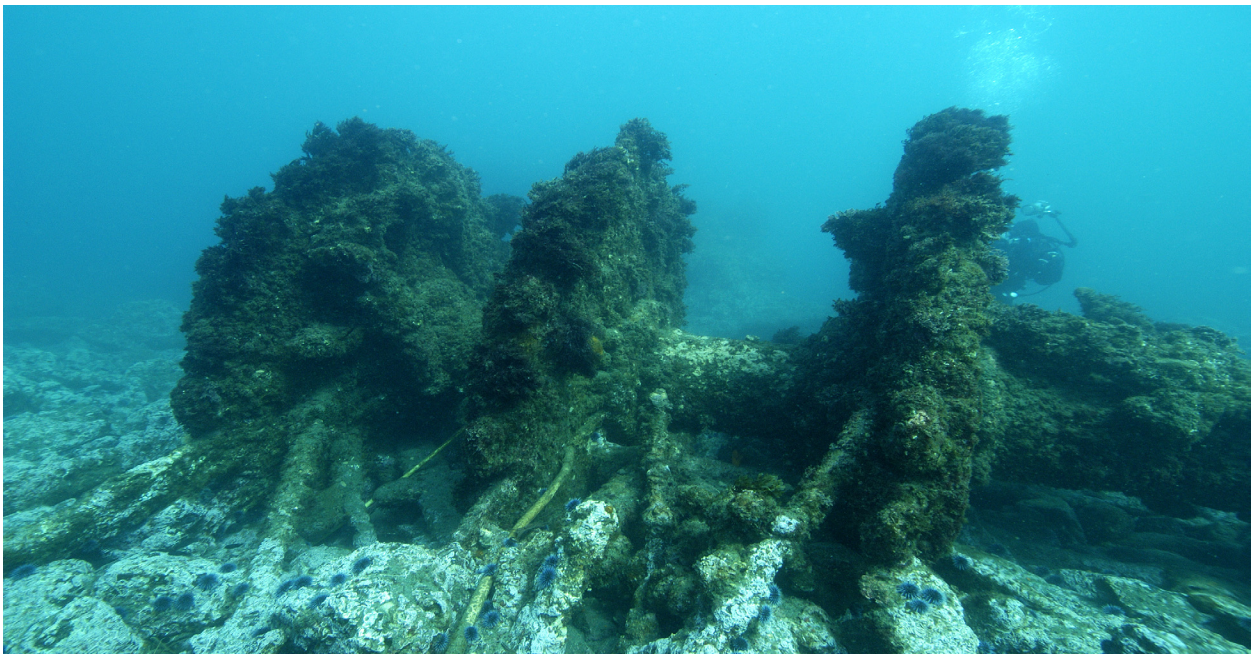


Photo: Robert Schwemmer, NOAA

Figure 13. Paddlewheel from the California Gold Rush Steamer *Winfield Scott*, which stranded on Anacapa Island in 1853.

Pressures on the Sanctuary

The number of people living near the coastal zone and using its resources has significantly increased (U.S. Census Bureau 2000 Web site). This urbanization has increased human demands on the ocean, including commercial and recreational fishing, tourism, and other activities. A burgeoning coastal population has greatly increased the use of coastal waters as receiving areas for human, industrial, and agricultural wastes. In addition, new technologies for fishing have placed pressure on fish populations and are partly responsible for declining stocks (Jackson et al. 2001). Concurrently, there have been fluctuations in weather and climate, including phenomena such as El Niño weather patterns and oceanographic regime shifts (McGowan et al. 1998, Mantua and Hare 2002).

The proximity of the Channel Islands to the mainland coast makes them accessible from Santa Barbara, Ventura, Port Hueneme, and Channel Islands Harbors, as well as from ports in Los Angeles County. Also, human use of the sanctuary is not limited to regional residents; almost 20 percent of those who use California's coastal areas for recreation are interstate or international visitors (Resources Agency of California 1997). In addition, population growth in Southern California has risen sharply over the last 20 years. The two counties adjacent to the sanctuary, Santa Barbara and Ventura, have a combined population of over 1.1 million and more than 20 million people live in the greater Southern California Bight region (U.S. Census Bureau 2000 Web site). As the number of people increases, the number of potential sanctuary users who may engage in a wide variety of activities, also increases.

Commercial and Recreational Fishing

The combination of direct take, bycatch, indirect effects, and habitat damage and destruction has adversely affected the marine environment around the Channel Islands. In the Channel Islands area, commercial and recreational fisheries target more than 100 fish species and more than 20 invertebrate species (Figure 14). Targeted species have exhibited high variability in landings from year to year and several species have seen extensive declines in catch (Dugan and Davis 1993, Love et al. 1998, Rogers-Bennet et al. 2004). Bycatch, defined here as unintentional take of non-target species, may be significant for some fisheries (Harrington et al. 2005). Fishing can alter ecosystem structure by removing species that play key ecological roles (Dayton et al. 1995, Tegner and Dayton 2000). Some types of fishing gear can cause temporary or permanent damage to marine habitats. The abrasive contact of mobile fishing gear with the seafloor, particularly trawling and dredging gear, can damage or destroy benthic habitats and fauna (Jones 1992, Watling and Norse 1998).

Photo: Robert Schwemmer/NOAA

Figure 14. A commercial fishing boat in the sanctuary.

Commercial Fishing

Many targeted species have seen historic declines in catch at the Channel Islands. For example, abalone populations were severely depleted resulting in closure of the fishery in 1997. All species of abalone are now uncommon in the sanctuary (except red abalone at San Miguel Island) as a result of disease and overfishing. Both white and black abalone are on the federal endangered species list (Hobday et al. 2001, Rogers-Bennet et al. 2004, http://swr.nmfs.noaa.gov). A number of rockfish species have also seen dramatic declines (Love et al. 1998) that have resulted in bottom fishing closures in large areas of the sanctuary. Of the sanctuary's commercially caught species, market squid, sea urchin, spiny lobster, and halibut are some of the most economically valuable. Commercial fishing gear used in the sanctuary includes nets, traps, lines, and dive equipment. Most recent data (from 2001) shows that approximately 450 commercial vessels fish in the sanctuary (Leeworthy and Wiley 2003) with most of the vessels concentrating close to the islands (Senyk et al. 2008).

Recreational Fishing

Recreational fisheries have seen declines in catch of rockfish and other species, partly as a result of overfishing (Love et al. 1998). Recreational fisheries in the sanctuary access both nearshore and offshore areas, using hook-and-line and spearguns to target bottom and mid-water fish species. Invertebrates are harvested with traps, hand-capture, and nets – these activities may be conducted from shore or vessels, or by freediving or using scuba equipment. Recreational fishing is primarily in the eastern half of the sanctuary that lies within easy boating distance to the mainland (Senyk et al. 2008) indicating that these areas may receive heavier recreational fishing pressure.

Shipping and Boating

Heavy vessel traffic creates the possibility of collision with large marine mammals, and noise from vessels may affect marine animals. Illegal discharge of oil, sewage, and other non-biodegradable materials from vessels in the sanctuary pose a threat to sanctuary resources, as well as air and water polluting activities that occur beyond the boundaries of the sanctuary. Spills may result from vessel groundings, sinkings, and plane crashes. Ballast water of cargo ships may transport non-indigenous species that, if released, could be damaging to sanctuary ecosystems.

Commercial shipping is prevalent in the sanctuary. Over 7,000 vessels transited the Santa Barbara Channel in 2005 (Santa Barbara County Air Pollution Control District 2006). The container trade at the Port of Long Beach has grown 150 percent since 1990 and is expected to continue to increase over the long term. However, the industry tends to track the economic climate and as such experienced an approximate 10% decline in 2008 (D. McKenna, 2008, Marine Exchange of Southern California, pers. comm.) The Santa Barbara Channel is a main thoroughfare, with the shipping lanes passing through a portion of the sanctuary. However, large cargo ships (greater than 300 gross registered tons) are prohibited by sanctuary regulation from entering waters within one nautical mile of the islands.

Smaller vessels are also prevalent in the sanctuary. Nearby harbors contain over 5,000 slips used by smaller recreational, commercial, and research vessels. Wildlife viewing, sailing, diving, and fishing trips take place year round, but whale watching is especially popular in the winter and spring during gray whale migratory season. Sanctuary visits by private boaters are expected to increase as the coastal population grows.

A higher volume of shipping traffic and larger commercial ships have caused anthropogenic noise in the ocean to increase over the past few decades (Andrew et al. 2002). In Southern California in particular, ocean noise has increased significantly since the 1960s (McDonald et al. 2006). Although large commercial ships account for most of this increase, other sources of noise are military activities, construction, oil and gas production, and smaller boats. Effects from high decibel noise, especially at close range, can cause acute physiological effects in living marine resources, such as tissue damage in lungs and ears and ruptured or hemorrhaged body parts (Evans and England 2001, reviewed in Polefka 2004). Other effects include masking of important signals (such as those used for echolocation, intra-species communication, and predator-prey cues) (Southall 2005), behavioral alterations (such as changes in migration patterns or abandonment of important habitats), and adverse effects to animal energy and physiology (Richardson and Wursig 1997, Ketten 1998). Fish and invertebrates may experience damage to eggs, reduced reproduction rates, and physiological or morphological damage (Myrberg 1990, Hastings 1991).

Offshore Oil and Gas Industry

Spills from oil platforms operating close to sanctuary boundaries and effects of oil production on water quality are of concern. Since the sanctuary was designated, all new oil and gas exploration, development, and protection activities are prohibited within sanctuary boundaries. However, there are 39 developed or active leases in the Channel Islands region. Two of these lease tracts that pre-date sanctuary designation slightly overlap the sanctuary at its eastern boundary; the rest are outside of the sanctuary (Figure 15).

Before sanctuary designation, an oil platform spill in 1969 released 200,000 gallons of oil into the Santa Barbara Channel. Although spill response contingency plans and improved platform technologies and practices are now in place, such spills remain a threat to the sanctu-

Photo: Robert Schwemmer/NOAA

Figure 15. An oil platform near the sanctuary.

ary. Oil and chemical spills in the sanctuary region can result from accidents associated with oil production and could range from small, localized spills to large events that span hundreds of kilometers of coastline. A large spill could have a major impact on foraging birds, marine mammals, fishes, and kelp, as well as wetlands and rocky shores, and on tourism and the coastal economy.

The region is also known for natural hydrocarbon seeps. Natural oil seeps at Coal Oil Point in the Santa Barbara Channel are estimated to discharge approximately 150-170 barrels (6,300-7,140 gallons) of oil per day (Hornafius et al. 1999). Some of this hydrocarbon discharge enters the sanctuary and affects water quality.

Climate Change

Climate change is projected to profoundly affect coastal and marine ecosystems on a global scale, and the Channel Islands sanctuary is expected to manifest the consequences as well. The Channel Islands are at a transition zone between cold northern currents and warm southern currents (Figure 16). Geographic position and variability in the transition zone are important drivers of community structure. Changes in that boundary driven by large-scale climate alteration can be expected to have correlated large scale changes in the marine community. These community changes may occur as a result of habitat changes and shifts in species ranges; the Channel Islands are a northern or southern range limit for many species. In addition, many local species have multiple, different habitat requirements within their life-histories making access to the diversity of conditions seen in the sanctuary a critical component of ecosystem health. Furthermore, climate change could affect species through changes in phenology and disease ecology. For example, reproductive performance of Cassin's Auklets may be affected by oceanographic conditions and prey availability during breeding seasons (Adams et al. 2004) and alterations due to climate change may exacerbate these conditions. In addition, although the red abalone population at San Miguel Island does not exhibit symptoms of withering syndrome, at least half of the population harbors the infectious bacterium responsible for the disease (CDFG 2007). It appears that the symptoms are more prevalent in populations located in warmer water; therefore, increases in seawater temperature may lead to outbreaks of the disease.

The region is affected locally by climatic short-time scale events such as El Niño-related sea surface temperature anomaly and upwelling variability (McGowan et al. 1998), and decadal-scale variability such as the Pacific Decadal Oscillation (Mantua and Hare 2002). Up-

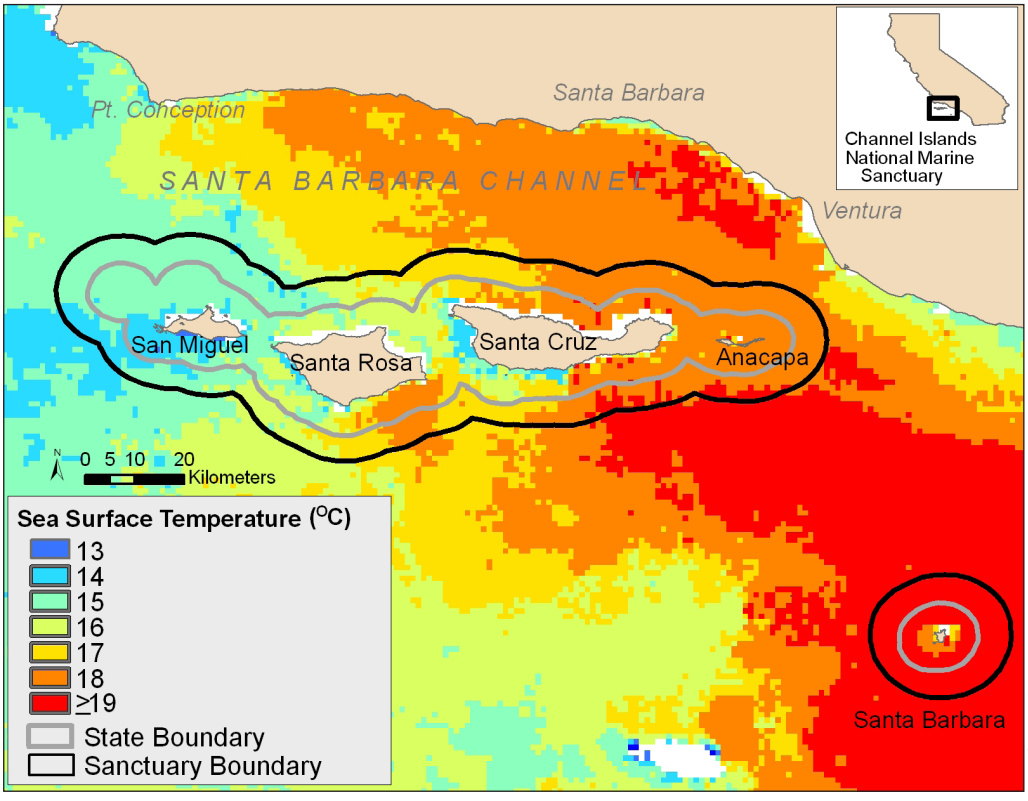


Figure 16. The sanctuary is an area of mixing for cold water from the north and warm water from the south, causing a gradient of temperatures across the sanctuary.

welling variability, driven by variability in the path of the atmospheric jet stream, combined with local El Niño anomalies (Bane et al. 2007), is an important driver of zooplankton productivity and food web integrity on the scale of the California Current (Barth et al. 2007). Changes in upwelling driven by climatic alteration, such as changes in jet stream intensity and trajectory (Archer and Caldiera 2008), can therefore be expected to have a direct impact on ecosystem health in the Channel Islands sanctuary. Other possible threats from climate change include changes in ocean chemistry and sea level rise. Large scale changes in ocean chemistry, and acidification specifically, are increasingly recognized as threats. The impacts are expected to be intense and widespread – particularly at the bottom of the food web where trophic processes are so tightly coupled to environmental chemistry (Hays et al. 2005, Fabry et al. 2008). The impacts of climate can be expected to be profoundly transformative and widespread across all components of the ecosystem. However, specific, reliable forecasts are still not possible. An important contributor to forecast uncertainty is that the important drivers for climate alteration, greenhouse gas emissions, have exceeded even the most extreme predictions of the last 10 years (Raupach et al. 2007). Without reliable forecasts of the ecosystem drivers, confident predictions of ecosystem changes will be impossible.

Pollutants and Marine Debris

Poor water quality can cause illness or disease, impair condition and reproductive capacity, and decrease productivity in marine organisms. It can also endanger human users of the sanctuary. Sources of water quality impairment in the sanctuary are land-based discharges from the mainland and the islands (for example, runoff can include sediment, bacteria, and agricultural-based chemicals such as pesticides and herbicides), vessel discharges from recreational, commercial, and industrial vessels (sewage, bacteria, and marine debris), and discharges associated with oil production (Engle 2006). Nonpoint source pollution from the mainland may reach the eastern portion of the sanctuary (Anacapa and Santa Cruz Islands) during major runoff events via plumes from the Ventura and Santa Clara Rivers (Engle 2006) (Figure 17). Agricultural and urban runoff, as well as effluent from municipal wastewater treatment plants, may be some of the sources of pollution from the mainland that reach the sanctuary. Because pollutants can be carried to the sanctuary by ocean currents, or transported through the food chain, the spatial extent of water quality threats is much larger than the sanctuary itself. For example, the pesticide DDT was manufactured in Los Angeles until the early 1970s and discharged into the ocean off the Palos Verdes pen-

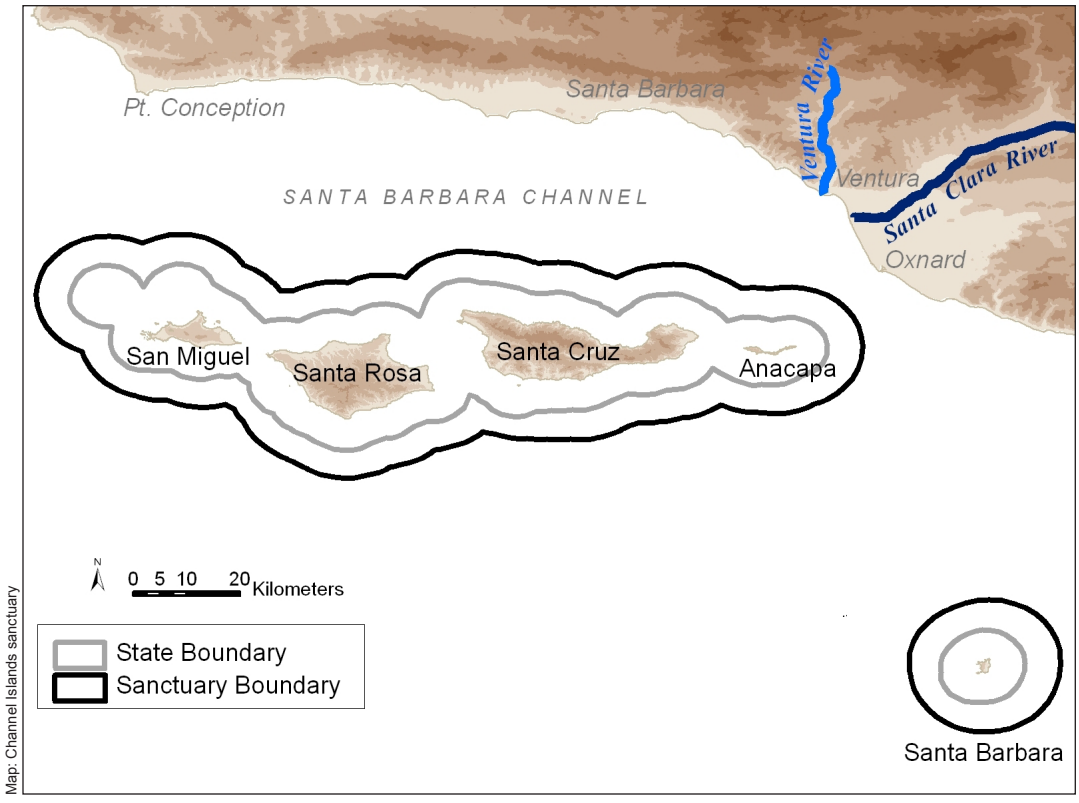


Figure 17. The Ventura and Santa Clara Rivers flow into the Santa Barbara Channel, nearest to the east end of the sanctuary.

Photo: Robert Schwemmer, NOAA

Figure 18. Island Packers' vessels bring visitors to the national park and sanctuary.

Photo: Robert Schwemmer, NOAA

Figure 19. Kayakers enjoy recreating in the sanctuary.

insula. The chemical-contaminated fish within those waters were in turn eaten by seabirds and marine mammals. This affected foraging communities throughout Southern California, including the Channel Islands, long after the chemical production stopped. Levels of DDT and a derivative DDE are still measurable in sediments. Some wildlife species such as bald eagles are only now beginning to recover.

Marine debris threatens sanctuary resources. Marine animals are harmed by ingestion of or entanglement in marine debris (reviewed in Derraik 2002). Debris can also endanger divers and boaters. Typical debris includes lost fishing gear, household and industrial plastics, and styrofoam. These forms of debris can originate from land, offshore vessels, or may be transported from distant sources in currents. Marine debris is a worldwide problem due to the many potential sources of debris, longevity of debris (especially plastics) in the marine environment, and continuing impacts caused by debris even as they degrade to smaller particles.

Visitor Use

Visitors can affect sanctuary resources through activities such as harvesting, polluting, littering, disturbing wildlife, anchoring in sensitive habitats, and trampling. The sanctuary is located close to the heavily populated area of Southern California where population growth has risen sharply over the last 20 years. As the population increases, so does the potential number of sanctuary users who may engage in a variety of activities such as fishing, marine wildlife viewing, boating, snorkeling, diving, and kayaking (Figures 18,19).

Methods and Protocols

This report is intended to convey the status and trends of the ecological and cultural resources of the Channel Islands sanctuary. In principal, the strategic plan for reporting the condition of sanctuary resources includes a targeted monitoring and evaluation framework to support adaptive management decisions (NMSP 2004; pg. 3). In this framework, specific management needs are used to identify technical questions. Answers to these questions are derived from monitoring that is both effective and economical. The questions identified in this condition report and the decisions they support are examples of such framework components.

Unfortunately, available financial resources limit the amount of data, analysis, and synthesis to quantitatively address the questions presented in this condition report. As pointed out in the Monitoring Framework for the National Marine Sanctuary Program (NMSP 2004):

> "In the past, monitoring in the sanctuaries proceeded primarily on a site-by-site basis, with independent development of monitoring programs tailored to address some, but not all of the priority information needs of the sanctuaries…
>
> Monitoring in the sanctuaries has generally been characterized by substantial dependence on federal, state, and local governmental partners, academia, and volunteers, both for project funding and field support. Unfortunately, inconsistent funding and changing mechanisms for the distribution of funds have affected program stability, leaving at risk our knowledge of the natural and cultural resources the program is directed to protect. Furthermore, most current monitoring in the NMSP is not coordinated regionally or nationally, either among the sites, or between the sites and germane non-sanctuary programs. One result has been the inability to generate long-term data sets that would otherwise contribute important information on regional environmental changes." (NMSP 2004; pg. 7)

This program-wide characterization is true for the Channel Islands sanctuary. In the absence of targeted, stable monitoring along with synthesis and analysis performed to address the questions, the authors of this report have relied heavily on the expertise and best professional judgment of local researchers and authorities. Thus, while targeted monitoring is critical for a scientifically robust condition report, in practice the Channel Islands sanctuary at the present time has to rely on 1) monitoring that was designed to answer other needs and may have a limited ability to address these specific questions; 2) assembling a variety of diverse data types; and 3) expert professional judgment to develop new inferences and assess overall sanctuary conditions based on these diverse data types.

In an effort to document the information and the process used to arrive at the conclusions in this report, all contributors were asked how much of their assessment was derived directly from monitoring data, from data published in peer-reviewed literature, or from their own professional experience and judgment. Specifically, each contributor was asked to report the relative role of a) explicit, quantitative decision support models, b) management guidelines or benchmarks, or c) professional judgment in translating the information available to a status and trend ranking. Detailed results of this survey are available on request. General findings were that professional experience and judgment constituted many of the conclusions in this report, and decision support models and ecosystem benchmarks were not used when there was an absence of targeted, long-term monitoring data. More information about the methods used in compiling the report can be found in Appendix B.

State of Sanctuary Resources

This section provides summaries of the conditions and trends within four resource areas: water, habitat, living resources and maritime archaeological resources. For each, sanctuary staff and selected outside experts considered a series of questions about each resource area. The set of questions is derived from the Office of National Marine Sanctuaries' mission, and a system-wide monitoring framework (NMSP 2004) developed to ensure the timely flow of data and information to those responsible for managing and protecting resources in the ocean and coastal zone, and to those that use, depend on, and study the ecosystems encompassed by the sanctuaries. The questions address information needs that are common to nearly all sanctuaries throughout the sanctuary system. Appendix A (Rating Scheme for System-Wide Monitoring Questions) clarifies the set of questions and presents statements that were used to judge the status and assign a corresponding color code on a scale from "good" to "poor." These statements are customized for each question. In addition, the following options are available for all questions: "N/A" – the question does not apply; and "undetermined" – resource status is undetermined. In addition, symbols are used to indicate trends: " ▲ " – conditions appear to be improving; "—" – conditions do not appear to be changing; " ▼ " – conditions appear to be declining; and "?" – the trend is undetermined.

This section of the report provides answers to the set of questions. Answers are supported by specific examples of data, investigations, monitoring and observations, and the basis for judgment is provided in the text and summarized in the table for each resource area. Where published or additional information exists, the reader is provided with appropriate references and Web links.

Judging an ecosystem as having "integrity" implies the relative wholeness of ecosystem structure and function, along with the spatial and temporal variability inherent in these characteristics, as determined by the ecosystem's natural evolutionary history. Ecosystem integrity is reflected in the system's ability to produce and maintain adaptive biotic elements. Fluctuations of a system's natural characteristics, including abiotic drivers, biotic composition, complex relationships, and functional processes and redundancies are unaltered and are either likely to persist or be regained following natural disturbance.

Water

1. ***Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?*** Stressors on water quality in the sanctuary, specifically the impacts of diatom blooms, and possibly the conditions causing them, may preclude full development of living resources assemblages and habitats, but are not likely to cause substantial or persistent declines. For this reason, the rating for this question is "good/fair," however the trend is "undetermined" because of a lack of monitoring data for some parameters. Although significant sediment plumes from mainland rivers are visible from satellite images during the rainy season (Figure 20), storm events are rarely intense enough for these plumes to reach the islands (Otero and Siegel 2004). Sediment toxicity is lower in the sanctuary than in the Southern California Bight (Bay et al. 2005). Sampling conducted by the Southern California Coastal Water Research Project (a collaborative research institute for coastal environmental research) typically measures the highest water quality in and around the sanctuary, suggesting that water quality impacts from regional anthropogenic point- and non-point pollutant discharges are significantly mitigated by distance from the mainland and have probably declined over several decades due to improved regulation and management by state and federal agencies.

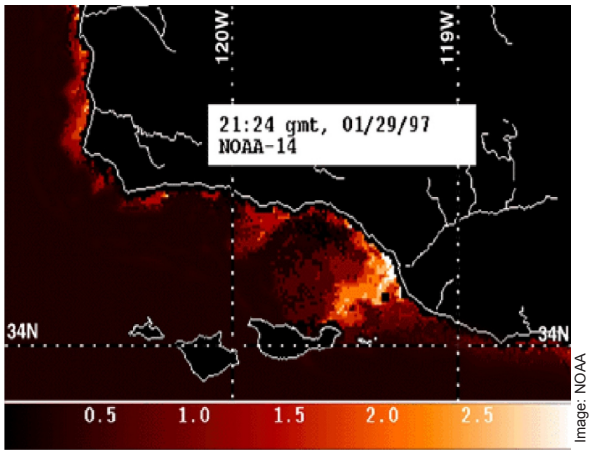


Figure 20. Satellite image of a temperature anomaly. The anomaly idicates a sediment plume originating from the Santa Clara River after a major rainfall event.

Since 2001, there has been an apparent increase in diatom blooms. These were identified as the diatom *Pseudo-nitzschia* which produces the neurotoxin domoic acid (Anderson et al. 2008), a potent neurotoxin that can cause neural damage, disorientation, short-term memory loss and even seizures, brain damage, and death in seabirds, such as cormorants and gulls, and marine mammals, such as seals and sea lions. These blooms appear to be increasing in intensity and length of season each year (Busse et al. 2006, Schnetzer et al. 2007) and they can be harmful or fatal to seabirds and marine mammals. In recent years, there have been extensive marine animal mortality events attributed to domoic acid (Gulland 2000, Scholin et al. 2000).

The effects of global climate change are currently not well understood but could adversely affect water quality through changes in ocean chemistry, seawater temperature increases, and changes in upwelling and oceanographic patterns.

2. *What is the eutrophic condition of sanctuary waters and how is it changing?* The offshore location of the islands protects the sanctuary from much of the runoff from the mainland. Therefore, eutrophic conditions do not appear to have the potential to negatively affect living resources or habitat quality. For this reason, the rating for this question is "good and not changing." The sanctuary does not experience much, if any, nutrient enrichment from mainland discharges and runoff. Nutrient delivery from mainland coastal streams and rivers is rather minimal and has been shown to account for a small portion of the annual nitrogen budget for the Santa Barbara Channel (McPhee-Shaw et al. 2007). In addition, the islands are a national park and have minimal development so there is little nutrient enrichment from streams located on the islands themselves. However, nutrient inputs generated at the islands, such as from marine mammals which historically had modest impacts, may now be affecting benthic community structure due to the synergistic impacts of multiple stressors (S. Katz, CINMS, pers. obs. 2008.). It is possible that there may be some localized effects of sewage from vessels that visit the islands, but this has not been measured adequately. In addition, discharge of untreated sewage was prohibited out to three miles from the islands and in March 2009 it became prohibited throughout the sanctuary. Spring phytoplankton blooms are primarily driven by seasonal upwelling of new nutrients from deep waters, and while there has been an apparent increase in the frequency and intensity of harmful diatom blooms (Anderson et al. 2008), the relationship between these blooms and natural and anthropogenic inputs is complex and studies are not yet conclusive (Schnetzer et al. 2007).

Water Quality Status & Trends

#	Status	Rating	Basis for Judgment	Description of Findings
1	Stressors	?	Distance from the mainland and regulations limit impacts; sampling generally indicates water quality is better at the islands than the mainland. However, there is concern about an apparent increase in the frequency and extent of diatom blooms. Also, the effects of ocean acidification, although not currently well understood, are expected to have significant impacts.	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
2	Eutrophic Condition	—	Mainland runoff does not reach the island in significant amounts and lack of development on the islands means there is little local land-based nutrient inputs; island runoff is minimal. However, there may be localized inputs from marine mammals and possibly vessel discharge.	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.
3	Human Health	—	There are no known occurrences of risks resulting from water contact or seafood consumption at the islands. However, there are known vectors for shellfish poisoning through *Pseudo-nitzschia*/domoic acid blooms although shellfish poisoning has not been reported in the sanctuary.	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.
4	Human Activities	—	Many activities are present that have the potential to harm water quality: shipping traffic, vessel discharges, DDT, and mainland land use runoff. However, they are not causing significant damage at this time.	Few or no activities occur that are likely to negatively affect water quality.

Status: Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

Trends: Improving (▲), Not Changing (**–**), Declining (▼), Undetermined Trend (**?**), Question not applicable (**N/A**)

3. *Do sanctuary waters pose risks to human health?* No known illnesses have been reported from eating shellfish harvested from the Channel Islands sanctuary. However, several potential risks to human health do exist. For this reason, the rating for this question is rated as "good/fair and not changing." For example, recreationally harvested shellfish species such as scallops and clams that are harvested during *Pseudo-nitzschia* blooms may cause shellfish poisoning in humans (Novelli et al. 1992). Quarantines are established by the state of California during these outbreaks.

A potential threat of swimming in the ocean is illness resulting from contact with harmful bacteria. However, there are no known health risks from swimming in sanctuary waters. The sanctuary is not subject to major sources of human fecal pollution. It is unlikely that viruses and other pathogens from mainland sewer discharges and runoff could reach the islands intact and virulent due to dilution, exposure to sunlight, and salinity. Significant elevated levels of harmful bacteria from vessel discharges were not detected in a small study conducted for the sanctuary by Santa Barbara Channelkeeper (Altstatt 2007).

4. What are the levels of human activities that may influence water quality and how are they changing? Although there are many activities that have the potential to affect water quality, sanctuary water quality appears not to have suffered significant damage from anthropogenic impacts. Therefore, the rating for this question is "good and not changing." The human activities that affect water quality in the sanctuary are shipping traffic, vessel discharges, contaminants such as DDT, and mainland land use runoff. Each year, approximately 7,000 cargo ships transit through the sanctuary; this number is expected to increase over the long term in response to increases in global trade at the Los Angeles and Long Beach port complex. Little is known about the deposition of airborne contaminants from commercial shipping traffic and the extent and effects of vessel discharges in the sanctuary. Persistent contaminants such as DDT and derivatives from pesticide industries are still detected in sediments decades after production has ceased but in lower amounts in the sanctuary compared to the mainland (Schiff et al. 2006). Mainland runoff does not currently reach the islands in significant amounts (Otero and Siegel 2004) but an increase in pollution from development and agricultural runoff coupled with significant storm events could eventually affect sanctuary water quality.

Habitat

5. What are the abundance and distribution of major habitat types and how are they changing? The abundance and distribution of major habitat types in the sanctuary is rated as "fair" based on the past and current levels of human activities that influence the distribution, abundance, and quality of benthic habitats and associated living resources. The trend is "undetermined" due to a lack of information on the extent of harm and the rate and degree of recovery of habitat and associated living resources inside recently established regulatory areas.

Approximately only a third of the sanctuary has been mapped using high resolution imaging, however deepwater areas are not well studied thus limiting the ability to quantitatively estimate the status of sanctuary habitat and how it is changing over time. Although a thorough study of the local effects of past and present trawling has not been completed in the Channel Islands sanctuary, it has been well documented to alter marine communities elsewhere. Experts believe the level of trawling activity that historically took place in the sanctuary may have degraded deep soft-bottom and some hard-bottom habitats (J. Engle, UCSB, pers. comm. 2007). Trawling has significantly decreased from historic levels as a result of the recently established Cowcod Conservation Area (2000), Rockfish Conservation Area (2002), a ban on spot prawn trawling in state waters (2003), and the creation of marine reserves (in state waters in 2003 and in federal waters in 2007) (Figure 21). Other types of fishing, such as trap gear, may also impact benthic

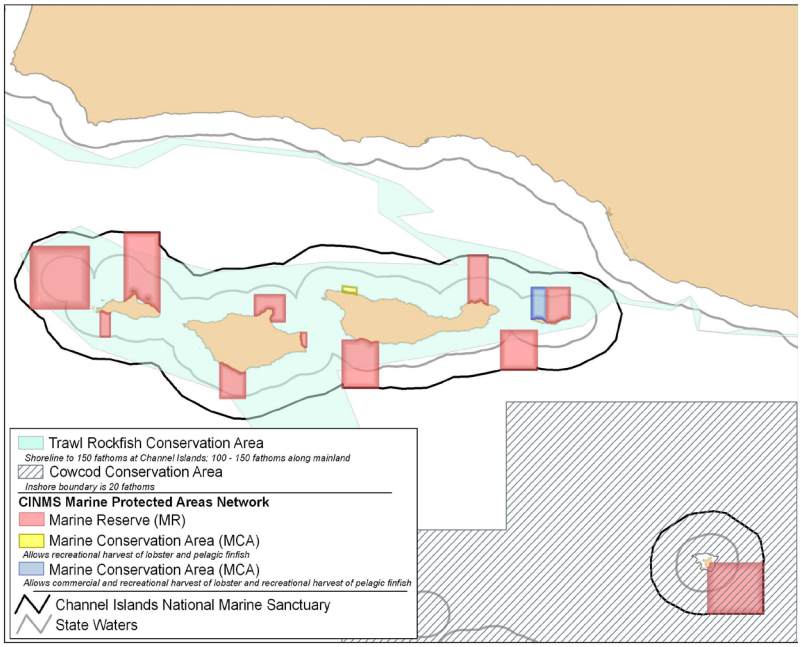


Figure 21. Restricted fishing areas within the Channel Islands sanctuary, as of August 2008.

habitat. Lost fishing gear such as nets and line continue to impact benthic areas. Considerable amounts of marine debris adversely affect pelagic and shoreline habitats (Richards 1993).

6. ***What is the condition of biologically structured habitats and how is it changing?*** The condition of biologically structured habitats in the sanctuary is rated as "fair and not changing." The historical harvest of important predators, including lobsters and sea otters, has destabilized highly diverse and productive kelp forest communities, resulting in a major, long-term loss of giant kelp and understory habitat-forming algae (especially at Santa Barbara, Anacapa, and eastern Santa Cruz Island) (Behrens and Lafferty 2004, Lafferty 2004). In addition, the destabilization of kelp forest rocky reef habitats has resulted in extensive, persistent, poor-quality urchin barrens, which are areas that have been denuded of algae by sea urchins. In the short term, however, kelp abundance in the Channel Islands region increased during 2003-2007 compared to the period 1998-2002 (CDFG et al. 2008). This increase was greater inside marine reserves than outside (CDFG et al. 2008).

   Although a thorough study of the effects of fishing activities on habitats has not been completed, trawling and trapping activities have likely degraded deep hard-bottom coral communities (including cup corals, purple hydrocoral, and gorgonian sea fans) to some unknown extent (J. Engle, UCSB, pers. comm. 2007). Recovery may be possible as a result of the creation of reserves and other relatively recent regulations that now prohibit trawling and trapping in many areas. Anchoring damages eelgrass and kelp habitats, and recreational anchoring is expected to increase. A population increase of white urchins in the 1980s resulted in a severe decline in eelgrass habitats at Anacapa Island (Engle and Miller 2005). Transplantation efforts by Santa Barbara Channelkeeper have resulted in a minor recovery of eelgrass (Altstatt 2005). Dramatic declines in rocky intertidal mussel bed community diversity as well as variable declines in biomass and bed thickness have occurred from the 1970s to 2000s at Southern California island and mainland survey locations, with declines possibly due to a climate regime shift toward warmer sea temperatures. However, it is unclear whether this is the result of a natural cycle or anthropogenically driven global climate change (Smith et al. 2006a, b).

7. ***What are the contaminant concentrations in sanctuary habitats and how are they changing?*** The relative remoteness of the Channel Islands sanctuary from mainland pollution sources and protections afforded by the Channel Islands National Park and the Channel Islands sanctuary have resulted in lower contaminant levels at the islands as compared to the mainland, and therefore the rating for this question is "good/fair and improving." Production of the pesticide DDT was halted in the early 1970s and sediment contamination is much lower in the sanctuary compared to the rest of the Southern California Bight (Schiff et al. 2006). Although production ceased, DDT and its derivatives are still found in sediments, pelagic forage fish, invertebrates (Jarvis et al. 2007), and marine mammals (Blasius and Goodmanlowe 2008), indicating that the toxins are still accessible to marine organisms in the Southern California Bight. Suspended sediment plumes from mainland storm runoff, which may contain pollutants, do not commonly reach the islands (Otero and Siegel 2004). Illegal discharges from vessels occur to an unknown extent and vessel groundings occasionally release petroleum and other chemicals. Several small vessels have run aground in the sanctuary in recent years with associated minor fuel and shipboard chemical spills (i.e., lubricants, solvents, paints) that quickly dissipate and/or breakdown. Potential oil and other chemical spills from platforms and vessels remain a threat.

8. ***What are the levels of human activities that may influence habitat quality and how are they changing?*** The level of human activity impacting sanctuary habitat quality is rated as "fair." The trend of human impacts is "improving" because trawling and trapping activities have significantly decreased since the creation of no-take reserves and other fishery regulations. Past harvesting of sea otters and continued substantial commercial and sport harvest of fish and invertebrates have reduced habitat quality, particularly on rocky reefs by directly removing top predators and community dominants and indirectly reducing productive, habitat-forming seaweed assemblages (via release from predation of grazers that results in an increase in herbivory). Marine debris (including dumped trash and lost fishing gear that can continue to trap animals), illegal vessel discharges, and anchoring can harm or damage sanctuary habitat. Oil platform production and commercial vessel traffic continue to be potential sources of catastrophic impacts should major spills or accidents occur. Commercial and recreational fishing activities have declined in reserve areas that are off-limits to fishing, but visitation by non-consumptive users has remained nearly constant (Senyk et al. 2008). Enforcement of marine reserves appears to be effective and outreach efforts have increased public awareness of regulations (CDFG et al. 2008).

Habitat Status & Trends

#	Status	Rating	Basis for Judgment	Description of Findings
5	Abundance/ Distribution	?	Past trawling, lost fishing gear, and marine debris have harmed habitats, although little is known about deepwater habitats. Recent trawl bans and other regulations may improve conditions.	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources or water quality.
6	Structure	–	Long-term loss of giant kelp and understory habitat-forming algae, trawling damage to hard-bottom coral communities, anchor damage to eelgrass and kelp, declines in eelgrass as a result of white urchin increases, decline in mussel bed community diversity, biomass, and bed thickness. Short term increases in kelp, an eelgrass restoration project, reserves, and trawl regulations may help habitats recover.	Selected habitat loss or alteration may inhibit the development of living resources and may cause measurable but not severe declines in living resources or water quality.
7	Contaminants	▲	Distance from mainland reduces impacts from mainland discharges, DDT still detectable but some species recovering, vessel discharges are present but regulations have kept contamination at low levels.	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.
8	Human Activities	▲	Impacts to habitat quality may have resulted from historic or current direct or incidental extraction of biogenic species, marine debris, vessel discharges, and anchoring; creation of reserves and other fishing regulations may improve conditions.	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized, not widespread.

Status: Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

Trends: Improving (▲), Not Changing (–), Declining (▼), Undetermined Trend (**?**), Question not applicable (**N/A**)

Living Resources

9. What is the status of biodiversity and how is it changing? Biodiversity is variation of life at all levels of biological organization, and also commonly encompasses diversity within a species (genetic diversity) and among species (species diversity), and comparative diversity among ecosystems (ecosystem diversity). This report focuses on species diversity. Overall the biodiversity in the Channel Islands sanctuary is rated as "fair" and the trend is "unknown." Although thorough historic and current comparative evaluations of species are not available to fully measure biodiversity status, there are key components that have been altered and indicate compromised biodiversity. Sanctuary-wide extraction of fish and invertebrates by commercial and recreational fishing has led to conditions that are far from pristine for all ecosystems. Recreational and commercial fishing has removed fish, such as sheephead, kelp bass, and rockfish, and invertebrates, such as lobster and abalone, and this extraction has altered the ecosystem. At San Miguel, Santa Rosa, and the western portion of Santa Cruz Island, where fishing pressure is lower, there are lush kelp forests with high biodiversity. However, even these locations are missing key species such as sea otters and larger individuals of some fish species (D. Kushner, CINP, pers. comm. 2007). At the eastern end of the island chain, Anacapa Island, Santa Barbara Island, and the eastern portion of Santa Cruz Island where fishing pressure is greater, there has been an overall decline in biodiversity in many areas (D. Kushner, CINP, pers. comm. 2007). However, recent studies comparing no-take reserves to fished areas show that there are more species of fish inside reserves than outside (CDFG et al. 2008).

Many areas that previously supported kelp forests or eelgrass beds are now dominated by one or more species of echinoderms

Photo: Robert Schwemmer, NOAA

Figure 22. Lobsters and urchins in Channel Islands National Marine Sanctuary.

(urchins and brittle stars) and have lower biodiversity (J. Altstatt, Santa Barbara Channelkeeper (SBCK), pers. comm. 2007, J. Engle, UCSB, pers. comm. 2007) (Figure 22). In some nearshore areas around Anacapa, brittle stars have been found at densities greater than 1000 per square meter (Altstatt 2005). Although some species can coexist with urchins, areas dominated by brittlestars appear to prevent the colonization of other species (J. Altstatt, SBCK, pers. comm. 2007). In addition, throughout the sanctuary abalone, rockfish, shark, and swordfish populations have been severely depleted (D. Richards, CINP, pers. comm. 2007). In the intertidal community, there has been a decrease in abundance and diversity of mussel bed communities (Smith et al. 2006a, b). Less is known about the biodiversity in deepwater habitats, where technological challenges make studying this habitat difficult. Advances in technology are just now emerging to make this more feasible.

10. What is the status of environmentally sustainable fishing and how is it changing? The status and trend ratings for this question are based on the available scientific knowledge (e.g., published studies, unpublished data, and expert opinion) of targeted and non-targeted living resources that are directly and indirectly affected by fishing. Because this is the sanctuary's first condition report, the rating reflects a more historical view of the potential effects of fishing activity on biological community development, function, and ecosystem integrity, over the last two to three decades. Subsequent reports will take a more contemporary view of the ecosystem level impacts of fishing. The rating does not serve as an assessment of the status of current fisheries management practices in the region. However, the determination of an increasing trend for this question does reflect recent changes in fisheries management practices and their positive effects on living resources in the sanctuary.

The status of environmentally sustainable fishing is rated "fair/poor" and the trend is "improving." Environmentally sustainable fishing protects the fish and the environment in which they live while allowing responsible use of the species that come from that environment. It is designed to protect the integrity of ecosystem structure, productivity, function and biodiversity, including habitat and associated dependent and ecologically related biological communities. Historical records indicate commercial and recreational fishing at the Channel Islands has occurred since the 1800s and sustenance fishing occurred as early as thousands of years ago. Marine communities at the Channel Islands are subject to complex pressures and interactions, and many targeted species are long lived. Therefore, fishery management actions aiming to allow population recovery may experience a long lag period before changes are observed.

Despite the long history of extraction, fisheries managers at state and federal resource agencies appear optimistic that fishery stocks are being managed sustainably. The NOAA National Marine Fisheries Service (NOAA Fisheries) uses the following definitions that set the standards by which Federal fisheries managers determine the status of federally managed stocks (NOAA FIsheries 2008):

- A stock that is subject to overfishing has a fishing mortality (harvest) rate above the level that provides for the maximum sustainable yield.

- A stock that is overfished has a biomass level below a biological threshold specified in its fishery management plan.

By these definitions and NOAA Fisheries research, none of the federally managed fisheries in the area of the sanctuary are subject to overfishing, and only four Pacific groundfish species remain in an overfished status. These four remaining overfished species – cowcod, bocaccio, dark-blotched rockfish, and yelloweye rockfish – are all covered by rebuilding plans and are making progress at meeting their rebuilding targets (NOAA Fisheries 2008). Likewise, state fisheries managers are optimistic about improved environmental conditions and more sustainable fisheries for those species managed by the state of California (such as squid, spiny lobster, red sea urchin, sea cucumber, kelp bass, rock crab, prawns, and sheephead) as a result of recent regulatory changes.

However, the question of environmentally sustainable fishing considered for this report is broader than stock assessments and incorporates concepts such as size structure, trophic interactions, biodiversity, bycatch removal, and ecosystem integrity. Local experts report conditions and long-term changes in the fish and invertebrate populations and communities that suggest that environmentally sustainable fishing goals are compromised, at least until a number of key populations have recovered from past overfishing.

At least in part as a result of past or historic fishing, declines have occurred in several species of sharks, giant sea bass, swordfish, various rockfish, and abalone populations (Leet et al. 2001, Rogers-Bennet et al. 2004). Even though the harvest of certain species has ended in a few areas, populations remain well below historic numbers. For example, as a result of a combination of fishing and disease, black and white abalone populations have decreased to the point that they are listed as federally endangered species, and red abalone are rare in Southern California, except at San Miguel Island. Populations of other species have shifted towards smaller sizes, such as red sea urchins, lobster, and sheephead in some areas where fishing occurs (D. Richards, CINP, pers. comm. 2007). Size is an important factor

in environmentally sustainable fishing because larger organisms have higher fecundity and make a greater contribution to healthy, robust populations. Changes in size, abundance, and diversity can have effects throughout the food web. For example, extraction of lobster has led to an increase in urchins and a decrease in kelp abundance in some areas (Behrens and Lafferty 2004).

Another concern is the methods used in some fisheries. Gill netting, which can have substantive bycatch, is allowed in some areas of the sanctuary, but not within one mile of the islands. The Channel Islands sanctuary defines bycatch as catch of non-target species; note however, that NOAA Fisheries does not consider organisms as bycatch if they are marketable, and therefore distinguishes between economic and regulatory bycatch. Gill netting in the sanctuary generally targets white sea bass, flatfish, swordfish, and sharks, but can entangle many other species, including other fin fish, mammals, birds, and turtles. In addition, lost lobster or fish traps can indiscriminately capture marine organisms.

Finally, there is concern about indirect effects of fishing to other animals in the sanctuary. Seabird researchers are concerned about effects of: a) fishing of northern anchovy and Pacific sardine on prey availability for Brown Pelicans [note, however, that the federal Coastal Pelagic Species Fishery Management Plan incorporates 150,000 metric tonnes for ecosystem forage needs]; b) bycatch from gill-net fishing on cormorants and alcids; c) bycatch of pelicans from recreational fishing; and d) disturbance of colonial surface-nesting seabirds and roosting seabirds by fishing, diving, and boating activities near shore: and e) light pollution impacts (i.e., increased avian predation or increased nest abandonment) from squid fishing on small seabirds (e.g., Xantus's Murrelets, Ashy Storm-Petrels) that visit nesting colonies only at night or collide with lighted structures or vessels (Gress and Anderson 1983, Carter et al. 2000, Carter et al. 2008). Studies are needed to better assess fishing impacts on seabirds, especially boat disturbance and light pollution.

In recent years many new regulations have gone into effect including federal abalone fishery closures, a network of marine reserves regulated by both the state and federal government, a gill net ban within one mile of the islands, Rockfish Conservation Area, Cowcod Conservation Area, spot trawl ban, Essential Fish Habitat designation, and new regulations on nearshore fishery species (see Figure 21, Question 5). All of these regulatory actions contribute to the "improving" trend of this issue. However, historic fishing pressure has had impacts that are still evident in the environment. Furthermore, fishing is still allowed in most of the sanctuary and there are significant gaps in our knowledge of fishery effects, basic life history, and ecosystem dynamics that impede management certainty that fishing is not having undue and unexpected deleterious effects on overall ecosystem health.

11. What is the status of non-indigenous species and how is it changing?

The status of non-indigenous species in the marine environment is rated "good" and the trend is "getting worse" because although invasives do not appear to be much of an issue at present, there are several algal species (including *Undaria pinnatifida*, *Sargassum filicinum*, and *Caulacanthus ustulatus*) that are appearing in Southern California and have proliferated at Santa Catalina Island and other areas (Miller et al. 2006). The Japanese brown alga *Undaria pinnatifida* has been found in Santa Barbara and Ventura Harbors and the brown alga *Sargassum filicinum* has been found at Santa Catalina Island (Miller et al. 2006). The Asian red alga *Caulacanthus ustulatus* has been observed at one site at Anacapa Island. If these species become established and widespread at the islands, they could outcompete native species and adversely affect species richness and diversity patterns in the invaded habitats. Several ongoing monitoring programs record observations of invasive species as part of their standard procedures, so the sanctuary is hopeful that early detection can be achieved.

12. What is the status of key species and how is it changing?

The overall status of key species in the sanctuary is rated as "fair" and the trend is "not changing." Key species in the sanctuary include urchins, sunflower star, California spiny lobster, sheephead, giant sea bass, rockfish and other fish species, red abalone, and sea otters. Key seabird species include Brown Pelicans, Brandt's Cormorants, Cassin's Auklets, Xantus's Murrelets, and Ashy Storm-Petrels. Four species of whales are key species: fin, humpback, blue, and gray.

In areas where kelp forests are present, some key fish species have increased (D. Kushner, CINP, pers. comm. 2007) and reserves may be helping fish species to recover (CDFG et al. 2008). Populations of giant sea bass, once abundant, have improved in recent years, but levels are still well below historic populations and they remain vulnerable to both legal incidental harvest in gill net fisheries and poaching (Leet et al. 2001). Although once persistent, kelp beds have become more transient in nature; of 16 sites originally designated by the National Park Service in 1981 as kelp forest monitoring sites, only one, within a long-standing no-take reserve at Landing Cove on Anacapa Island, has remained persistent over a 20-plus year survey (Lafferty and Behrens 2005). Kelp may be reduced as a result of fishing impacts to other species, such as spiny lobster, which prey on sea urchins (Lafferty 2004). When predators are removed, sea urchins can increase and thus reduce kelp on which they graze. Red abalone and sea otters are key species that were once abundant in the sanctuary and have been depleted as a result of disease and historic harvesting. Both species are now protected, but recovery has not yet been observed. Both black and

Photo: Jeff Wiant

Figure 23. Brown Pelicans in the Channel Islands sanctuary.

Photo: Robert Schwemmer, NOAA

Figure 24. Humpback whale and Shearwater in Channel Islands sanctuary.

white abalone, which were once common in the sanctuary, are now listed under the federal Endangered Species Act.

Deepwater habitat includes a majority of area in the sanctuary and contains key species unique to that habitat. However, little is known about this habitat, and key species in deepwater cannot be identified at this time. Monitoring in deep water is logistically challenging and expensive and will require working with remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), or submersibles.. The sanctuary is working to develop a deepwater monitoring plan and acquire funding to be able to address this issue.

Seabirds feed at a high trophic level and are good indicators of ecosystem health. There is a variety of impacts to seabird populations. More than 30 years after DDT was banned, there have been dramatic improvements in Brown Pelicans (Gress 1995, unpubl. data). In 2008, the U.S. Fish and Wildlife Service proposed to remove California Brown Pelicans (Figure 23) from the U.S. endangered species list. Brandt's Cormorant populations fluctuate dramatically with population declines during major El Niño events (1992-93, 1998), and population increases in intervening years (Carter et al. 1996, Capitolo et al. 2008). In general, cormorants are maintaining large populations and have recovered to a substantial degree from many past human disturbance factors and pollutant issues. Cassin's Auklet populations are declining, apparently in relation to changes in prey resources possibly related to climate change (Adams 2008). About a third to a half of the world population of this species occurs in the sanctuary (Karnovsky et al. 2005, Carter unpubl. data), and it was listed by the state of California as threatened in 2004 (Burkett et al. 2003), with a federal listing decision pending. Xantus's Murrelets are declining at Santa Barbara Island due to impacts from high levels of egg predation by high population levels of native deer mouse, and high levels of adult predation by avian predators (e.g., owls, falcons, and gulls) (Burkett et al 2003). Recent invasive rat eradication from Anacapa Island is helping the nesting population at this location to recover (Whitworth et al. 2006). Ashy Storm-Petrels are found almost exclusively in California, in addition to a colony in Northern Baja, and the Channel Islands sanctuary hosts about half of the world population (Carter et al. 1992). This species was petitioned in 2007 to be listed under the federal Endangered Species Act. Ashy Storm-Petrels in the Channel Islands may be declining due to continuing effects of pollutants (e.g., DDT and PCB), high predation of adults by avian predators, human disturbance, and light pollution (Carter et al. 2008). After an absence of breeding for many years, Tufted Puffins bred at San Miguel Island from 1991-1997 but no longer breed there today (H. R. Carter, Carter Biological Consulting, unpubl. data). Rhinoceros Auklets have bred at San Miguel Island since 1991 and were not known to breed there in the past (Carter et al. 1992, unpubl. data). Common Murres have not bred at San Miguel Island since the early 1900s, but birds have been attending breeding habitats since 1999 and may soon recolonize (H.R. Carter, Carter Biological Consulting, unpubl. data).

Raptors are top trophic predators that feed on seabirds, fish, or scavenge marine mammal carcasses. Raptors at the Channel Islands - Peregrine Falcons, Bald Eagles, and Osprey - were extirpated from the Channel Islands by the effects of DDT. Peregrine Falcons have returned to breed in relatively large numbers in the Channel Islands after significant efforts to reintroduce them to the islands. Efforts to reintroduce bald eagles to Santa Cruz Island have had initial moderate success, with successful natural breeding, nesting, and fledging by several adult pairs. Osprey have not yet been reintroduced.

Four species of baleen whales use the sanctuary for significant feeding grounds or migration routes: fin, humpback (Figure 24),

blue, and gray whales can be found in the sanctuary during parts of the year. Fin whale numbers appear to still be depleted from commercial whaling, and they remain listed as endangered. However, there have been indications of increased sightings of fin whales in many areas and it is expected they are making a recovery from whaling. Data on this is very limited, and increased sightings could be caused by shifts in distribution rather than an actual increase in population size (J. Calambokidis, Cascadia Research, pers. comm. 2008).

Humpback abundance off the U.S. West Coast appears to be increasing steadily at about 8% per year, although there was a slight decline after the 1998 El Niño (Calambokidis and Barlow 2004, Calambokidis et al. 2005). They are now expected to number around 20,000 in the North Pacific, approaching the numbers thought to exist prior to whaling (Calambokidis et al. 2008). In recent years, humpback whales off California have switched from feeding predominantly on krill to fish (J. Calambokidis, Cascadia Research, pers. comm. 2007). This switch may reflect declines in available krill that could also be affecting blue whales, and possibly other species. This decline in their primary food source may negatively affect humpback abundance in the sanctuary over the longer term.

The blue whale population status over the long term has been improving, but there have been indications of declining conditions in recent years. There was an apparent dramatic decline in blue whale abundance off California in 2001 and 2005 compared to the 1990s (Barlow and Forney 2007). This may be related to evidence of increasing use by blue whales of feeding areas outside California, including waters off Mexico, British Columbia, and Alaska (Calambokidis et al. 2007). Blue whales are exclusively krill feeders and may be more vulnerable to the apparent local declines in krill abundance, based on recent declines in local krill-feeding bird species and the locally observed switch in prey of humpback whales. At this point it is not possible to determine if this change in whale distribution is part of a natural cycle or related to climate change. An additional and emerging threat to large whales is ship strikes, which has affected blue whales locally. In 2007 several dead blue whales were discovered in the region, two of which were confirmed ship strikes. The sanctuary and an interagency subcommittee responded to this event with increased monitoring for the presence of blue whales, and by recommending a voluntary speed reduction for cargo ships in the Santa Barbara Channel during blue whale season (generally in the late summer and fall months).

Gray whales steadily recovered from whaling, and in the 1990s reached what was thought to be pre-whaling numbers. In the late 1990s, the gray whale population experienced a high level of mortality and low calf production, apparently due to a combination of an increasing population and decreases in prey in the Bering Sea. This may have resulted in a decline of about a quarter of the population during this period (J. Calambodokidis, Cascadia Research, pers. comm. 2007).

13. What is the condition or health of key species and how is it changing? The overall diminished health of key species in the sanctuary is rated as "fair," however the trend is "undetermined." For example, overall abalone populations remain depressed at the islands (except at San Miguel Island), there is little indication of any recent recovery, and disease remains a concern. Abalone are susceptible to withering syndrome, and a large portion of the remaining red abalone population seems to harbor the disease, even if individuals do not exhibit symptoms (CDFG 2007). Although black abalone abundances have shown very slight increases in recent years, disease occurrences for this important key intertidal species continue. In 2008, black abalone were listed under the federal Endangered Species Act. Echinoderm diseases (especially in sea urchins and seastars) are common, but little is known about the cause or effects.

Size of marine organisms is important because larger individuals have higher reproductive fitness. Outside of marine reserves (see Figure 21, Question 5), large spiny lobsters are uncommon but have increased inside reserves (CDFG et al. 2008). Though several species of fish (e.g., sheephead and kelp bass) appear to have increased in abundance recently (probably due to favorable oceanographic conditions), their size distribution has not changed appreciably (presumably due to fishing pressure). These fish also remain noticeably small at several of the islands (mainly Santa Barbara, Anacapa, and the eastern portion of Santa Cruz Island) (D. Kushner, CINP, pers. comm. 2007).

Populations of some species of seabirds plummeted as a result of eggshell thinning caused by the pesticide DDT. Since production ceased in the 1970s populations have been recovering (H. Carter, Carter Biological Consulting, pers. comm. 2007, CINP Brown Pelican Web site, Engle 2006, Sydeman et al. 2001, CINP Bald Eagle Web site). In addition to effects on seabirds, fish, invertebrates (Jarvis et al. 2007) and marine mammals (Blasius and Goodmanlowe 2008) have measurable levels of DDT in the Southern California Bight.

Cassin's Auklets have had high nesting failures in recent years, and this may be a result of reduced food sources due to changing oceanographic conditions (Adams 2008). Xantus's Murrelets nested later in 2005-2007, though nesting was earlier in 2008 (Whitworth et al. 2006, Whitworth unpubl. data). Ashy Storm-Petrels at Santa Cruz Island have had declines in nest-

ing at some locations as a result of skunk predation and light pollution (Carter et al. 2007, Carter et al. 2008, unpubl. data). These changes may reflect changes in food availability, predation, habitat, or other resources.

14. What are the levels of human activities that may influence living resource quality and how are they changing? Human activities influencing living resource quality in the sanctuary is rated as "fair and getting worse." Although there are some impacts that are becoming less severe, these are overwhelmed by others that are getting worse. For example, it appears that improved fishing regulations and marine reserves (see Figure 21, Question 5) may allow populations to recover although historic sanctuary-wide extraction has led to severe declines in some exploited species, such as abalone, lobster, and rockfish. In contrast, there are some impacts that are increasing in frequency and severity. A growing human population provides the potential for increasing visitation which could increase the chance for potential introduction of species and disturbance. Mechanisms of disturbance include anchoring, noise, lights, trash, increased harvest pressure, and illegal fishing.

An increase in recreational diving, kayaking, boating, and wildlife watching could bring harm by disturbing wildlife and habitats. People who land on shore could trample seabird nests or intertidal animals. Wildlife disturbance from recreational boats and disturbance of the seabed from anchoring are also concerns. Eelgrass beds in high-use anchorages such as Scorpion and Prisoners at Santa Cruz Island experience frequent scarring from anchoring (J. Altstatt, SBCK, pers. comm., 2007). Over the long term, shipping traffic is expected to increase in the Santa Barbara Channel, potentially increasing the risk of air and water pollution, a wreck, spill, collision with marine mammals or other vessels, and the introduction of invasive species through ballast water.

Unfortunately, these localized impacts are likely to be overwhelmed in the longer term by the adverse and wide-ranging effects of anthropogenically caused climate change effects on sea level, air and water temperatures, and ocean chemistry.

Living Resources Status & Trends

#	Status	Rating	Basis for Judgment	Description of Findings
9	Biodiversity	?	Extraction of fish (e.g., sheephead, kelp bass, rockfish) and invertebrate (e.g., lobster and abalone) species has decreased biodiversity and simplified community structures (e.g., dominance of urchins and brittlestars).	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
10	Extracted Species	▲	Declines have occurred in several species of sharks, giant sea bass, swordfish, various rockfish, and abalone populations; recent implementation of marine reserves may improve conditions.	Extraction has caused or is likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.
11	Non-Indigenous Species	▼	No problematic species have become established; there is concern that invasive algae from mainland harbors and Catalina could reach the islands.	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function)
12	Key Species	–	Removal of key species, including sea otters, led to an increase in urchins and urchin barrens. Some species (black sea bass and lobsters) have shown recent increases, but do not approach historic levels.	The reduced abundance of selected keystone species may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity; or selected key species are at reduced levels, but recovery is possible.
13	Health of Key Species	?	Withering foot syndrome in abalone, small size of fished species, low fecundity in sea birds; although some birds have shown recent recovery from historic reproductive impairment from high levels of DDT.	The diminished condition of selected key resources may cause a measurable but not severe reduction in ecological function, but recovery is possible.
14	Human Activities	▼	Increased visitation and potential disturbance along with expected climate change offset gains made in resource protection.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread

Status: Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

Trends: Improving (▲), Not Changing (–), Declining (▼), Undetermined Trend (**?**), Question not applicable (**N/A**)

Maritime Archaeological Resources

15. What is the integrity of known maritime archaeological resources and how is it changing? The integrity of submerged maritime archaeological resources is rated "fair and getting worse." A comprehensive inventory of archaeological resources began at the time of sanctuary designation in 1980 and continues today. Approximately 30 archaeological site locations have been inventoried and are in various stages of survey, including site map development and monitoring. Archival research suggests over 140 historic maritime archaeological resources, including ship and aircraft wrecks, may exist in the sanctuary (Morris and Lima 1996). Most of the known shallow water sites are in various stages of degradation due to their close proximity to shore. Sites in shallow water environments within higher energy zones are more likely to be subjected to degradation by waves, shifting sands, and strong currents. Some sites are regularly visited by divers, and in some cases, artifacts have been removed from accessible sites. It is assumed shallow-water relic hunting has declined due to enforcement, education, and the fact that most of the accessible sites have already been pilfered.

Submerged cultural material associated with Native American terrestrial sites has been recorded nearshore as a result of coastal land erosion. There is a possibility of Native American submerged materials in deeper water, in areas occupied during times of lower sea levels thousands of years ago, but such resources have not yet been discovered.

There is a greater uncertainty of the integrity of offshore submerged maritime archaeological resources in depths greater than 120 feet (36 meters). To date, only two deep offshore archaeological sites have been inventoried by NOAA in the Channel Islands sanctuary (WWII era TBF *Avenger* military aircraft and a shipwreck known as *Bar-bee*, both near Anacapa Island). No other evaluations of deepwater archaeological sites have been conducted by other federal, state, or private resource management agencies. Sites in deep water are naturally in better condition than those in shallow water because they are not impacted by strong currents and the cold, deep water environment tends to have fewer biological processes accelerating ship degradation. However, because these sites are intact they may be attractive to looters, particularly those with technical diving capabilities who may still be determined to access sites despite recent enforcement efforts. An additional probable impact in offshore waters is from bottom trawling, but because the majority of wreck locations are unknown, so are the impacts from past trawling. Trawling has recently declined in the sanctuary because of fishing regulations (see Figure 21, Question 5).

The sanctuary works in collaboration with the Channel Islands National Park, California's State Lands Commission, and Coastal Maritime Archaeology Resources organization to survey and monitor submerged sites annually. To date, one nearshore site (California Gold Rush passenger steamship *Winfield Scott*, lost 1853) has been added to the National Register of Historic Places (Figure 25).

16. Do known maritime archaeological resources pose an environmental hazard and is this threat changing? The Channel Islands sanctuary's inventory of known maritime archaeological resources suggests it is unlikely that shipwrecks within sanctuary boundaries have the potential to pose an environmental hazard to sanctuary resources due to hazardous cargoes and/or bunker fuels; therefore, this question is rated "good/fair" with an "improving" trend. Shipwrecks that once had the capacity to hold bunker fuel and hazardous cargoes have been surveyed and are no longer considered to pose a threat because degradation of hull structure has allowed materials to dissipate. A greater threat to sanctuary resources is from shipwrecks in the contiguous waters just outside the sanctuary boundaries. For example, the bulk-carrier *Pacbaroness* that sank approximately 10 nautical miles northwest of the sanctuary after a collision in 1987 carried a cargo of 21,000 metric tons of finely powdered copper concentrate, 339,360 gallons of fuel oil, and 10,015 gallons of lubricating oil. Due

Photo: Deborah Marx Collection

Figure 25. Side-wheel passenger steamer Winfield Scott lost at Anacapa Island in 1853 is the earliest recorded shipwreck at Channel Islands and is on the National Register for Historic Places.

to the prevailing current and wind, the oil was transported in close proximity of San Miguel Island, considered to be one of the most biologically rich of the islands within the sanctuary. A northerly flowing current became predominant over the wind and carried the oil away from the sanctuary before it reached shore. Other submerged vessels that could pose a threat may include those that have been scuttled by the military to dispose of weapons. A military disposal site exists off Santa Cruz Island; research to date has not identified the existence of hazardous maritime archaeological resources.

17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing? Human activities affecting maritime archaeological resources in the sanctuary are minimal. Therefore, the rating for this question is "fair and improving." Site looting (where objects are intentionally pilfered from submerged sites) was a major threat to submerged archaeological resources including these historic shipwrecks: California Gold Rush passenger steamer *Winfield Scott* lost in 1853, 19th-century-built sailing ship *Aggi* lost in 1915 (Figure 26), 19th-century bark *Goldenhorn* lost in 1892, 19th-century-built cargo/passenger steamer *Cuba* lost in 1923 (Figure 27), and 19th-century steamship collier *Crown of England* lost in 1894. With the successful prosecution of sport divers involved in site looting in the 1980s along with expanded education and outreach programs established by the sanctuary, the risk of looting has declined (Schwemmer 2001). Other potential impacts to archaeological sites include sport divers accidentally causing injury through poor diving techniques such as inadvertently holding onto fragile artifacts or striking them with scuba tanks. Vessel activities, such as anchor drags or modern ship groundings, can also cause serious injury to submerged archaeological resources.

Historical and recent bottom trawling is one probable impact to offshore maritime archaeological resources from which these resources cannot recover. Recently, the numbers of trawlers and areas available to trawling have decreased due to management regulations. With the recent trawl closures, the shift of fishing effort to new areas may increase risk to resources that have not been impacted in the past. Because the majority of wreck locations are unknown, the impacts from historical and recent trawling are unknown.

Photo: Robert Schwemmer, NOAA

Figure 26. NPS diver Kelly Minas installing permanent datum stations at the *Aggi* shipwreck site to assist archaeologists in accurately mapping the distribution of artifacts.

Photo: Lester Family Collection

Figure 27. Pacific Mail Steamship Company's passenger-cargo steamer *Cuba* was lost off San Miguel Island in 1923 due to navigational error in fog.

Maritime Archaeological Resources

#	Status	Rating	Basis for Judgment	Description of Findings
15	Integrity	▼	Past looting of some shallow sites, natural deterioration of all sites contribute to declining integrity; integrity of deeper wrecks is unknown, but some accidental fouling by fishing gear may have occurred.	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific or educational value and may affect the eligibility of some sites for listing in the National Register of Historic Places.
16	Threat to Environment	▲	Sites just outside sanctuary boundaries pose a greater threat from leaching chemicals such as bunker fuels and cargos.	Selected maritime archaeological resources may pose isolated or limited environmental threats, but substantial or persistent impacts are not expected.
17	Human Activities	▲	Impacts to maritime archaeological resources may result from site looting, injury by divers, and vessel activity. Increases in education, enforcement, and trawling closures may allow for improvement.	Selected activities have resulted in measurable impacts to maritime archaeological resources, but evidence suggests effects are localized, not widespread.

Status: Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

Trends: Improving (▲), Not Changing (–), Declining (▼), Undetermined Trend (?), Question not applicable (**N/A**)

Response to Pressures

Photo: Channel Islands sanctuary

RV *Shearwater*.

Regulatory Setting

Channel Islands National Marine Sanctuary is an area of complex jurisdiction and management. The sanctuary boundary extends from mean high tide at the islands out to six nautical miles. State jurisdiction extends from mean high tide to three nautical miles. Channel Islands National Park property includes most of the land of the islands offshore to one nautical mile. The military owns San Miguel Island, although it is actively managed by the National Park Service, and the non-profit organization The Nature Conservancy also owns the western three-quarters of Santa Cruz Island. Other government agencies that operate in the sanctuary and exercise authority over portions of the resources include: NOAA's National Marine Fisheries Service (NOAA Fisheries), Pacific Fishery Management Council (PFMC), U.S. Coast Guard, Minerals Management Service, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, California State Lands Commission, California Coastal Commission, California Department of Fish and Game, California Fish and Game Commission, California Department of Boating and Waterways, California State Water Resources Control Board, Central Coast Regional Water Quality Control Board, California Environmental Protection Agency, California Air Resources Board, Santa Barbara and Ventura County government, and Santa Barbara and Ventura counties' Air Pollution Control Districts. The sanctuary works in cooperation with all of these organizations. Sanctuary regulations can be found on the sanctuary Web site and in the sanctuary's management plan. The management plan was revised in 2009 and includes updates to management and operational strategies and regulations.

Commercial and Recreational Fishing

Although living marine resources have been historically depleted, current regulations and oversight aim to improve their status. NOAA's National Marine Fisheries Service regulates commercial and recreational fishing in federal waters, and California Department of Fish and Game regulates fishing in state waters. Current regulations include a Rockfish Conservation Area and a Cowcod Conservation Area that prohibits bottom fishing. In addition, there is a network of 13 marine zones which include 11 no-fishing reserves and two conservation areas that allow some forms of fishing (see Figure 21, Question 5). The first phase of implementation for these marine zones promulgated by the state established marine reserves and marine conservation areas in 2003 under state law (the California Marine Life Protection Act) that extend from mean high water to the state waters boundary at three miles. In July 2007, under a combination of the National Marine Sanctuaries Act and Magnuson Stevens Act, some of these zones were extended to the federal boundary at six nautical miles, and one new zone was established (the "Footprint" marine reserve south of the Anacapa Passage between Anacapa and Santa Cruz Islands).

In addition to spatial closures, gear restrictions have also been implemented. Over the last decade, bottom-trawling activities were restricted in sanctuary waters. The California state legislature passed a bill in the

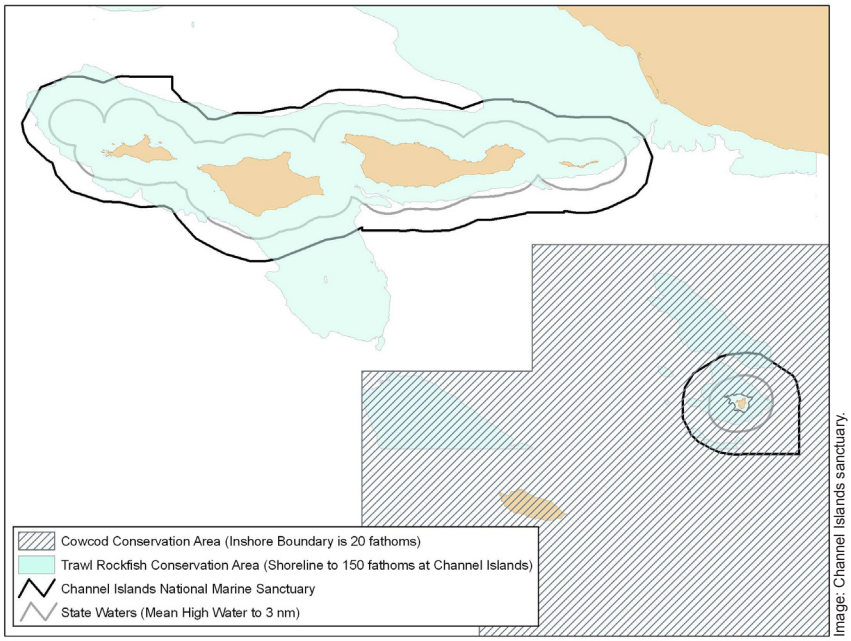


Figure 28.
Two of the major fishing regulations in the sanctuary are the Cowcod Conservation Area and the Trawl Rockfish Conservation Area.

1990s prohibiting bottom-trawling in most state waters out to three nautical miles (5.5 km) offshore. Revision of this legislation in 2006 extended the prohibition to all state waters with some exemptions for areas and fisheries. Since some of this trawling had occurred on hard bottom, this action resulted in protection of sensitive benthic habitat.

The PFMC together with the NOAA Fisheries has prohibited bottom trawling in two types of zones – a Trawl Rockfish Conservation Area (Figure 28) and Essential Fish Habitat. The Trawl Rockfish Conservation Area was closed beginning in 2002 to prevent bycatch of depleted rockfish species. The upper and lower boundaries of this closure have changed slightly over time, but generally encompass the seafloor between 100 and 150 fathoms (180 and 275 meters). NOAA Fisheries identified the Essential Fish Habitat trawl closure areas in consultation with the trawling industry and they were implemented in June of 2006. A Cowcod Conservation Area encompasses Santa Barbara Island and prohibits bottom fishing in this area (Figure 28).

The sanctuary's response to pressures on living marine resources has been to work cooperatively on regulations, enforcement, and monitoring. Implementation of the network of marine protected areas within the sanctuary was accomplished by working closely with public stakeholders, the state, and NOAA Fisheries. To ensure compliance with regulations, the Channel Islands sanctuary has cooperative agreements with the U.S. Coast Guard, Channel Islands National Park, and the CA Department of Fish and Game for enforcement through surveillance and patrols. This cooperative effort ensures what is believed to be a high level of compliance.

Continuing to monitor living marine resources in terms of marine reserve effectiveness and developing comprehensive monitoring to address some of the issues in this report is a priority. Scientists at universities, government agencies, and non-profit organizations work in partnership with the sanctuary to monitor the effectiveness of the reserves. In addition, the sanctuary has a socioeconomic monitoring plan in place. The first five-year evaluation of these marine reserves occurred in 2008 (CDFG et al. 2008). Preliminary results suggest the reserves may have higher abundance and higher biomass of targeted species, but that more time is needed to confirm trends. Looking towards the future, the sanctuary aims to focus monitoring efforts on continuing long-term data sets and filling gaps in monitoring efforts.

Shipping and Boating

Shipping presents two major concerns: marine noise and whale strikes. The U.S. Coast Guard enforces federal shipping and boating regulations. In addition, the sanctuary and the state regulate discharge of sewage and graywater. The sanctuary also monitors patterns of use by vessels through the Sanctuary Aerial Monitoring Program Spatial Analysis Program (SAMSAP). This program monitors and records all locations, types of vessels, and activities during periodic overflights, which allows an analysis of vessel distribution and use of the sanctuary.

In 2004, the sanctuary advisory council addressed concerns about anthropogenic noise by unanimously adopting and forwarding a report created by the conservation working group on anthro-

pogenic noise in the sanctuary to the sanctuary superintendent. The report focused on noise from ships and other sources such as military activities, construction, oil and gas production, and smaller boats (Polefka 2004). Sanctuary staff took this report under advisement and began implementing some of its recommendations, including developing research partnerships. The sanctuary has partnered with Dr. John Hildebrand and researchers in his lab at Scripps Institution of Oceanography, who monitor ship traffic using the Automated Identification System (AIS). In addition, the researchers monitor marine mammal noise and marine mammal response to noise in the sanctuary. Using the AIS information and noise recordings from the Santa Barbara Channel, the researchers can begin to understand the noise in the channel from both marine mammals and ships, and ultimately plan to study the animals' behavioral response to noise.

In response to a number of blue whale deaths in 2007 – several of which were confirmed ship strikes – the sanctuary began work to protect large cetaceans in the sanctuary and Santa Barbara Channel. Sanctuary staff engaged the sanctuary advisory council, and created a subcommittee of council members to address the issue. The subcommittee drafted a prevention and response plan and, through the U.S. Coast Guard, implemented a Notice to Mariners in 2008 advising ships to slow down voluntarily while in the Santa Barbara Channel during periods when whales were believed to be present. Sanctuary staff flew weekly or biweekly survey flights of the shipping lanes to record the presence of whales. The sanctuary education team, a working group of the sanctuary advisory council, is exploring ways to improve outreach to ship operators and crews. Analysis of the effectiveness of these protective actions and plans for future measures are being evaluated.

In addition, Dr. John Calambokidis with Cascadia Research tags whales to obtain information about their short term movements, diving behavior, and acoustic behavior and environment. In light of recent events, he is focusing on whales in and around the shipping lanes and works closely with the Hildebrand lab and the sanctuary. Dr. Bruce Mate of Oregon State University uses tags that stay attached to blue whales over long periods, and provides information about long-range movements. Many questions remain about ships and whales, such as understanding the biological and physical conditions in the ocean that determine the distribution and behavior of large whales with respect to coastal shipping lanes, and understanding how large whales respond to ship presence and noise.

Offshore Oil and Gas Industry

The Minerals Management Service regulates oil and gas activities in federal waters. Sanctuary regulations prohibit new oil and gas exploration within the sanctuary. There are 39 federal leases in the Channel Islands region, two of which pre-date sanctuary designation and overlap the sanctuary at its eastern boundary. To minimize the effects of a spill, oil companies and responding agencies have contingency plans in place. The sanctuary participates in oil spill response readiness training and coordinates closely with the U.S. Coast Guard and the state of California's Office of Spill Prevention and Response. The sanctuary's response readiness includes training sanctuary staff, development of a response manual, and use of two databases called SHIELDS (Sanctuary Hazardous Incident Emergency Logistics Database Systems) and RUST (Resources and Under Sea Threats). SHIELDS provides national marine sanctuary superintendents and staff with a Web-based hazards contingency plan and set of response tools to identify resources at risk, additional threats, available response and information assets, notification contacts, maps and jurisdictional information. It includes GIS maps, environmental sensitivity indexes, resources at risk information, and various coastal observation systems. RUST stores information on undersea threats associated with cultural resources and hazards. This may include lost cargo, dumpsites, ordnance, shipwrecks, and aircraft wrecks.

Climate Change

The impacts of global-scale climate change are already significant, and local-scale effects will be profoundly transformative. However, uncertainty still remains as to the eventual magnitude of climate alteration on local ecosystem condition. Consequently, precise local-scale forecasts of global climate change are not possible. Uncertainty results from both our limited ability to forecast climate change drivers and an incomplete understanding of the local ecosystem and how it is coupled to the global climate system. This forecast uncertainty makes it difficult to prioritize responses to climate change at the sanctuary scale. What little is known about climate change is that almost all driving processes and many responses operate on larger scales far beyond the sanctuary's jurisdiction, significantly limiting the ability of the sanctuary to develop climate change response or management strategies.

Current sanctuary responses to this pressure are to develop a synthetic and comprehensive monitoring program that is designed to inform 1) a more mature understanding of how local-scale ecosystem processes are coupled to global-scale climate and 2) how the local-scale ecosystem is responding to climate alteration. Deployment of such a monitoring effort is dependent on funding availability. However, sanctuary staff has significant expertise in climate process impacts on local ecosystems, and can leverage this expertise with local academic and agency partners to increase the likelihood of successful monitoring program development. In addition, concerned members of the sanctuary advisory council are working with staff to characterize the carbon budget of the sanctuary. It is anticipated that improved cli-

mate impact monitoring will inform the development of management tools for mitigation and response to climate alteration. There is no guarantee however, that local scale management alternatives exist; the scales of the pressure may exceed our ability to manage. One thing we can be certain about however, is if we fail to improve our understanding of climate process in the sanctuary through research we will surely fail to identify potential mitigation alternatives.

Pollutants and Marine Debris

Numerous state and federal statutes relate to water quality. The U.S. EPA regulates water quality and discharges in federal waters, and the State Water Resources Control Board regulates state water. Notable federal statutes include the Clean Water Act, Federal Water Pollution Control Act, the Rivers and Harbors Act, the Oil Pollution Control Act of 1990, the Comprehensive Environmental Response, Compensation, and Liability Act, and the Coastal Zone Management Act. State statutes include the Porter Cologne Water Quality Control Act, the California Coastal Act, and the Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990.

Sanctuary regulations prohibit discharge of any material into the sanctuary, with some exceptions for routine vessel operations and lawful fishing activities. Discharge of untreated sewage is prohibited throughout the sanctuary (and within the three-mile boundary of all state waters). In sanctuary waters, vessels under 300 gross registered tons may discharge waste that has been treated with a type I or type II marine sanitation device. Large ships (300 gross tons or larger) are prohibited from discharging in the sanctuary, regardless of treatment. However, this does not preclude pollution or marine debris released outside sanctuary boundaries from entering.

Toxic algal blooms in response to changes in ocean conditions can result in the periodic toxicity of shellfish. The state Department of Public Health maintains a monitoring program to track blooms and disseminate information (CA Dept. of Public Health Web site, Marine Biotoxin Monitoring Reports).

In response to a recognition that more information is needed about the water quality of the sanctuary, the conservation working group of the sanctuary advisory council developed a water quality needs assessment that was subsequently unanimously adopted by the council in 2005 (Polger et al. 2005). The assessment includes recommendations for development of a water quality program. As part of a response to this assessment, a water quality characterization is being developed to document the known sources of water quality impairments, research activities, and data sets. This document will be followed by water quality actions and implementation. The sanctuary also participates in and supports several water quality monitoring and research programs, including bacteria monitoring at popular island anchorages, and monitoring through the Southern California Coastal Water Research Project. The available data is good, but is temporally and spatially limited. Although the water quality at the sanctuary is believed to be good, a more rigorous monitoring plan is desired. An ideal plan would cover more area of the sanctuary, sample at regular intervals, and would provide information on standard environmental parameters such as salinity, temperature, dissolved oxygen, chlorophyll, currents, and other parameters. This data would not only inform an assessment of water quality, but would provide a link between physical, chemical, and biological processes. In addition, this information could be used in analysis of other pressures mentioned in this report, such as climate change and threats to living marine resources.

In 2006, the SeaDoc Society at UC Davis, in partnership with NOAA's Marine Debris Program, initiated a lost fishing gear removal project that recovered 10 tons of fishing gear from the sanctuary – mainly lobster traps and some seine nets. The SeaDoc Society continues to work on this project. The sanctuary welcomes this and other marine debris removal partnerships.

Visitor Use

There are no prohibitions on entry into the sanctuary except for large ships within one nautical mile of the islands. However, the offshore location of the sanctuary limits access to visitors with private boats (Figure 29), or those on charter cruises and concessionaire boats. Although increased visitor use creates increased pressure on sanctuary resources, it is also an opportunity to inform users and build support for the public resource. To balance visitor use with resource protection, sanctuary education and outreach programs inform users about the special resources found in the sanctuary and ways that they can protect them. Staff and volunteers distribute educational brochures at public events and to businesses. The sanctuary's main outreach brochure, "Protecting Your Channel Islands" has been distributed to thousands of users and continues to be updated and reprinted. Channel Islands Naturalist Corps volunteers are present on whale watching trips, island transportation vessels, and island hikes to interpret sanctuary rules and resource information. In 2008, 150 members of the Naturalist Corps volunteered over 30,000 hours interpreting the resources in the Channel Islands National Marine Sanctuary, Channel Islands National Park, and Santa Barbara Channel to visitors (Figure 30). Channel Islands sanctuary, the sanctuary advisory council, and the sanctuary education team (a working group of the council) continue to look for opportunities to reach visitors. To reach more visitors from diverse audiences, sanctuary staff is working to develop new outreach materials such as signs at boat ramps, films, brochures, educational programs, and interactive electronic kiosks.

Photo: Robert Schwemmer, NOAA

Figure 29. Recreational boaters at Pelican Bay Santa Cruz Island.

Photo: Channel Islands sanctuary

Figure 30. Channel Islands Naturalist Corps volunteers interpret the resources of the Channel Islands Sanctuary and Channel Islands National Park to the public.

Concluding Remarks

This initial report on resource status and trends for the Channel Islands National Marine Sanctuary indicates the need for management actions that address the degraded conditions of some key habitats and living resources in the sanctuary. Seven categories relating to habitat and living resources have "fair" ratings. In addition, one living resources category has a "fair/poor" rating. On the other hand, the general status for water quality appears to be "good" to "good/fair" and the status for maritime archaeological resources appears to be "good/fair" to "fair". The report suggests that habitats and living resources need to be closely monitored and restored.

Channel Islands National Marine Sanctuary is committed to taking the collected information in this condition report, based largely on best professional judgment, as a framework to prioritize and economize future monitoring needed to quantitatively and rigorously verify these assessments and the effectiveness of continuing and future management actions. Sanctuary staff will work closely with partners to focus future work on these priorities.

Sound research and monitoring programs will continue to be an essential precursor to management at the Channel Islands National Marine Sanctuary. Through its management plan and condition report, the sanctuary and its partners will set a course of action for the restoration and protection of the sanctuary's rich natural resources and cultural legacy.

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Cited Resources

Abbott, I.A. and G.J. Hollenberg. 1976. Marine algae of California. Stanford University Press, Stanford, CA.

Adams, J. 2008. Cassin's Auklet (*Ptychoramphus aleuticus*) pp. 204-212. *In*: W.D. Shuford and T. Gardali (eds.). California bird species of special concern: a ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California.

Adams, J., J.Y. Takekawa, and H.R. Carter. 2004. Stable foraging areas and variable chick diet in Cassin's auklets (*Ptychoramphus aleuticus*) off Southern California. Canadian Journal of Zoology. Vol 82. pp. 1578-1595.

Altstatt J. 2005. Restoration of a historic eelgrass (*Zostera marina*) bed at Frenchy's Cove, Anacapa Island. Proceedings of the Sixth California Islands Symposium. D.K. Garcelon and C. A. Schwemm (Eds.) National Park Service Technical Publication CHIS-05-01, Institute for Wildlife Studies, Arcata, CA. 397-403pp.

Altstatt, J. 2007. Final Report on Santa Barbara Channelkeeper/CINMS 2006 Pilot Water Quality Monitoring Project Submitted to CINMS by Santa Barbara Channelkeeper on July 27, 2007.

Anderson, C.R., D.A. Siegel, N. Guillocheau, M.A. Brzezinski. 2008. Controls on temporal patterns in phytoplankton community structure in the Santa Barbara Channel, California. Journal of Geophysical Research 113:C04038.

Andrew, R.K., B.M. Howe, J.A. Mercer, M.A. Dzieciuch. 2002. Ocean ambient sound: comparing the 1960s with the 1990s for a receiver off the California coast. Acoustics Research Letters Online 3(2)47-82.

Archer, C.L. and K. Caldeira. 2008. Historical trends in the jet streams, Geophysical Research Letters 35, L08803, doi:10.1029/2008GL033614

Bane, J.M., Y.H. Spitz, R.M. Letelier, W.T. Peterson. 2007. Jet stream intraseasonal oscillations drive dominant ecosystem variations in Oregon's summertime. Proceedings of the National Academy of Sciences. 104(33)13262-13267.

Barlow, J. and K. Forney. 2007. Abundance and population density of cetaceans in the California current system. Fishery Bulletin 105:509-526.

Barth, J.A., B.A. Menge, J. Lubchenco, F. Chan, J.M. Bane, A.R. Kirincich,M.A. McManus, K.J. Nielsen, S.D. Pierce, and L. Washburn. 2007. Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California current. PNAS March 6, 2007 vol. 104 no. 10 3719-3724.

Bay, S.M., T. Mikel, K. Schiff, S. Mathison, B. Hester, D. Young, D. Greenstein. 2005. Southern California Bight 2003 regional monitoring program: I. Sediment Toxicity. Southern California Coastal Water Research Project. Westminster, CA.

Behrens, M.D. and K.D. Lafferty. 2004. Effects of marine reserves and urchin disease on Southern California rocky reef communities. Marine Ecology Progress Series 279: 129-139. Electronic document available from: http://www.werc.usgs.gov/chis/pdfs/Behrens&Lafferty2004.pdf

Blasius, M. and G. Goodmanlowe. 2008. Contaminants still high in top level carnivores in the Southern California Bight: levels of DDT and PCBs in resident and transient pinnipeds. Marine Pollution Bulletin 56(12):1973-1982.

Burkett, E.E., N.A. Rojek, A.E. Henry, M.J. Fluharty, L. Comrack, P.R. Kelly, A.C. Mahaney, K.M. Fien. 2003. Report to the California Fish and Game Commission: status review of Xantus's Murrelet (*Synthliboramphus hypoleucus*) in California. Unpublished report, California Department of Fish and Game, Habitat Conservation Planning Branch, Status Report 2003-01, Sacramento, California. 70pp (plus appendices).

Busse L.B., E.L. Venrick, R. Antrobus, P.E. Miller, V. Vigilant, M.W. Silver, C. Mengelt, L. Mydlarz, B. Prezelin. 2006. Domoic acid in phytoplankton and fish in San Diego, CA, USA. Harmful Algae 5:91-101.

Calambokidis, J. and J. Barlow. 2004. Abundance of blue and humpback whales in the eastern North Pacific estimated by capture-recapture and line-transect methods. Marine Mammal Science 20(1):63-85.

Calambokidis, J., J. Barlow, E.A. Falcone, L. Schlender, A.B. Douglas, G.H. Steiger, K.B. Ford. 2005. Changes in abundance of humpback whales off the west coast of the U.S. Abstract (Proceedings) 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA, December 12-16, 2005.

Calambokidis, J., A. Douglas, E. Falcone, and L. Schlender. 2007. Abundance of blue whales off the US West Coast using photographic identification. Conducted Report for PO: AB133F06SE3906 from Southwest Fisheries Science Center, La Jolla, CA. Electronic document available from: www.cascadiaresearch.org

Calambokidis, J., E.A. Falcone, T.J. Quinn, A.M. Burdin, P. Clapham, J.K.B. Ford, C.M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B.L. Taylor, J. Urbán, D. Weller, B.H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific, Final report for Contract AB133F-03-RP-00078. Electronic document available from: http://www.cascadiaresearch.org/SPLASH/splash.htm

California Department of Public Health, Marine Biotoxin Monitoring Reports http://www.cdph.ca.gov/healthinfo/environhealth/water/Pages/shellfishreports.aspx

Capitolo. P.J., J.N. Davis, L.A. Henkel, W.B. Tyler, and H.R. Carter. 2008. Aerial photographic surveys of breeding colonies of Brandt's, Double-Crested, and Pelagic Cormorants in Southern California, 2005-2007. Unpublished report, University of California, Institute of Marine Sciences, Santa Cruz, California. 49pp.

Carr, M.H. 1994. Effects of macroalgal dynamics on recruitment of a temperate reef fish. Ecology 75(5):1320-1333.

Carter, H.R., G.J. McChesney, D.L. Jaques, C.S. Strong, M.W. Parker, J.E. Takekawa, D.I. Jory, D.L. Whitworth. 1992. Breeding populations of seabirds in California, 1989-1991. Volume I - Population estimates. Unpublished report, U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center Dixon, California. 491pp.

Carter, H.R., G.J. McChesney, J.E. Takekawa, L.K. Ochikubo, D.L. Whitworth, T.W. Keeney, W.R. McIver, C.S. Strong. 1996. Population monitoring of seabirds in California: 1993-1995 aerial photographic surveys of breeding colonies of Common Murres, Brandt's Cormorants and Double-crested Cormorants. Unpublished final report, U.S. Geological Survey, California Science Center, Dixon, California.

Carter, H.R., D.L. Whitworth, J.Y. Takekawa, T.W. Keeney, P.R. Kelly. 2000. At-sea threats to Xantus' Murrelets (*Synthliboramphus hypoleucus*) in the Southern California Bight. pp. 435-447. *In*: D.R. Browne, K.L. Mitchell, H.W. Chaney (eds.). Proceedings of the fifth California Islands symposium. 29 March to 1 April 1999. U.S. Minerals Management Service, Camarillo, California.

Carter, H.R., W.R. McIver, J. Adams, J.Y. Takekawa. 2007. Population monitoring of Ashy Storm-Petrels and Cassin's Auklets at Santa Cruz Island, California, in 2006. Unpublished report, Carter Biological Consulting, Victoria, British Columbia; U.S. Fish and Wildlife Service, Ventura, California; and U.S. Geological Survey, Moss Landing & Vallejo, California. 32pp.

Carter, H.R., W.R. McIver, G.J. McChesney. 2008. Ashy Storm-Petrel (*Oceanodroma homochroa*). pp. 117-124. *In*: W.D. Shuford, and T. Gardali (eds.). California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California.

CDFG (California Department of Fish and Game). 2005. Final market squid fishery management plan. Electronic document available from: http://www.dfg.ca.gov/marine/msfmp/index.asp

CDFG (California Department of Fish and Game). 2006. California sea urchin fishery report: 2005 wrap-up. Electronic document available from: http://www.dfg.ca.gov/marine/seaurchin/su_report_0406.pdf

CDFG (California Department of Fish and Game). 2007. Presentation to Channel Islands National Marine Sanctuary Advisory Council Research Activities Panel, February 28, 2007. Available from CINMS.

CDFG (California Department of Fish and Game), Partnership for Interdisciplinary Studies of Coastal Oceans, Channel Islands National Marine Sanctuary, and Channel Islands National Park. 2008. Channel Islands Marine Protected Areas: First 5 Years of Monitoring: 2003-2008.

Airamé, S. and J. Ugoretz (eds.). 20pp. Electronic document available from: http://www.dfg.ca.gov/marine/channel_islands/fiveyears.asp

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 387(6630):253-260.

Dayton, P.K. 1985. Ecology of kelp communities. Annual Review of Ecological Systems 16:215-45.

Dayton P.K., S. F. Thrush, M. T. Agardy, R. J. Hofman, 1995, Environmental effects of marine fishing. Aquatic Conservation: Marine and Freshwater Ecosystems 5(3)205-232.

Den Hartog, C. 1970. The sea-grasses of the world. North Holland Pub. Co., Amsterdam, The Netherlands.

Derraik, J.G.B. 2002. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin 44(9)842-852.

Dugan, J.E. and G.E. Davis. 1993. Applications of marine refugia to coastal fisheries management. Canadian Journal of Fisheries and Aquatic Sciences 50:2029-2042.

Evans, D.L. and G.R. England. 2001. Joint interim report, Bahamas marine mammal stranding event of 15-16 March 2000. Electronic document available from: http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_bahamas2000.pdf

Engle, J.M. and K.A. Miller 2005, Distribution and Morphology of Eelgrass (*Zostera marina*) at the California Channel Islands. Proceedings of the Sixth California Islands Symposium, Ventura, California, Dec 1-3, 2003, National Park Service Technical Publication CHIS-05-01, Institute for Wildlife Studies, Arcata, California. pp 405-414

Engle, D.L. 2006. Assessment of coast water resources and watershed conditions at Channel Islands National Park, California. Technical Report NPS/NRWRD/NRTR-2006/354.

Fabry, V.J., B.A. Seibel, R.A. Feely, J.C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. ICES Journal of Marine Science 65:414–432.

Fonseca M.S. and J.S. Fisher. 1986. A comparison of canopy friction and sediment movement between four species of seagrass with reference to their ecology and restoration. Marine Ecology Progress Series 29:15-22.

Geiger, D. L. 1999. Distribution and biogeography of the recent Haliotidae (Gastropoda: Vetigastropoda) world-wide. Int. J. Malacology 120pp.

Graham, M.H. 2004. Effects of local deforestation on the diversity and structure of Southern California giant kelp forest food webs. Ecosystems 7(4): 341-357.

Gress, F. 1995. Organochlorines, eggshell thinning, and productivity relationships in Brown Pelicans breeding in the Southern California Bight. Ph.D. dissertation, University of California Davis, California.

Gress, F. and D.W. Anderson. 1983. A recovery plan for the California Brown Pelican. U.S. Fish and Wildlife Service, Portland, Oregon.

Gulland, F. 2000. Domoic acid toxicity in California sea lions (*Zalophus californianus*) stranded along the central California coast, May-October 1998. Report to the National Marine Fisheries Service Working Group on Unusual Marine Mammal Mortality Events. U.S. Department Commerce, NOAA Tech. Memo. NMFS-OPR-17 45pp.

Harms, S. and C.D. Winant. 1998. Characteristic patterns of the circulation in the Santa Barbara channel. Journal of Geophysical Research 103(C2)3041-3065.

Harrington, J.M., R.A. Myers, A.A. Rosenberg. 2005. Wasted fishery resources: discarded bycatch in the USA. Fish and Fisheries 6:350-361.

Hastings, M.C. 1991. Harmful effects of underwater sound on fish. Journal of the Acoustical Society of America 90(4)2335.

Hays, G.C., A.J. Richardson, C. Robinson. 2005. Climate change and marine plankton. Trends in Ecology and Evolution 20(6):337-344.

Heck, K.L., G. Hays, R.J. Orth. 2003. Critical evaluation of the nursery role hypothesis for seagrass beds. Marine Ecology Progress Series 253: 123-136.

Hemminga, M. and C.M. Duarte. 2000. Seagrass Ecology. Cambridge (United Kingdom): Cambridge University Press.

Hendershott, M.C. and C.D. Winant. 1996. Surface circulation in the Santa Barbara Channel. Oceanography 9(2):114-121.

Hobday, A.J., M.J. Tegner, P.L. Haaker. 2001. Over-exploitation of a broadcast spawning marine invertebrate: decline of the white abalone. Reviews in Fish Biology and Fisheries 10:493–514.

Hornafius, J.S., D.C. Quigley, B.P. Luyendyk. 1999. The world's most spectacular marine hydrocarbons seeps (Coal Oil Point, Santa Barbara Channel, California): quantification of emissions. Journal Geophysical Research 104(C9): 20703-20711.

Jackson, J.B.C., M.X. Kirby, W.H. Berger, K.A. Bjorndal, L.W. Botsford, B.J. Bourque, R.H. Bradbury, R. Cooke, J. Erlandson, J.A. Estes, T.P. Hughes, S. Kidwell, C.B. Lange, H.S. Lenihan, J.M. Pandolfi, C.H. Peterson, R.S. Steneck, M.J. Tegner, R.R. Warner. 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293:629 – 637.

Jarvis, E., K. Schiff, L. Sabin, M.J. Allen. 2007. Chlorinated hydrocarbons in pelagic forage fishes and squid of the Southern California bight, USA. Southern California Coastal Water Research Project, Annual Report. pp 245-258.

Johnson, J.R., T.W. Stafford, H.O. Ajie, D.P. Morris, Arlington Springs revisited. 1999. 541-545pp. *In*: Browne, D K. Mitchell and H. Chaney (eds), Proceedings of the Fifth California Islands Symposium. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Jones, J.B. 1992. Environmental impact of trawling on the seabed – a review. New Zealand Journal of Marine and Freshwater Research 26(1):59-67.

Karnovsky, N.J., Spear, L.B., Carter, H.R., Ainley, D.G., Amey, K.D., Ballance, L.T., Briggs, K.T., Ford, R.G., Hunt, G.L., Jr., Keiper, C., Mason, J.W., Morgan, K.H., Pitman, R.L. and Tynan, C.T. 2005. At-sea distribution, abundance and habitat affinities of Xantus's Murrelets. Marine Ornithology 33:89-104.

Ketten, D.R. 1998. Marine mammal auditory systems: a summary of audiometric and anatomical data and its implications for underwater acoustic impacts. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center Technical Memorandum No. NOAA-TM-NMFS-SWFSC 256.

Lafferty, K.D. 2004. Fishing for lobsters indirectly increases epidemics in sea urchins. Ecological Applications 14:6 1566-1573.

Lafferty K.D. and M.D. Behrens, 2005. Temporal variation in the state of rocky reefs: does fishing increase the vulnerability of kelp forests to disturbance? Proceedings of the Sixth California Islands Symposium. 2005. D.K. Garcelon and C.A. Schwemm (Eds.). National Park Service Technical Publication CHIS-05-01, Institute for Wildlife Studies, Arcata, CA. 499-508pp.

Leatherwood, S., R. Reeves, W. Perrin, W. Evans. 1982. Whales, dolphins and porpoises of the eastern north Pacific and adjacent arctic waters. NOAA Technical Report, National Marine Fisheries Service.

Leatherwood, S., B. Stewart, P. Folkens. 1987. Cetaceans of the Channel Islands National Marine Sanctuary. Channel Islands National Marine Sanctuary, NOAA and the National Marine Fisheries Service.

Leet, W.S., C.M. Dewees, R. Klingbeil, E.J. Larson. 2001. California's living marine resources: a status report, California Department of Fish and Game.University of California. Agriculture and Natural Resources. Publication SG01-11.

Leeworthy, V.R. and P.C. Wiley. 2003 Socioeconomic impact analysis prepared for the Channel Islands National Marine Sanctuary. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects Office, Silver Spring, Maryland.

Love, M.S., J.E. Caselle, W. Van Buskirk. 1998. A severe decline in the commercial passenger fishing vessel rockfish (*Sebastes* spp.) catch

in the Southern California bight, 1980-1996. CalCOFI Report 39:180-195.

Mantua N.J. and S.R. Hare. 2002. The Pacific decadal oscillation. Journal of Oceanography 58: 35-44.

McGowan, J.A., D.R. Cayan, L.M. Dorman. 1998. Climate-ocean variability and ecosystem response in the northeast Pacific. Science 281(5374):210-217.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins. 2006. J. Acoust. Soc. Am. 120 (2)711-718.

McPhee-Shaw, E.E., D.A. Siegel, L. Washburn, M.A. Brzezinski, J.L. Jones, A. Leydecker, J. Melack. 2007. Mechanisms for nutrient delivery to the inner shelf: observations from the Santa Barbara Channel. Limnology and Oceanography 52(5):1748–1766.

Miller, K.A., J.M. Engle, S. Uwai, H. Kawai. 2006. First report of the Asian seaweed *Sargassum filicinum* Harvey (Fucales) in California, USA. Biological Invasions 9(5)609-613.

Morris, D. P. and Lima, J. 1996. Channel Islands National Park and Channel Islands National Marine Sanctuary - submerged cultural resources assessment. Submerged Cultural Resources Unit National Park Service.

Murray, S.N. and R.N. Bray. 1993. Benthic macrophytes. pp 304-368 *In*: M.D. Dailey, D.J. Reish, J.W. Anderson (eds.). Ecology of the Southern California bight: a synthesis and interpretation. University of California Press, Berkeley, CA pp. 304-368.

Myrberg, A.A. Jr. 1990. The effects of man-made noise on the behavior of marine animals. Environment International 16:575-586.

NMSP (National Marine Sanctuary Program). 2004. A monitoring framework for the national marine sanctuary system. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. Silver Spring, MD. 22pp.

NOAA Fisheries (NOAA National Marine Fisheries Service). 2008. Annual report to congress on the status of U.S. Fisheries-2007, U.S. Department of Commerce, NOAA, Natl., Mar. Fish. Serv., Silver Spring, MD, 23pp. Electronic document available from: http://www.nmfs.noaa.gov/sfa/statusoffisheries/SOSmain.htm

Norris, R.M. and R.W. Webb. 1990. Geology of California. John Wiley and Sons, New York.

Novelli, A., M.T. Fernandez-Sanchez, J. Kispert, A. Torrelanca, S. Gascon, V. Zitko. 1992. The amnesic shellfish poison domoic acid enhances neurotoxicity by excitatory amino acids in cultured neurons. Amino Acids 2(3)233-244.

Orth, R.J., K.L. Heck Jr,, J. Van Montfrans. 1984. Faunal communities in seagrass beds: a review of the influence of plant structure and prey characteristics on predator-prey relationships. Estuaries 7(4A):339-350.

Otero, M.P. and D.A. Siegel. 2004. Spatial and temporal characteristics of sediment plumes and phytoplankton blooms in the Santa Barbara Channel. Deep-Sea Research II 51:1129-1149.

Polefka, S. 2004. Anthropogenic noise and the Channel Islands National Marine Sanctuary, a report by the Environmental Defense Center. Adopted by the Channel Islands National Marine Sanctuary Advisory Council. Unpublished report. Electronic document available from: http://www.channelislands.noaa.gov/sac/report_doc.html

Polger S., S. Polefka, A. Eastley. 2005. A water quality needs assessment for the Channel Islands National Marine Sanctuary, submitted to the Channel Islands National Marine Sanctuary Advisory Council by the Conservation Working Group. Electronic document available from: http://www.channelislands.noaa.gov/sac/report_doc.html.

Port of Long Beach. 2005. Annual report and facilities guide, Port of Long Beach annual report 2005.

Raupach, M.R., G. Marland, P. Ciais, C. Le Que´ re´ , J.G. Canadell, G. Klepper, C.B. Field. 2007. Global and regional drivers of accelerating CO2 emissions. Proceedings of the National Academy of Sciences 104(24)10288-10293.

Resources Agency of California. 1997. California's Ocean Resources: An Agenda for the Future. Electronic document available from: http://

resources.ca.gov/ocean/97Agenda/PDF

Richards, D.V. 1993. Marine debris monitoring program 1993 annual report, National Park Service, Channel Islands National Park, Technical Report CHIS-94-04.

Richardson, W.J. and B. Wursig. 1997. Influences of man-made noise and other human actions on cetacean behaviour. Marine and Freshwater Behavior and Physiology 29(1-4):183-209.

Rogers-Bennett L., B. L. Allen, and G. E. Davis. 2004. Measuring abalone (*Haliotis* spp.) recruitment in California to examine recruitment overfishing and recovery criteria. Journal of Shellfish Research 23(4): 1201-1207.

Santa Barbara County Air Pollution Control District. 2006. Marine shipping emissions, maritime working group meeting presentation, September 12, 2006 Electronic document available from: http://www.sbcapcd.org/itg/download/tmm9-12-06.pdf

Schiff, K., K. Maruya, K. Christensen. 2006. Southern California Bight 2003 Regional Monitoring Program: II. Sediment Chemistry.Southern California Coastal Water Research Project. Westminster, CA.

Schnetzer A., P.E. Miller, R.A. Schaffner, B.A. Stauffer, B.H. Jones, S.B. Weisberg, P.M. DiGiacomo, w.M. Berelson, D.A. Caron. 2007. Blooms of *Pseudo-nitzschia* and domoic acid in the San Pedro Channel and Los Angeles harbor areas of the Southern California Bight, 2003-2004. Harmful Algae 6:327-387.

Scholin, C.A., F. Gulland, G.J. Doucette, S. Benson, M. Busman, F. Chavez, J. Cordaro, E.F. Delong, A.D. Vogelaere, J. Harvey, M. Haulena, K. Lefebvre, T. Lipscomb, S. Loscutoff, L.J. Lowenstine, R. Marin III, P.E. Miller, W.A. McLellan, P.D.R. Moeller, C.L. Powell, T. Rowles, P. Silvagni, M.W. Silver, T. Spraker, V.L. Trainer, F.M.V. Dolah. 2000. Mortality of sea lions along the central California coast linked to a toxic diatom bloom. Nature 403:80-84.

Schwemmer, R. 2001. Shipwreck *Winfield Scott* Artifact Disturbance Report Recorded 25 July 2001. Channel Islands National Marine Sanctuary unpublished report.

Schwemmer, R. 2002. Shipwrecks as environmental threats to California's National Marine Sanctuaries California and World Ocean Conference, Santa Barbara, California. pp 785-796 *In*: California and the World Ocean '02: Revisiting and Revising California's Ocean Agenda: Proceedings of the Conference, October 27-30, 2002, Santa Barbara California (Reston, VA: American Society of Civil Engineers, 2005).

Senyk, N., D. Greenberg, B. Waltenberger. 2008. Changes in vessel distribution before and after state marine protected areas were established. Presented at the Channel Islands Marine Reserves Symposium Special Session, February 8, 2008.

Smith, J.R., P. Fong, R.F. Ambrose. 2006a. Dramatic declines in mussel community diversity: response to climate change? Ecology 87:1153-1161.

Smith, J.R., R.F. Ambrose, P. Fong. 2006b. Long-term change in mussel (*Mytilus californianus* Conrad) populations along the wave-exposed coast of Southern California. Marine Biology 149:537-545.

Smith, R.I. and J.T. Carlton. 1975. Light's manual: Intertidal invertebrates of the central California coast, 3rd Edition. University of California Press, Berkeley, CA.

Southall, B.L. 2005. Shipping Noise and Marine Mammals: a Forum for Science, Management, and Technology. Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium. U.S. NOAA Fisheries, Arlington, Virginia, May 18-19, 2004, 40 pp.

Straughan, D. and R. W. Klink. 1980. A taxonomic listing of common marine invertebrate species from Southern California. Technical Report No. 3 Prep. by Allan Hancock Foundation, University of Southern California, Los Angeles, CA.

Sydeman W.J., M.M. Hester, J.A. Thayer, F. Gress, P. Martin, J. Buffa. 2001. Climate change, reproductive performance and diet composition of marine birds in the Southern California Current system, 1969-1997. Progress in Oceanography 49:309-329.

Tegner, M.J. and P.K. Dayton. 2000. Ecosystem effects of fishing in kelp forest communities. ICES Journal of Marine Science 57(3):579-589.

Thompson, B., J. Dixon, S. Schroeter, D.J. Reish. 1993. Benthic Invertebrates. *In*: Ecology of the Southern California bight: a synthesis and interpretation. M.D. Daily, D.J. Resih, J.W. Anderson (eds.) University of California Press, Berkeley, CA., pp. 369-458.

Tissot, B.N., M.M. Yoklavich, M.S. Love, K. York, M. Amend. 2006. Benthic invertebrates that form habitat on deep banks off Southern California, with special reference to deep sea coral. Fishery Bulletin 102(2)167-181.

U.S. Census bureau 2000 Web site http://www.census.gov/main/www/cen2000.html

U.S. Department of Commerce., National Oceanic and Atmospheric Administration, National Marine Sanctuary Program. 2007. Channel Islands National Marine Sanctuary final environmental impact statement for the consideration of marine reserves and marine conservation areas. Silver Spring, MD.

Watling, L. and E.A. Norse. 1998. Disturbance of the seabed by mobile fishing gear: a comparison to forest clearcutting. Conservation Biology 12(6):1180-1197.

Watts, J., B. Fulfrost, J. Erlandson. 2008. Searching for Santarosae, The Santarosae Maritime Landscape Survey. Reconstructing paleo-environments to find submerged evidence of human habitation. Society for Historical Archeology Conference 2008.

Whitworth, D.L., J.S. Koepke, H.R. Carter, F. Gress, D. Lipski. 2006. Nest monitoring of Xantus's Murrelets at Anacapa Island, California: 2006 annual report. Unpublished report, California Institute of Environmental Studies, Davis, California (prepared for the American Trader Trustee Council and Channel Islands National Park). 27pp.

Winant, C.D., E.P. Dever, M.C. Hendershott. 2003. Characteristics patterns of shelf circulation at the boundary between central and Southern California. Journal of Geophysical Research 108(C2):3021.

Additional Resources

California Air Resources Board http://www.arb.ca.gov

California Coastal Commission http://www.coastal.ca.gov

California Department of Boating and Waterways http://www.dbw.ca.gov

California Department of Fish and Game http://www.dfg.ca.gov

California Department of Public Health http://www.cdph.ca.gov

California Environmental Protection Agency http://www.calepa.ca.gov

California Fish and Game Commission http://www.fgc.ca.gov

California Office of Spill Prevention and Response http://www.dfg.ca.gov/ospr

California State Lands Commission http://www.slc.ca.gov

California State Water Resources Control Board http://www.swrcb.ca.gov

Cascadia Research http://www.cascadiaresearch.org

Center for Coastal Studies http://www.coastalstudies.org

Central Coast Regional Water Quality Control Board http://www.swrcb.ca.gov/rwqcb3

Channel Islands National Marine Sanctuary http://channelislands.noaa.gov

Channel Islands National Marine Sanctuary Management Plan http://channelislands.noaa.gov/manplan/overview.html

Channel Islands National Park http://www.nps.gov/chis

Channel Islands Naturalist Corps http://channelislands.noaa.gov/edu/edu_natc.html

CINP Bald Eagle Web site http://www.nps.gov/chis/naturescience/bald-eagles.htm

CINP Brown Pelican Web site http://www.nps.gov/chis/naturescience/brown-pelican.htm

Marine Exchange of Southern California http://www.mxsocal.org

Marine Protected Areas of the United States http://www.mpa.gov

Minerals Management Service http://www.mms.gov

National Register of Historic Places http://www.nps.gov/nr

NOAA Marine Debris Program http://marinedebris.noaa.gov

NOAA National Marine Fisheries Service http://www.nmfs.noaa.gov

NOAA National Ocean Service http://oceanservice.noaa.gov

NOAA Ocean Explorer http://www.oceanexplorer.noaa.gov/welcome.html

NOAA Office of National Marine Sanctuaries http://sanctuaries.noaa.gov

NOAA Undersea Research Center http://www.uncwil.edu/nurc

Oregon State University http://oregonstate.edu

Pacific Fishery Management Council http://www.pcouncil.org

Santa Barbara County http://www.countyofsb.org

Ventura County http://www.countyofventura.org

Santa Barbara Channelkeeper http://www.sbck.org=

Santa Barbara County Air Pollution Control District http://www.sbcapcd.org

Ventura County Air Pollution Control Districts http://www.vcapcd.org

Scripps Institution of Oceanography http://www.sio.ucsd.edu

SeaDoc Society http://www.seadocsociety.org

Southern California Coastal Observing System http://www.sccoos.org

The Nature Conservancy http://www.nature.org

U.S. Coast Guard http://www.uscg.mil

U.S. Environmental Protection Agency http://www.epa.gov

U.S. Fish and Wildlife Service http://www.fws.gov

University of California, Davis http://www.ucdavis.edu

University of California, Santa Barbara http://www.ucsb.edu

Appendix A: Rating Scheme for System-Wide Monitoring Questions

The purpose of this appendix is to clarify the 17 questions and possible responses used to report the condition of sanctuary resources in "Condition Reports" for all national marine sanctuaries. Individual staff and partners utilized this guidance, as well as their own informed and detailed understanding of the site to make judgments about the status and trends of sanctuary resources.

The questions derive from the National Marine Sanctuary System's mission, and a system-wide monitoring framework (NMSP2004) developed to ensure the timely flow of data and information to those responsible for managing and protecting resources in the ocean and coastal zone, and to those that use, depend on and study the ecosystems encompassed by the sanctuaries. They are being used to guide staff and partners at each of the 14 sites in the sanctuary system in the development of this first periodic sanctuary condition report. Evaluations of status and trends may be based on interpretation of quantitative and, when necessary, non-quantitative assessments and observations of scientists, managers and users.

Judging an ecosystem as having "integrity" implies the relative wholeness of ecosystem structure and function, along with the spatial and temporal variability inherent in these characteristics, as determined by the ecosystem's natural evolutionary history. Ecosystem integrity is reflected in the system's ability to produce and maintain adaptive biotic elements. Fluctuations of a system's natural characteristics, including abiotic drivers, biotic composition, complex relationships, and functional processes and redundancies are unaltered and are either likely to persist or be regained following natural disturbance.

Following a brief discussion about each question, statements are presented that were used to judge the status and assign a corresponding color code. These statements are customized for each question. In addition, the following options are available for all questions: " N/A" - the question does not apply; and "Undet." - resource status is undetermined.

Symbols used to indicate trends are the same for all questions: "▲ " - conditions appear to be improving; "—" - conditions do not appear to be changing; "▼ " - conditions appear to be declining; and "?" – trend is undetermined.

Water Stressors

1. Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality and how are they changing?

This is meant to capture shifts in condition arising from certain changing physical processes and anthropogenic inputs. Factors resulting in regionally accelerated rates of change in water temperature, salinity, dissolved oxygen or water clarity could all be judged to reduce water quality. Localized changes in circulation or sedimentation resulting, for example, from coastal construction or dredge spoil disposal can affect light penetration, salinity regimes, oxygen levels, productivity, waste transport and other factors that influence habitat and living resource quality. Human inputs, generally in the form of contaminants from point or nonpoint sources, including fertilizers, pesticides, hydrocarbons, heavy metals and sewage, are common causes of environmental degradation, often in combination rather than alone. Certain biotoxins, such as domoic acid, may be of particular interest to specific sanctuaries. When present in the water column, any of these contaminants can affect marine life by direct contact or ingestion, or through bioaccumulation via the food chain.

[Note: Over time, accumulation in sediments can sequester and concentrate contaminants. Their effects may manifest only when the sediments are resuspended during storm or other energetic events. In such cases, reports of status should be made under Question 7 – Habitat contaminants.]

Good	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.
Good/Fair	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
Fair	Selected conditions may inhibit the development of assemblages and may cause measurable but not severe declines in living resources and habitats.
Fair/Poor	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
Poor	Selected conditions have caused or are likely to cause severe declines in most, if not all, living resources and habitats.

Water Eutrophic Condition

2. What is the eutrophic condition of sanctuary waters and how is it changing?

Nutrient enrichment often leads to planktonic and/or benthic algae blooms. Some affect benthic communities directly through space competition. Overgrowth and other competitive interactions (e.g., accumulation of algal-sediment mats) often lead to shifts in dominance in the benthic assemblage. Disease incidence and frequency can also be affected by algae competition and the resulting chemistry along competitive boundaries. Blooms can also affect water column conditions, including light penetration and plankton availability, which can alter pelagic food webs. Harmful algal blooms often affect resources, as biotoxins are released into the water and air, and oxygen can be depleted.

Good	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.
Good/Fair	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
Fair	Selected conditions may inhibit the development of assemblages and may cause measurable but not severe declines in living resources and habitats.
Fair/Poor	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
Poor	Selected conditions have caused or are likely to cause severe declines in most if not all living resources and habitats.

Water Human Health

3. Do sanctuary waters pose risks to human health and how are they changing?

Human health concerns are generally aroused by evidence of contamination (usually bacterial or chemical) in bathing waters or fish intended for consumption. They also emerge when harmful algal blooms are reported or when cases of respiratory distress or other disorders attributable to harmful algal blooms increase dramatically. Any of these conditions should be considered in the course of judging the risk to humans posed by waters in a marine sanctuary.

Some sites may have access to specific information on beach and shellfish conditions. In particular, beaches may be closed when criteria for safe water body contact are exceeded, or shellfish harvesting may be prohibited when contaminant loads or infection rates exceed certain levels. These conditions can be evaluated in the context of the descriptions below.

Good	Conditions do not appear to have the potential to negatively affect human health.
Good/Fair	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.
Fair	Selected conditions have resulted in isolated human impacts, but evidence does not justify widespread or persistent concern.
Fair/Poor	Selected conditions have caused or are likely to cause severe impacts, but cases to date have not suggested a pervasive problem.
Poor	Selected conditions warrant widespread concern and action, as large-scale, persistent and/or repeated severe impacts are likely or have occurred.

Water
Human Activities

4. What are the levels of human activities that may influence water quality and how are they changing?

Among the human activities in or near sanctuaries that affect water quality are those involving direct discharges (transiting vessels, visiting vessels, onshore and offshore industrial facilities, public wastewater facilities), those that contribute contaminants to stream, river, and water control discharges (agriculture, runoff from impermeable surfaces through storm drains, conversion of land use), and those releasing airborne chemicals that subsequently deposit via particulates at sea (vessels, land-based traffic, power plants, manufacturing facilities, refineries). In addition, dredging and trawling can cause resuspension of contaminants in sediments.

Good	Few or no activities occur that are likely to negatively affect water quality.
Good/Fair	Some potentially harmful activities exist, but they do not appear to have had a negative effect on water quality.
Fair	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts have occurred or are likely to occur.

Habitat
Abundance & Distribution

5. What are the abundance and distribution of major habitat types and how are they changing?

Habitat loss is of paramount concern when it comes to protecting marine and terrestrial ecosystems. Of greatest concern to sanctuaries are changes caused, either directly or indirectly, by human activities. The loss of shoreline is recognized as a problem indirectly caused by human activities. Habitats with submerged aquatic vegetation are often altered by changes in water conditions in estuaries, bays, and nearshore waters. Intertidal zones can be affected for long periods by spills or by chronic pollutant exposure. Beaches and haul-out areas can be littered with dangerous marine debris, as can the water column or benthic habitats. Sandy subtidal areas and hardbottoms are frequently disturbed or destroyed by trawling. Even rocky areas several hundred meters deep are increasingly affected by certain types of trawls, bottom longlines and fish traps. Groundings, anchors and divers damage submerged reefs. Cables and pipelines disturb corridors across numerous habitat types and can be destructive if they become mobile. Shellfish dredging removes, alters and fragments habitats.

The result of these activities is the gradual reduction of the extent and quality of marine habitats. Losses can often be quantified through visual surveys and to some extent using high-resolution mapping. This question asks about the quality of habitats compared to those that would be expected without human impacts. The status depends on comparison to a baseline that existed in the past - one toward which restoration efforts might aim.

Good	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
Good/Fair	Selected habitat loss or alteration has taken place, precluding full development of living resource assemblages, but it is unlikely to cause substantial or persistent degradation in living resources or water quality.
Fair	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources or water quality.
Fair/Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in most if not all living resources or water quality.

Habitat Structure

6. What is the condition of biologically structured habitats and how is it changing?

Many organisms depend on the integrity of their habitats and that integrity is largely determined by the condition of particular living organisms. Coral reefs may be the best known examples of such biologically-structured habitats. Not only is the substrate itself biogenic, but the diverse assemblages residing within and on the reefs depend on and interact with each other in tightly linked food webs. They also depend on each other for the recycling of wastes, hygiene and the maintenance of water quality, among other requirements.

Kelp beds may not be biogenic habitats to the extent of coral reefs, but kelp provides essential habitat for assemblages that would not reside or function together without it. There are other communities of organisms that are also similarly co-dependent, such as hard-bottom communities, which may be structured by bivalves, octocorals, coralline algae, or other groups that generate essential habitat for other species. Intertidal assemblages structured by mussels, barnacles, algae and seagrass beds are other examples. This question is intended to address these types of places where organisms form structures (habitats) on which other organisms depend.

Good	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
Good/Fair	Selected habitat loss or alteration has taken place, precluding full development of living resources, but it is unlikely to cause substantial or persistent degradation in living resources or water quality.
Fair	Selected habitat loss or alteration may inhibit the development of living resources and may cause measurable but not severe declines in living resources or water quality.
Fair/Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in most if not all living resources or water quality.

Habitat Contaminants

7. What are the contaminant concentrations in sanctuary habitats and how are they changing?

This question addresses the need to understand the risk posed by contaminants within benthic formations, such as soft sediments, hard bottoms, or biogenic organisms. In the first two cases, the contaminants can become available when released via disturbance. They can also pass upwards through the food chain after being ingested by bottom dwelling prey species. The contaminants of concern generally include pesticides, hydrocarbons and heavy metals, but the specific concerns of individual sanctuaries may differ substantially.

Good	Contaminants do not appear to have the potential to negatively affect living resources or water quality.
Good/Fair	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.
Fair	Selected contaminants may inhibit the development of assemblages and may cause measurable but not severe declines in living resources or water quality.
Fair/Poor	Selected contaminants have caused or are likely to cause severe declines in some but not all living resources or water quality.
Poor	Selected contaminants have caused or are likely to cause severe declines in most if not all living resources or water quality.

Habitat
Human Activities

8. What are the levels of human activities that may influence habitat quality and how are they changing?

Human activities that degrade habitat quality do so by affecting structural (geological), biological, oceanographic, acoustic or chemical characteristics. Structural impacts include removal or mechanical alteration, including various fishing techniques (trawls, traps, dredges, longlines and even hook-and-line in some habitats), dredging channels and harbors and dumping spoil, vessel groundings, anchoring, laying pipelines and cables, installing offshore structures, discharging drill cuttings, dragging tow cables, and placing artificial reefs. Removal or alteration of critical biological components of habitats can occur along with several of the above activities, most notably trawling, groundings and cable drags. Marine debris, particularly in large quantities (e.g., lost gill nets and other types of fishing gear), can affect both biological and structural habitat components. Changes in water circulation often occur when channels are dredged, fill is added, coastal areas are reinforced, or other construction takes place. These activities affect habitat by changing food delivery, waste removal, water quality (e.g., salinity, clarity and sedimentation), recruitment patterns and a host of other factors. Acoustic impacts can occur to water column habitats and organisms from acute and chronic sources of anthropogenic noise (e.g., shipping, boating, construction). Chemical alterations most commonly occur following spills and can have both acute and chronic impacts.

Good	Few or no activities occur that are likely to negatively affect habitat quality.
Good/Fair	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.
Fair	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent and/or repeated severe impacts have occurred or are likely to occur.

Living Resources
Biodiversity

9. What is the status of biodiversity and how is it changing?

This is intended to elicit thought and assessment of the condition of living resources based on expected biodiversity levels and the interactions between species. Intact ecosystems require that all parts not only exist, but that they function together, resulting in natural symbioses, competition and predator-prey relationships. Community integrity, resistance and resilience all depend on these relationships. Abundance, relative abundance, trophic structure, richness, H' diversity, evenness and other measures are often used to assess these attributes.

Good	Biodiversity appears to reflect pristine or near-pristine conditions and promotes ecosystem integrity (full community development and function).
Good/Fair	Selected biodiversity loss has taken place, precluding full community development and function, but it is unlikely to cause substantial or persistent degradation of ecosystem integrity.
Fair	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
Fair/Poor	Selected biodiversity loss has caused or is likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.
Poor	Selected biodiversity loss has caused or is likely to cause severe declines in ecosystem integrity.

Living Resources
Extracted Species

10. What is the status of environmentally sustainable fishing and how is it changing?

Commercial and recreational harvesting are highly selective activities, for which fishers and collectors target a limited number of species, and often remove high proportions of populations. In addition to removing significant amounts of biomass from the ecosystem, reducing its availability to other consumers, these activities tend to disrupt specific and often critical food web links. When too much extraction occurs (i.e. ecologically unsustainable harvesting), trophic cascades ensue, resulting in changes in the abundance of non-targeted species as well. It also reduces the ability of the targeted species to replenish populations at a rate that supports continued ecosystem integrity.

It is essential to understand whether removals are occurring at ecologically sustainable levels. Knowing extraction levels and determining the impacts of removal are both ways that help gain this understanding. Measures for target species of abundance, catch amounts or rates (e.g., catch per unit effort), trophic structure and changes in non-target species abundance are all generally used to assess these conditions.

Other issues related to this question include whether fishers are using gear that is compatible with the habitats being fished and whether that gear minimizes bycatch and incidental take of marine mammals. For example, bottom-tending gear often destroys or alters both benthic structure and non-targeted animal and plant communities. "Ghost fishing" occurs when lost traps continue to capture organisms. Lost or active nets, as well as lines used to mark and tend traps and other fishing gear, can entangle marine mammals. Any of these could be considered indications of environmentally unsustainable fishing techniques.

Good	Extraction does not appear to affect ecosystem integrity (full community development and function).
Good/Fair	Extraction takes place, precluding full community development and function, but it is unlikely to cause substantial or persistent degradation of ecosystem integrity.
Fair	Extraction may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
Fair/Poor	Extraction has caused or is likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.
Poor	Extraction has caused or is likely to cause severe declines in ecosystem integrity.

Living Resources
Non-Indigenous Species

11. What is the status of non-indigenous species and how is it changing?

Non-indigenous species are generally considered problematic and candidates for rapid response, if found, soon after invasion. For those that become established, their impacts can sometimes be assessed by quantifying changes in the affected native species. This question allows sanctuaries to report on the threat posed by non-indigenous species. In some cases, the presence of a species alone constitutes a significant threat (certain invasive algae). In other cases, impacts have been measured and may or may not significantly affect ecosystem integrity.

Good	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).
Good/Fair	Non-indigenous species exist, precluding full community development and function, but are unlikely to cause substantial or persistent degradation of ecosystem integrity.
Fair	Non-indigenous species may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
Fair/Poor	Non-indigenous species have caused or are likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.
Poor	Non-indigenous species have caused or are likely to cause severe declines in ecosystem integrity.

Living Resources
Key Species

12. What is the status of key species and how is it changing?

Certain species can be defined as "key" within a marine sanctuary. Some might be keystone species, that is, species on which the persistence of a large number of other species in the ecosystem depends - the pillar of community stability. Their functional contribution to ecosystem function is disproportionate to their numerical abundance or biomass and their impact is therefore important at the community or ecosystem level. Their removal initiates changes in ecosystem structure and sometimes the disappearance of or dramatic increase in the abundance of dependent species. Keystone species may include certain habitat modifiers, predators, herbivores and those involved in critical symbiotic relationships (e.g. cleaning or co-habitating species).

Other key species may include those that are indicators of ecosystem condition or change (e.g., particularly sensitive species), those targeted for special protection efforts, or charismatic species that are identified with certain areas or ecosystems. These may or may not meet the definition of keystone, but do require assessments of status and trends.

Good	Key and keystone species appear to reflect pristine or near-pristine conditions and may promote ecosystem integrity (full community development and function).
Good/Fair	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
Fair	The reduced abundance of selected keystone species may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity; or selected key species are at reduced levels, but recovery is possible.
Fair/Poor	The reduced abundance of selected keystone species has caused or is likely to cause severe declines in some but not all ecosystem components, and reduce ecosystem integrity; or selected key species are at substantially reduced levels, and prospects for recovery are uncertain.
Poor	The reduced abundance of selected keystone species has caused or is likely to cause severe declines in ecosystem integrity; or selected key species are a severely reduced levels, and recovery is unlikely.

Living Resources
Health of Key Species

13. What is the condition or health of key species and how is it changing?

For those species considered essential to ecosystem integrity, measures of their condition can be important to determining the likelihood that they will persist and continue to provide vital ecosystem functions. Measures of condition may include growth rates, fecundity, recruitment, age-specific survival, tissue contaminant levels, pathologies (disease incidence tumors, deformities), the presence and abundance of critical symbionts or parasite loads. Similar measures of condition may also be appropriate for other key species (indicator, protected or charismatic species). In contrast to the question about keystone species (#12 above), the impact of changes in the abundance or condition of key species is more likely to be observed at the population or individual level and less likely to result in ecosystem or community effects.

Good	The condition of key resources appears to reflect pristine or near-pristine conditions.
Good/Fair	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
Fair	The diminished condition of selected key resources may cause a measurable but not severe reduction in ecological function, but recovery is possible.
Fair/Poor	The comparatively poor condition of selected key resources makes prospects for recovery uncertain.
Poor	The poor condition of selected key resources makes recovery unlikely.

Living Resources
Human Activities

14. What are the levels of human activities that may influence living resource quality and how are they changing?

Human activities that degrade living resource quality do so by causing a loss or reduction of one or more species, by disrupting critical life stages, by impairing various physiological processes, or by promoting the introduction of non-indigenous species or pathogens. (Note: Activities that impact habitat and water quality may also affect living resources. These activities are dealt with in Questions 4 and 8, and many are repeated here as they also have direct effect on living resources).

Fishing and collecting are the primary means of removing resources. Bottom trawling, seine-fishing and the collection of ornamental species for the aquarium trade are all common examples, some being more selective than others. Chronic mortality can be caused by marine debris derived from commercial or recreational vessel traffic, lost fishing gear and excess visitation, resulting in the gradual loss of some species.

Critical life stages can be affected in various ways. Mortality to adult stages is often caused by trawling and other fishing techniques, cable drags, dumping spoil or drill cuttings, vessel groundings or persistent anchoring. Contamination of areas by acute or chronic spills, discharges by vessels, or municipal and industrial facilities can make them unsuitable for recruitment; the same activities can make nursery habitats unsuitable. Although coastal armoring and construction can increase the availability of surfaces suitable for the recruitment and growth of hard bottom species, the activity may disrupt recruitment patterns for other species (e.g., intertidal soft bottom animals) and habitat may be lost.

Spills, discharges, and contaminants released from sediments (e.g., by dredging and dumping) can all cause physiological impairment and tissue contamination. Such activities can affect all life stages by reducing fecundity, increasing larval, juvenile, and adult mortality, reducing disease resistance, and increasing susceptibility to predation. Bioaccumulation allows some contaminants to move upward through the food chain, disproportionately affecting certain species.

Activities that promote introductions include bilge discharges and ballast water exchange, commercial shipping and vessel transportation. Releases of aquarium fish can also lead to species introductions.

Good	Few or no activities occur that are likely to negatively affect living resource quality.
Good/Fair	Some potentially harmful activities exist, but they do not appear to have had a negative effect on living resource quality.
Fair	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent and/or repeated severe impacts have occurred or are likely to occur.

Maritime Archaeological Resources Integrity

15. What is the integrity of known maritime archaeological resources and how is it changing?

The condition of archaeological resources in a marine sanctuary significantly affects their value for science and education, as well as the resource's eligibility for listing in the National Register of Historic Places. Assessments of archaeological sites include evaluation of the apparent levels of site integrity, which are based on levels of previous human disturbance and the level of natural deterioration. The historical, scientific and educational values of sites are also evaluated and are substantially determined and affected by site condition.

Good	Known archaeological resources appear to reflect little or no unexpected disturbance.
Good/Fair	Selected archaeological resources exhibit indications of disturbance, but there appears to have been little or no reduction in historical, scientific or educational value.
Fair	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific or educational value and may affect the eligibility of some sites for listing in the National Register of Historic Places.
Fair/Poor	The diminished condition of selected archaeological resources has substantially reduced their historical, scientific or educational value and is likely to affect their eligibility for listing in the National Register of Historic Places.
Poor	The degraded condition of known archaeological resources in general makes them ineffective in terms of historical, scientific or educational value and precludes their listing in the National Register of Historic Places.

Maritime Archaeological Resources Threat to Environment

16. Do known maritime archaeological resources pose an environmental hazard and how is this threat changing?

The sinking of a ship potentially introduces hazardous materials into the marine environment. This danger is true for historic shipwrecks as well. The issue is complicated by the fact that shipwrecks older than 50 years may be considered historical resources and must, by federal mandate, be protected. Many historic shipwrecks, particularly early to mid-20th century, still have the potential to retain oil and fuel in tanks and bunkers. As shipwrecks age and deteriorate, the potential for release of these materials into the environment increases.

Good	Known maritime archaeological resources pose few or no environmental threats.
Good/Fair	Selected maritime archaeological resources may pose isolated or limited environmental threats, but substantial or persistent impacts are not expected.
Fair	Selected maritime archaeological resources may cause measurable, but not severe, impacts to certain sanctuary resources or areas, but recovery is possible.
Fair/Poor	Selected maritime archaeological resources pose substantial threats to certain sanctuary resources or areas, and prospects for recovery are uncertain.
Poor	Selected maritime archaeological resources pose serious threats to sanctuary resources, and recovery is unlikely.

Maritime Archaeological Resources
Human Activities

17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

Some human maritime activities threaten the physical integrity of submerged archaeological resources. Archaeological site integrity is compromised when elements are moved, removed or otherwise damaged. Threats come from looting by divers, inadvertent damage by scuba diving visitors, improperly conducted archaeology that does not fully document site disturbance, anchoring, groundings, and commercial and recreational fishing activities, among others.

Good	Few or no activities occur that are likely to negatively affect maritime archaeological resource integrity.
Good/Fair	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.
Fair	Selected activities have resulted in measurable impacts to maritime archaeological resources, but evidence suggests effects are localized, not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts have occurred or are likely to occur.

Appendix B: Consultation with Experts and Document Review

The process for preparing condition reports involves a combination of accepted techniques for collecting and interpreting information gathered from subject matter experts. The approach varies somewhat from sanctuary to sanctuary in order to accommodate differing styles for working with partners. The Channel Islands National Marine Sanctuary approach was closely related to the Delphi Method, a technique designed to organize group communication among a panel of geographically dispersed experts by using questionnaires, ultimately facilitating the formation of a group judgment. This method can be applied when it is necessary for decision-makers to combine the testimony of a group of experts, whether in the form of facts or informed opinion, or both, into a single useful statement.

The Delphi Method relies on repeated interactions with experts who respond to questions with a limited number of choices to arrive at the best supported answers. Feedback to the experts allows them to refine their views, gradually moving the group toward the most agreeable judgment. For condition reports, the Office of National Marine Sanctuaries uses 17 questions related to the status and trends of sanctuary resources, with accompanying descriptions and five possible choices that describe resource conditions.

In order to address the 17 questions, sanctuary staff selected and consulted outside experts familiar with water quality, living resources, habitat, and maritime archaeological resources. Experts represented various affiliations including California Department of Fish and Game, Carter Biological Consulting, Cascadia Research, Channel Islands National Marine Sanctuary, Channel Islands National Park, Partnership for Interdisciplinary Studies of Coastal Oceans, Reef Environmental Education Foundation, Santa Barbara Channelkeeper, Southern California Coastal Water Research Project, and University of California Santa Barbara.

Expert opinion was solicited electronically and through one-on-one contact via phone calls and/or emails. Background material was provided to the experts in order to develop a consistent understanding of the project and the questions. Experts were asked to use Appendix A, which accompanies every report to guide their responses. Appendix A clarifies the set of questions and presents standardized statements that are used to describe the status and assign a corresponding color code on a scale from "good" to "poor." These statements are customized for each question.

During the initial request for response to questions, a total of 28 experts were contacted and 13 responded. They were asked to rate resource status and trends based on guidance provided, and submit supplemental comments, data, graphics, literature citations, Web site links and other relevant information.

The combined input of all experts was considered by a writing team composed of individuals from the sanctuary and the national office. They tallied and discussed ratings and accompanying comments, and summarized the input in a written draft that included a proposed status rating and a proposed trend for each question. The initial ratings represented agreement by the writing team based on interpretation of quantitative and, when necessary, non-quantitative expert input, as well as other available information, such as assessments and observations of scientists, managers and users. In some cases, certain input was not used because it was either not relevant to the question it accompanied, or it was too narrowly focused to address the question. Nevertheless, the ratings and text are intended to summarize the opinions and uncertainty expressed by experts, who based their input on knowledge and perceptions of local conditions. Comments and citations received from the experts were included, as appropriate, in text supporting the ratings.

This draft document was sent back to the subject experts for what was called an initial review, a 21-day period that allowed them to ensure that the report accurately reflected their input, identify information gaps, provide comments or suggest revisions to the ratings and text. Upon receiving those comments, the writing team revised the text and ratings as they deemed appropriate. The final interpretation, ratings, and text in the draft condition report were the responsibility of sanctuary staff, with final approval by the sanctuary manager. To emphasize this important point, authorship of the report is attributed to the sanctuary alone. Subject experts were not authors, though their efforts and affiliations are acknowledged in the report.

The second phase of review, called invited review, involved particularly important partners in research and resource management, including the research activities panel, sanctuary advisory council, NOAA's Marine Debris Program, and NOAA's National Marine Fisheries Service. These bodies were asked to review the technical merits of resource ratings and accompanying text, as well as to point out any omissions or factual errors. The comments and recommendations of invited reviewers were received, considered by sanctuary staff, and incorporated, as appropriate, into a final draft document.

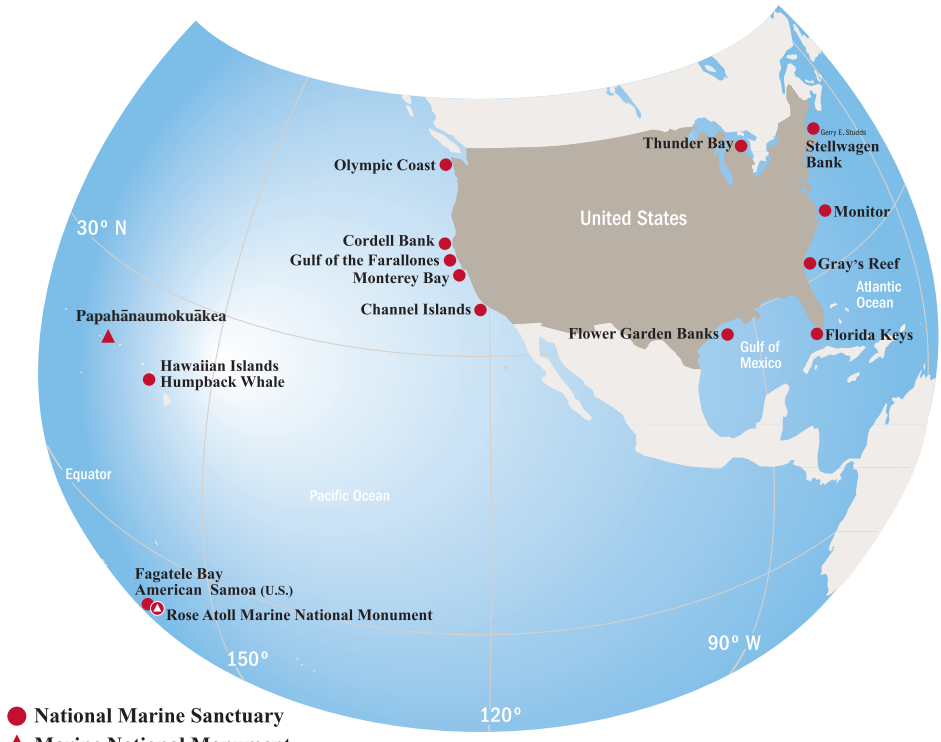
A draft final report was then sent to John Butler, NOAA's National Marine Fisheries Service; Don Morris, National Park Service (retired); and Jen Smith, Scripps Institution of Oceanography, University of California San Diego, who served as external peer reviewers. This external peer review is a requirement that started in December 2004 when the White House Office of Management and Budget (OMB)

issued a Final Information Quality Bulletin for Peer Review (OMB Bulletin) establishing peer review standards that would enhance the quality and credibility of the federal government's scientific information. Along with other information, these standards apply to Influential Scientific Information which is information that can reasonably be determined to have a "clear and substantial impact on important public policies or private sector decisions." The Condition Reports are considered Influential Scientific Information. For this reason, these reports are subject to the review requirements of both the Information Quality Act and the OMB Bulletin guidelines. Therefore, following the completion of every condition report, they are reviewed by a minimum of three individuals who are considered to be experts in their field, were not involved in the development of the report, and are not ONMS employees. Comments from these peer reviews were incorporated into the final text of the report. Furthermore, OMB Bulletin guidelines require that reviewer comments, names, and affiliations be posted on the agency website: http://www.osec.doc.gov/cio/oipr/pr_plans.htm. Reviewer comments, however, are not attributed to specific individuals. Reviewer comments are posted at the same time as with the formatted final document.

Notes

THE NATIONAL MARINE SANCTUARY SYSTEM

The Office of National Marine Sanctuaries, part of the National Oceanic and Atmospheric Administration, serves as the trustee for a system of 14 marine protected areas encompassing more than 150,000 square miles of ocean and Great Lakes waters. The 13 national marine sanctuaries and one marine national monument within the National Marine Sanctuary System represent areas of America's ocean and Great Lakes environment that are of special national significance. Within their waters, giant humpback whales breed and calve their young, coral colonies flourish, and shipwrecks tell stories of our maritime history. Habitats include beautiful coral reefs, lush kelp forests, whale migrations corridors, spectacular deep-sea canyons, and underwater archaeological sites. These special places also provide homes to thousands of unique or endangered species and are important to America's cultural heritage. Sites range in size from less than one to almost 140,000 square miles and serve as natural classrooms, cherished recreational spots and are home to valuable commercial industries.



Scale varies in this perspective.
Adapted from National Geographic maps.

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

National Marine Sanctuaries