2009 CHANNEL ISLANDS NATIONAL MARINE SANCTUARY CONDITION REPORT

REVIEWERS AND AFFILIATIONS
Jennifer Smith
Center for Marine Biodiversity and Conservation
Scripps Institution of Oceanography

John Butler
NOAA's National Marine Fisheries Service
Southwest Fisheries Science Center

Don Morris
National Park Service (retired)

The document that follows is a copy of the DRAFT Channel Islands National Marine Sanctuary Condition Report that was disseminated to three individuals who served as peer reviewers. In December 2004, 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. Among other information, these standards apply to Influential Scientific Information (ISI), 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 report they are reviewed by a minimum of three individuals who are considered to be experts in the field, were not involved in the development of the report, and are not Office of National Marine Sanctuaries employees. Following the External Peer Review the comments and recommendations of the reviewers were considered by sanctuary staff and incorporated, as appropriate, into a final draft document. In some cases sanctuary staff reevaluated the status and trend ratings and when appropriate, the accompanying text in the document was edited to reflect the new ratings.

The comments and suggested edits that were received from the reviewers are embedded in the below draft. The final Channel Islands NMS Condition Report may be downloaded from: http://sanctuaries.noaa.gov/.

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Channel Islands National Marine Sanctuary
Condition Report

U.S. Department of Commerce
Carlos M. Gutierrez, Secretary

National Oceanic and Atmospheric Administration
VADM Conrad C. Lautenbacher, Jr. (USN-ret.)
Under Secretary of Commerce for Oceans and Atmosphere

National Ocean Service
John H. Dunnigan, Assistant Administrator

Office of National Marine Sanctuaries
Daniel J. Basta, Director

National Oceanic and Atmospheric Administration
Office of National Marine Sanctuaries
SSMC4, N/ORM6
1305 East-West Highway
Silver Spring, MD 20910
301-713-3125
http://sanctuaries.noaa.gov/

Channel Islands National Marine Sanctuary
113 Harbor Way, Suite 150
Santa Barbara, CA 93109
805-966-7107
http://www.channelislands.noaa.gov/

Report Preparers:

Office of National Marine Sanctuaries:
Kathy Broughton, Stephen R. Gittings

Channel Islands National Marine Sanctuary:
Danielle Lipski, Steve Katz

Southeast Atlantic, Gulf of Mexico, and Caribbean Region:
Sarah Fangman (formerly of Channel Islands National Marine Sanctuary)

Copy Editor:

Graphic Designer

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Comment [J1]: General Comments:
This document provides a reasonable overview of the history, status and trends within the CIMNS. However in many cases I feel that the details have been left out. The text across many of the different sections tends to be redundant and/or represents slightly reworded generalizations of previous sections of text. These generalizations are fine for the beginning of the report but I was hoping there would be more detail in the status of living marine resources section for example. Given the number of scientists working in the CIMNS and the extensive data that many organizations have it would be useful to provide some sort of summary of this information. How have populations of key taxa changed over time and in response to different management practices? Is there any indication that management strategies are working? Is there spatial and/or temporal variability? Is there any indication that certain areas may be more or less susceptible to climate change? What are sanctuary scientists and managers doing to insure the continued protection of the resources within the CINMS?

Specific comments: The text needs to be edited and the references need to be properly formatted. I would suggest attempting to reduce the level of redundancy in many of the sections (the DDT story is discussed at least 5 times with little to no new information presented in each of the discussions). The authors need to check that the figures are properly labeled and properly referred to in the text.

Cover photo credits left to right:
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

Suggested Citation:
Office of National Marine Sanctuaries. 2008. Channel Islands National Marine Sanctuary Condition Report 2008. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD. ** pp.

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About this Report

This "condition report" provides a summary 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). Resource status of 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 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, wind farming, artificial reefs and climate change.

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

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Despite this setting, most water quality parameters at the Channel Islands National Marine 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 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 historic 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.

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The sanctuary contains a network of marine zones established in state waters 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 and 2 marine conservation areas where some fishing is allowed. In addition, a new management plan for Channel Islands National Marine Sanctuary is scheduled for release in 2007; 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.

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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 (National Marine Sanctuary Program 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 the Appendix, 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.

Comment [kb2]: In text box below it says sanctuary is 1,128 sq nmi, but on page 11 it says 1,113 sq nmi.

Channel Islands National Marine Sanctuary

- *The sanctuary was designated on September 22, 1980 and encompasses 1,128 square nautical miles*
- *The Chumash were the first people to inhabit the Channel Islands*
- *The islands were first visited by Europeans in 1542*
- *In the 1800's the islands served as a location for sea otter, seal, and sea lion hunting. Subsequently, the land was cultivated for ranching and farming purposes.*
- *In 2003 eleven 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 water boundary*
- *Numerous shipwrecks surround the islands*
- *The sanctuary represents an important area for recreational and commercial use, including diving, kayaking, fishing, boating, wildlife viewing, shipping transit, and research.*

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Channel Islands National Marine Sanctuary
Condition Summary Table

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.
- N/A Question not applicable.

The following table summarizes the "State of Sanctuary Resources" section of this report. The first two columns list the 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 the Appendix for further clarification of the questions and the Description of Findings statements.

Comment [J3]: How are the responses from different groups represented in these tables? Are the responses simply summarized by one individual or is there some sort of more formal designation process?

#	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?	?	DDT contaminants are likely dissipating and are present in reduced levels. However, there is concern about recent apparent increases in *Pseudo-nitzschia*/domoic acid.	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) 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; island runoff is minimal.	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?	—	*Pseudo-nitzschia*/domoic acid blooms pose a threat for shellfish consumption, but 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?	—	Shipping traffic, vessel discharges, DDT, and mainland land use runoff may affect water quality.	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?	?	Trawling, anchoring and fishing gear impacts. 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?	—	Loss of giant kelp and understory habitat-forming algae, trawling damage to hard-bottom coral communities, white urchin increase resulted in decline in eelgrass, decline in mussel bed community diversity. Reserves and trawl regulations may help habitats to 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?	▲	DDT is present but gradually lessening, vessel discharges are present but regulations have kept contamination at low levels, mainland discharges seldom reach the islands.	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?	▲	Direct or incidental extraction of biogenic species, vessel discharges, and anchoring; recent management actions may improve conditions.	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized, not widespread	
LIVING RESOURCES					

Comment [J4]: What about the potential effects of global climate change on oceanographic conditions such as water movement, currents, pH, and the frequency, duration and spatial dynamics of upwelling events and subsequent chlorophyll levels?

Comment [J5]: What is the spatial extent of trawling damage on different habitat types? Is the damage restricted to offshore/deeper waters and would thus only have strong impacts on a few of the habitat types?

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9	What is the status of biodiversity and how is it changing?	?	Extraction of key species has decreased biodiversity and simplified community structures.	Selected biodiversity loss may inhibit full community development and function, and may cause measurable but not severe degradation of ecosystem integrity.	
10	What is the status of environmentally sustainable fishing and how is it changing?	▲	High levels of extraction of key species; 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 invasive species have become established; 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	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.	Marine reserves have recently been established which are expected to help some species recover over time.
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; some birds have shown recent recovery from historic 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?	—	Extraction, localized effects of boaters and visitors at Santa Cruz and Anacapa Islands, increase in shipping activity.	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 activities 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.	Selected archaeological resources exhibit indications of disturbance, but there appears to have been little or no reduction in historical, scientific, or educational value.	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?	▲	Increases in education and enforcement overall; decreased trawling as a result of regulatory actions.	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.	

Comment [J7]: Are there any monitoring programs established that would detect invasive species if they did eventually reach the islands?

Comment [J6]: What is the evidence that biodiversity has changed? There is often replacement of species when one is removed. Have there even been thorough biodiversity assessments of the sanctuary?

Comment [J8]: What about other key species such as various kelps that make up the kelp forest ecosystem, sea urchins, other target species?

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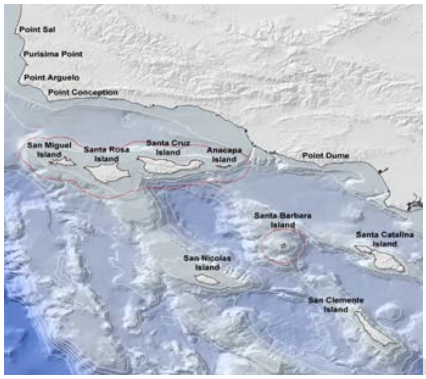

Figure 1. The Channel Islands sanctuary encompasses the waters surrounding Anacapa, San Miguel, Santa Barbara, Santa Cruz, and Santa Rosa Islands.

Figure 2. South side of Santa Cruz Island (Photo: Robert Schwemmer, Channel Islands sanctuary)

Comment [J9]: This map is poor resolution

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Site History and Resources

Overview

The Channel Islands National Marine 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 Department of Commerce. The sanctuary encompasses 1,113 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 Channel Islands National Marine 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 cultural resources, while allowing compatible human uses.

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.

Comment [kb10]: Text box on page 6 says 1,128 sq nmi

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. 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 development.

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 is the date associated with the early human remains discovered at Arlington Canyon on Santa Rosa Island. These are the oldest human remains yet discovered in North America (Johnson 2000). For hundreds of years the Chumash traveled the Santa Barbara Channel in plank canoes called *tomols* to trade with the mainland community (Figure 3).

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 1700's and continuing into the 1800's, Russian, British, and American fur traders hunted sea otters for their valuable furs. Once the sea otters were hunted to near-extinction, traders then focused their efforts on hunting seals and sea lions for their fur and oil.

Figure 3. Chumash paddlers reenact the historic channel crossing in traditional plank canoes called tomols. Photo: Channel Islands sanctuary

In the early 1800's 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-1800's 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).

In 1912 the U.S. Lighthouse Service (later the U.S. Coast Guard) began its stay on Anacapa Island and constructed the existing lighthouse in 1932 (Figure 4). 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.

Figure 4. The Anacapa Island Lighthouse was established in 1912 by the U.S. Lighthouse Service. The lighthouse is still operational. (Photo: National Park Service, Ralph Eshelman, http://www.cr.nps.gov/Maritime/park/anacapa.htm)

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 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 industries (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 (Figure 5). The Channel Islands sanctuary is located about 70 miles northwest of the port, which is the second busiest port in North America (Port of Long Beach 2005) and about 40 miles north west of Port Hueneme, a smaller deep-water 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. 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 (CINMS FEIS Marine Reserves 2007).

Figure 5. Long Beach is one of the biggest port complexes in the world. (Photo: Port of Long Beach)

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 http://www.sbcapcd.org/itg/shipemissions.htm).

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 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 scallops. Offshore recreational fishing focuses on mobile species such as yellowtail, tuna, white seabass, barracuda, broadbill swordfish, marlin, and mako shark.

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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 6). Beginning in early summer and continuing through fall, foraging wildlife frequent sanctuary waters. During this time 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, wildlife and scenic viewing.

Figure 6. A blue whale visits a commercial whale watching vessel (Photo by Fred Benko).

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 7). The Channel Islands are the portions of the ridges that rise above sea level. The Santa Barbara Basin is a deep (1650 ft, 500 m) submerged geological feature within the Santa Barbara Channel (the body of water between the islands and the mainland).

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More than 20 oil fields and several natural gas fields lie beneath the Santa Barbara Channel in the Santa Barbara Basin. A seep called the South Ellwood anticline, located about 3 kilometers offshore in the Santa Barbara Channel, has one of the highest rates of seepage in the world. Ongoing research conducted by the Minerals Management Service (MMS) suggests that 6 tons of oil and 24 tons of hydrocarbon gases are released per day from the South Ellwood anticline (Washburn and Clark 1998).

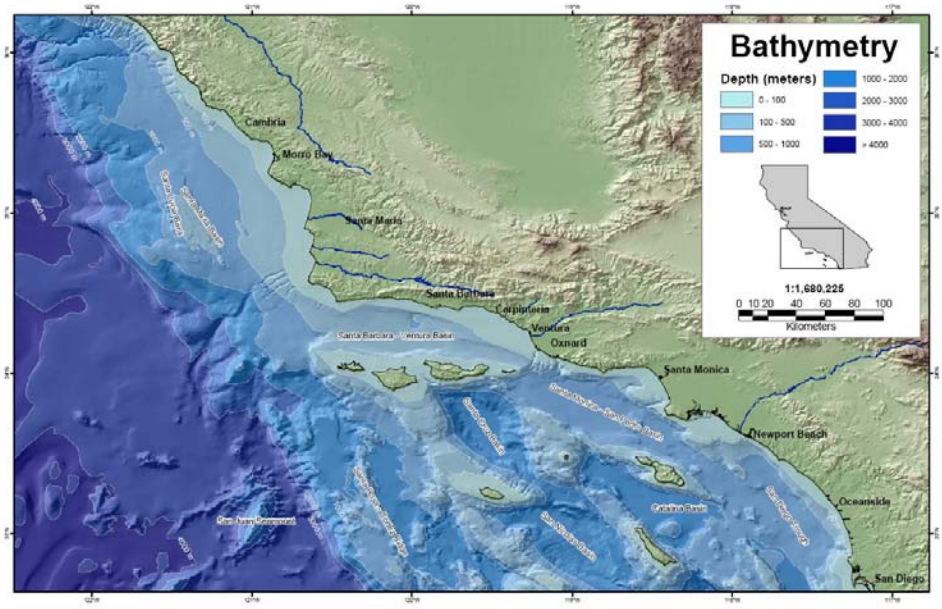

Figure 7. Bathymetric features of Southern California. Image by Natalie Senyk, CINMS.

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 (Hendershot 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.

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.

Comment [J11]: This section is overly vague. There is no discussion on the different types of hard-bottom, rocky reef communities, urchin barrens, habitats in fished versus unfished areas, etc.

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Intertidal Zone Habitat

Intertidal zones are composed of a variety of coastal habitats that are periodically covered and uncovered by waves and tides (Figure 8). 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 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 inhabit the intertidal zone surrounding the Channel Islands.

Comment [J12]: This is part of the definition of being in the intertidal…

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Figure 8. Intertidal zones are composed of a variety of coastal habitats that are periodically covered and uncovered by waves and tides (photo by Carol Pillsbury)

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Hard and Soft Bottom Subtidal Habitat

Comment [J13]: This section is very vague given the diversity of subtidal habitats in the CINMS and all that is known about the organisms that inhabit them

Subtidal habitats around the islands include those habitats 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 exposure, long-shore currents, upwelling, temperature, salinity, and nutrient differentials, and suspended sediment loads.

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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. In addition, a diverse assemblage also dwells within the soft sediment, including worms, crustaceans, snails and clams.

Rocky subtidal habitats are widespread around the Channel Islands, 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 and sedimentation and biological interactions such as competition and predation.

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Giant kelp in the Channel Islands National Marine Sanctuary (photo by Mark Conlin)

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 4 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 9). 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 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 1984, Hemminga and Duarte 2000). 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).

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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. Well over 90 percent of deep-water benthic habitats in the Southern California Bight consist of soft bottom habitat (Thompson *et al.*. 1993). Most of the deep-water 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 outcropings are features of these reefs in the deep waters 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 revealed deep sea corals, including a new species, and associated diverse fish and invertebrate communities (Tissot et al. 2006).

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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 m) which includes the photic (light penetrating) zone. Large migratory fish and marine mammals occupy the mesoplagic zone, from 200 to 1000m (CINMS FEIS for Marine Reserves 2007) and their wide ranges and long distance migrations make them difficult to study.

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 northern current and the cooler southern current and localized gyres. The Channel Islands are particularly 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 are populated with a greater portion of northern species. 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 allow for a wide variety of invertebrates, fish, macroalgae, marine plants, marine mammals, and seabirds.

Comment [J14]: What are these different species? Why not provide some examples?

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, is preyed upon by small schooling fish which support larger fish and marine mammals, including pelagic migratory species.

The total number of species of benthic invertebrates 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 star, abalone, nudibranchs, scallops, mussels, squid, clams, barnacles, snails, salps, tunicates, jellyfish, sea slugs, 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, ridgeback prawn, spot prawn, spiny lobster, rock crab (brown, yellow and red), abalone (black, green, pink, red, white), mussels, clams, scallops, market squid, sea urchins (red, purple and white), sea cucumbers, and sea stars (Leet et al. 2001). Several of these species are harvested commercially, and represent significant fisheries in the Southern California Bight.

Comment [kb15]: In addition to the species of abalone reported, both flat and northern (threaded) occur at the Channel Islands.

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

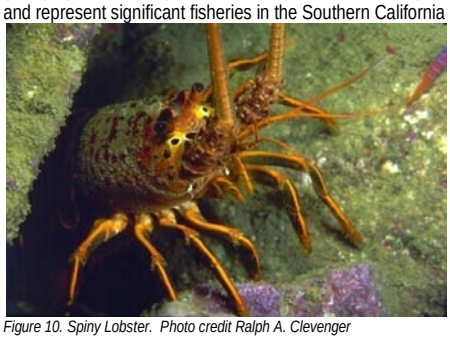

Figure 10. Spiny Lobster. Photo credit Ralph A. Clevenger

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, Pacific bonito, white seabass and yellowtail. Common groundfish found within sanctuary include bocaccio, cowcod, chilipepper, widow rockfish, bank rockfish, dover sole, English sole and sablefish. Coastal pelagics and highly migratory species include Pacific sardine, Northern anchovy, Pacific mackerel, jack mackerel, albacore, swordfish, Pacific northern bluefin

tuna, skipjack tuna, yellowfin tuna, striped marlin, shortfin mako shark, thresher shark, blue shark and opah. (http://www.dfg.ca.gov/mrd/ci_cega/index.html)

Figure 11. Purple sea urchin (Photo by Annie Crawley)

The Channel Islands region 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, Willet, Whimbrel, Long-billed Curlew, gulls, and sanderlings. The upland portions of the beach provide kelp deposits that attract invertebrates where Black and Ruddy Turnstones, dowitchers, and other shorebird species forage. Caves and crevices provide nest habitat for Xantus's murrelets and Ashy storm-petrels, while Cassin's auklets 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, California Brown Pelican, California Least Rern, Double-crested Cormorant, Rhinoceros Auklet, Western Snowy Plover, and Xantus's Murrelet.

Four species of sea turtles have been reported in the offshore southern California region: green, loggerhead, olive-Ridley and leatherback. 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 the region (Leatherwood et al. 1982; Leatherwood et al. 1987). Common cetaceans in the waters of sanctuary include: common, bottlenose, pacific white-sided, and Risso's dolphins, and California gray, blue, and humpback whales (Figure 12).

Figure 12. Humpbacks breaching (Carol Pillsbury)

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, Guadalupe fur seal, Northern elephant seals, Pacific harbor seal, California sea lion (Figure 13), and Steller sea lion. 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.

Figure 13. California Sea Lions (photo by Annie Crawley)

Finally, the southern sea otter 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 National Marine Sanctuary such as the passenger steamer *Cuba* 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 14). 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 of the Channel Islands reflect the diverse range of activities and nationalities that traversed the Santa Barbara Channel. European sailing and steam vessels, California built Chinese junks, American coastal traders, vessels engaged in island commerce and a Gold-Rush-era side-wheel steamer have all been lost in these waters. Each has a story to tell about the history, technology, and society of earlier times.

Comment [J16]: What is this?

Between the years 1853 to 1980, an inventory of over 140 historic ship and aircraft wrecks were documented in the Channel Islands National Marine Sanctuary and National Park. To date about thirty sites have been located. 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.

Figure 14. Paddlewheel from the California Gold-Rush Steamer Winfield Scott*, which stranded on Anacapa Island (photo by Robert Schwemmer, Channel Islands sanctuary).*

Pressures on the Sanctuary

The number of people living near the coastal zone and using its resources has significantly increased (US Census Bureau 2000). This urbanization has increased human demands on the ocean, including commercial and recreational fishing, wildlife viewing 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).

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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 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 twenty years. The two counties adjacent to the sanctuary, Santa Barbara and Ventura, have a combined population of over 1.1 million (US Census Bureau 2000)and there are more than 20 million people living in the greater Southern California Bight region (US Census Bureau 2000). As the numbers of people increase, the number of potential sanctuary users, who may engage in a wide variety of activities, also increases.

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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 15). 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 2004). Bycatch may be significant for some fisheries (Harrington et al. 2005), and 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).

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Commercial Fishing

Targeted species have seen 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 and white abalone is on the federal endangered species list (Hobday et al. 2001, Federal Register 2001, Rogers-Bennet et al. 2004). Rockfish 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).

Figure 15. A commercial fishing boat in the sanctuary. Photo: Channel Islands sanctuary

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, targeting bottom and mid-water fish species, using hook-and-line, nets, and spearguns, and may be conducted from shore, from vessels, freediving, or using SCUBA equipment. Recreational fishing is primarily in the eastern half of the sanctuary within easy boating distance to the mainland (Senyk et al. 2008) indicating that these areas may receive heavier fishing pressure.

Vessel Traffic

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.

Commercial shipping is prevalent in the sanctuary. Over 6,500 cargo vessels transited the Santa Barbara Channel in 2005 (Santa Barbara County Air Pollution Control District http://www.sbcapcd.org/itg/shipemissions.htm). The container trade at the Port of Long Beach has grown 150 percent since 1990 and is expected to continue to increase. The Santa Barbara Channel is a main thoroughfare with the shipping lanes passing through a portion of the sanctuary. However, cargo ships are prevented from entering waters within 1 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 trips take place year round, however, whale watching is especially popular during the winter and spring grey whale migratory season when charter boats make daily trips to the sanctuary. 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 (Andrews et al. 2002). In Southern California in particular, ocean noise in 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), altering behavior, migration patterns, or abandonment of important habitats, and negatively affecting 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).

WHAT ABOUT OTHER IMPACTS OF VESSEL TRAFFIC TO AND FROM COMMERCIAL PORTS SUCH AS THE TRANSPORT AND INTRODUCTION OF INVASIVE SPECIES???

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Offshore Oil and Gas Industry

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

Before sanctuary designation, an oil platform spill in 1969 released 200,000 gallons of oil into the Santa Barbara Channel and though contingency plans are now in place, such spills remain a threat to the sanctuary. 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 which form important habitats 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 (6,300-7140 gallons) of oil per day (Hornafius et al., 1999). Some of this hydrocarbon discharge may enter the sanctuary and affect water quality.

Figure 16. An oil platform near the sanctuary. Photo: Channel Islands sanctuary

Climate Change

The Channel Islands sanctuary will certainly manifest the consequences of global climate change. The region is affected locally by climatic short time scale events such as El Nino-related sea surface temperature anomalies and upwelling variability (McGowan et al. 1998), and decadal-scale variability such as the Pacific Decadal Oscillation (Mantua and Hare 2002). The Channel Islands are at a transition zone between cold northern currents and warm southern currents. Geographic position and variability in the transition zone is an important driver of community structure and 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 and 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. Upwelling variability, driven by variability in the path of the atmospheric jet stream, combined with local El Nino anomalies (Bane et al, 2007), are 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 appreciated. The impacts are expected to be intense and wide-spread – 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). While the impacts of climate can be expected to be profoundly transformative and wide spread across all components of the ecosystem making specific reliable predictions is still impossible. An important contributor to forecast uncertainty is that the important drivers for climate alteration, greenhouse gas emissions, have exceeded even the most extreme and extravagant predictions of the last 10 years (Raupach et al. 2008). Without reliable forecasts of the ecosystem drivers, predictions of ecosystem pathology magnitude will be impossible to make with confidence.

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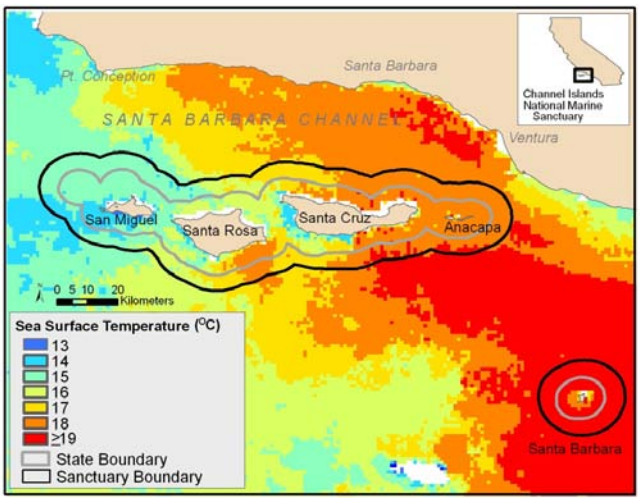

Figure 17. The sanctuary is an area of mixing for cold water from the north and warm water from the south, causing a gradient of temperatures across the sanctuary. Map: Natalie Senyk

Pollutants and Marine Debris

Poor water quality can cause illness or disease, impair condition and reproductive capacity, and decrease productivity in marine organisms. They 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 (chemicals, sediment, and bacteria), 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 18). 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 1970's and discharged into the ocean off the Palos Verdes peninsula. The chemical contaminated fish, which in turn were eaten by seabirds and marine mammals. This affected foraging communities in Southern California, including the Channel Islands long after the chemical production stopped. Levels of DDT and a derivative DDE are still measurable in sediments and some wildlife is still recovering.

Comment [J17]: Overly vague…fertilizers? Sewage, herbicides, pesticides, etc???

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. Sources of debris include the mainland, visitors to the islands, and lost fishing gear. The impact of debris is a world-wide problem due to the many potential sources of debris, longevity of debris (especially plastics) in the marine environment, and impacts caused by debris even as they degrade to smaller particles.

Comment [J18]: This is awkward: sources of debris include: derelict fishing gear, plastics, styrofoam etc and these forms of debris can originate from land, offshore vessels, or may be transported from distant sources in currents, etc.

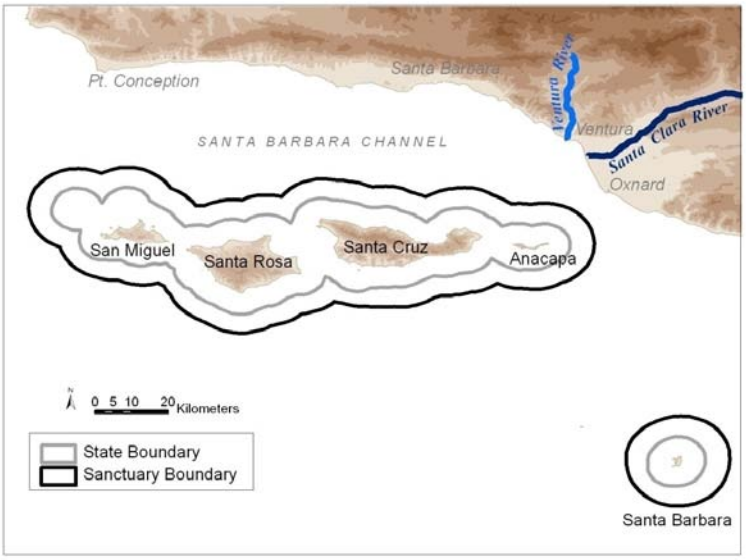

Figure 18. The Ventura and Santa Clara Rivers flow into the Santa Barbara Channel, nearest to the east end of the sanctuary. Map: Natalie Senyk, Channel Islands sanctuary

Visitor Use

Visitors can affect sanctuary resources through activities such as harvesting, polluting, littering, disturbing wildlife, anchoring in sensitive habitats, and trampling. The population of southern California is nearly 20 million, including a combined population of over 1.1 million for the two counties adjacent to the sanctuary, Santa Barbara and Ventura (U.S. Census Bureau http://www.census.gov/main/www/cen2000.html) which represents a regional increase in population of approximately 43% since 1980 (U.S. Census Bureau http://www.census.gov/). Within the sanctuary region, population growth has risen sharply over the last twenty years. As the numbers of people increase, so do 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 (Figure 19).

Comment [J19]: This was already discussed earlier on in the document…

Figure 19. Kayakers enjoy recreating in the sanctuary. Photo: Channel Islands sanctuary

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 on the condition of sanctuary resources includes targeted monitoring and evaluation that is placed in a competent and complete adaptive management framework. In such a framework, specific management decisions are used to identify technical questions, answers to which are derived from appropriate monitoring; where appropriate data is collected that expresses the specific information needed to answer the question in an effective and economical manner. The questions identified in this condition report and the decisions they support are examples of such framework components.

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Unfortunately, scarce and variable availability of resources prevent appropriate monitoring being in place to 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 performed to address the existing questions, the authors of this report have relied on the expertise of local researchers and authorities. Thus, while monitoring is a critical component of the plan for these condition reports, in practice they currently rely to large extent on monitoring that was designed to answer other needs and may have marginal ability to inform these questions. Indeed, the Channel Islands region is fortunate to be the focus of an abundance of monitoring by scientists at area universities, private and non-profit organizations, and state and federal agencies. However, these monitoring projects were largely developed to answer their own program needs. These circumstances require this report to rely to a large degree on professional judgment to extract from available monitoring new inferences and in assembling diverse data types into an assessment of overall condition.

In an effort to document the balance between monitoring and professional judgment in the information and the process used to arrive at an assessment all contributors to the assessment were asked to rate the fraction of information that contributed to their assessment that was derived directly from monitoring data, derived from data published in peer-reviewed literature, or their own professional experience and judgment. In addition, each contributor was asked to report the relative role of explicit, quantitative decision support model, management guideline or benchmark, or professional judgment in translating the information available to a status and trends ranking. Detailed results of this survey are available on request. General findings were that professional experience and judgment formed major portions of the information used, and decision support models and ecosystem benchmarks were not used in the absence of targeted monitoring data.

State of Sanctuary Resources

This section provides summaries of the condition 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 National Marine Sanctuary System's mission, and a system-wide monitoring framework (National Marine Sanctuary Program 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 are meant to set the limits of judgments so that responses can be confined to certain reporting categories that will later be compared among all sanctuary sites and combined. The Appendix (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

Water

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

In general, water quality in the sanctuary is rated as "good/fair", however the trend is "unknown". Distance from the mainland and current regulations limit pressures on water quality in the sanctuary. Significant sediment plumes from mainland rivers are visible from satellite images during the rainy season. However, storm events are rarely intense enough for these plumes to reach the islands (Otero and Siegel 2004). Sediment toxicity is lower in the sanctuary compared to the Southern California Bight (Bay et al. 2005). The contaminant DDT is present in the sanctuary (Schiff et al. 2006) but recovery of some affected bird species is occurring (Sydeman et al. 2001, Channel Islands National Park http://www.nps.gov/chis/naturescience/bald-eagles.htm). However, it is still found in significant levels in fish and other organisms in Southern California (Jarvis et al. 2007). 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). 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 and fatal to seabirds, such as cormorants and gulls, and marine mammals, such as seals and sea lions. In recent years there were extensive marine animal mortality events attributed to domoic acid (Gulland 2000, Scholin et al. 2000). The effects of global warming are currently not well understood but could result in sea level rise, changes in ocean chemistry, sea water temperature increases, shifts in species' geographic range, and disease outbreaks. For example, although red abalone populations at San Miguel Island do not exhibit symptoms of the Withering Syndrome, at least half of the populations harbors the infectious bacterium responsible for the disease (CDFG 2007). It appears that the symptoms are more prevalent in populations in warmer water locations, therefore, increases in sea water temperature may lead to outbreaks of the disease.

Comment [J20]: This seems out of place unless a case can be made as to how global warming will affect water quality…perhaps a separate climate change section would be better?

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

Comment [J21]: What about localized effects from dumping of sewage from tour/fishing boats?

The offshore location of the islands protects the sanctuary from much of the runoff from the mainland, therefore, the rating for this question is "good and not changing." As such, 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 very little 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 (Steve Katz, Pers. Obs). 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).

3. Do sanctuary waters pose risks to human health?

Water quality within the sanctuary is rated as "good/fair and not changing". No known illnesses have been reported from eating shellfish harvested from the Channel Islands. However, several potential risks do exist, 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. 1991). 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 the dilution, exposure to sunlight and salinity. Significant elevated levels of harmful bacteria from vessel discharges have not been 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 Channel Islands sanctuary are shipping traffic, vessel discharges, contaminants such as DDT, and mainland land use runoff. Each year, approximately 6,500 cargo ships transit through the sanctuary, this number is expected to increase 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. Proposed revisions in the Draft Management Plan further clarify vessel discharge regulations by limiting discharges from large vessels (300 gross tons or larger) and prohibiting untreated sewage from being discharged into the sanctuary. Contamination from toxins that are no longer in use can still have effects on sanctuary resources. For example, the pesticide DDT was banned in the early 1970's but is still detected in low levels in sediments (Schiff et al. 2006). Animals affected by DDT, such as brown pelicans and bald eagles, are making a comeback but are still below pre-DDT abundances (Harry Carter personal communication 2007, CINP http://www.nps.gov/chis/naturescience/brown-pelican.htm, Engle 2006, Sydeman et al. 2001, Channel Islands National Park http://www.nps.gov/chis/naturescience/bald-eagles.htm). 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 affect sanctuary water quality.

Water Quality Status & Trends

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

▲ = Improving ▬ = Not changing ▼ = Declining
? = Undetermined trend N/A = Question not applicable

#	Status	Rating	Basis for Judgment	Description of Findings
1	Stressors	?	DDT contaminants are likely dissipating and are present in reduced levels. However, there is concern about recent apparent increases in *Pseudo-nitzschia*/domoic acid.	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; island runoff is minimal.	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.
3	Human Health	--	*Pseudo-nitzschia*/domoic acid blooms pose a threat for shellfish consumption, but 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	--	Shipping traffic, vessel discharges, DDT, and mainland land use runoff may affect water quality.	Few or no activities occur that are likely to negatively affect water quality.

Habitat

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

Comment [J22]: This section is very vague and tells me next to nothing about the abundance and distribution of different habitat types in the sanctuary…

The abundance and distribution of major habitat types in the sanctuary is rated as "fair" but the trend is "unknown." Approximately a third of the Sanctuary has been mapped using high resolution imaging and deep water areas are not well

studied. However, experts believe the level of trawling activity that historically took place may have degraded deeper soft-bottom and some hard-bottom habitats (Engle personal communication 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). Other types of fishing, such as trap gear, may also impact benthic 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?

Comment [J23]: Is there any estimate of how much of the kelp forest habitat has been transformed into urchin barrens?

The condition of biologically-structured habitats in the sanctuary is rated as "fair and not changing". The historical harvest of top predators, including lobsters and sea otters has destabilized highly diverse and productive kelp forest communities, resulting in 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 by sea urchins grazing on algae. Trawling and trapping activities have likely degraded deeper hard-bottom coral communities (including cup corals, purple hydrocoral, and gorgonian sea fans) to some unknown extent (Engle personal communication 2007), though creation of reserves and other relatively recent regulations now prohibit trawling and trapping in some areas. Anchoring damages eelgrass and kelp habitats, with recreational anchoring likely increasing. 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 Channel Keepers has 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 climate regime shift toward warmer sea temperatures (however, it is unclear whether this is the result of a natural cycle or anthropogenically-driven global warming) (Smith et al. 2006a, Smith et al. 2006b).

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

The relative remoteness of Channel Islands sanctuary from mainland pollution sources and protections afforded by Channel Islands National Park and Channel Islands sanctuary have resulted in lower contaminant levels at the islands, therefore the rating for this question is "good/fair and improving." Adverse DDT influence on nesting birds (e.g., Brown Pelicans and Bald Eagles) is widespread, but is gradually lessening (Harry Carter personal communication 2007, CINP http://www.nps.gov/chis/naturescience/brown-pelican.htm, Diana Engle 2006, Sydeman et al. 2001, Channel Islands National Park http://www.nps.gov/chis/naturescience/bald-eagles.htm). Production of DDT was halted in the early 1970's and sediment contamination is much lower in the sanctuary compared to the rest of the Southern California Bight (Schiff et al. 2006). 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. Potential oil and other chemical spills from platforms and vessels remain a threat.

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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 community dominants (that often are slow-growing and long-lived) and indirectly reducing productive, habitat-forming seaweed assemblages (via increased 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 resources. Commercial and recreational fishing activities have declined in reserve areas 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. Boating and other marine activities also disturb marine life (e.g., fishes, birds, mammals) behavior patterns by vessel movements and underwater and topside noise production and lights. Oil platform production and commercial vessel traffic continue to be potential sources of catastrophic impacts should major spills or accidents occur.

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Habitat Status & Trends

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

▲ = Improving ▬ = Not changing ▼ = Declining
? = Undetermined trend N/A = Question not applicable

#	Status	Rating	Basis for Judgment	Description of Findings
5	Abundance/Distribution	?	Trawling, anchoring and fishing gear impacts. 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	--	Loss of giant kelp and understory habitat-forming algae, trawling damage to hard-bottom coral communities, white urchin increase resulted in decline in eelgrass, decline in mussel bed community diversity. Reserves and trawl regulations may help habitats to 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	▲	DDT is present but gradually lessening, vessel discharges are present but regulations have kept contamination at low levels, mainland discharges seldom reach the islands.	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.
8	Human Activities	▲	Direct or incidental extraction of biogenic species, vessel discharges, and anchoring; recent management actions may improve conditions.	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized, not widespread.

Living Resources

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

Overall the biodiversity in the Channel Islands sanctuary is rated as "fair" and the trend is "unknown." Although there is tremendous diversity at the islands there are key components that have been altered. 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, as observed through a long term monitoring program by Channel Islands National Park (D. Kushner personal communication 2007). At the eastern end of the island chain, Anacapa, Santa Barbara, and the eastern portion of Santa Cruz Islands where fishing pressure is greater there has been an overall decline in biodiversity in many areas (D. Kushner personal communication 2007). Many areas that previously supported kelp forests or eelgrass beds are now dominated by one or more species of echinoderms (urchins and brittle stars) and have lower biodiversity (J. Altstatt personal communication 2007, Engle personal communication 2007.). In some near shore areas around Anacapa brittle stars have been found at densities greater than 1000/m^2 (J. Altstatt 2005). Although some species can coexist with urchins, areas dominated by brittlestars appear to prevent the colonization of other species (J. Altstatt personal communication 2007). In addition, throughout the sanctuary abalone, rockfish, shark, and swordfish populations have been depleted severely (D. Richards personal communication 2007). In the intertidal community there has been a decrease in abundance and diversity of mussel bed communities (Smith et al. 2006a, Smith et al. 2006b).

Comment [J24]: The term "biodiversity" should be clearly defined here as it has several different meanings and connotations in ecology. Are there actual estimates of the number of species inhabiting these different areas and how they have changed in response to various disturbances? Is there evidence that actual species numbers have changed as a result of fishing? Often times disturbances can lead to a reduction in specific species that may be of commercial or ecological importance but may cause increases in the abundance of other species…this section needs to be more explicit regarding what aspect of "biodiversity" is being discussed.

Comment [J25]: Based on information that sanctuary, state and academic scientists have collected over the years how have populations of specific organisms changed? What is the current status of urchin, lobster, rockfish species, kelp, etc? How have populations changes inside of protected areas? Are there differences among protected areas?

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

The status of environmentally sustainable fishing is considered to be "fair/poor and improving." Gill netting, which generally has significant by-catch, is allowed in some areas of the sanctuary, but not within one mile of the islands. Gill netting in the sanctuary generally targets white sea bass, flatfish, swordfish, and sharks. In addition, lost lobster or fish traps have been observed ghost fishing for target species as well as non-target species. At least in part as a result of 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). Populations of other species have shifted towards smaller sizes such as red sea urchins and sheephead in some areas where fishing occurs (D. Richards personal communication 2007). Lobster harvest has led to an increase in urchins and a decrease in kelp abundance in some areas (Behrens and Lafferty 2004).

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Fishing does not only affect fish; much concern has been expressed by seabird researchers about effects of: a) fishing of Northern Anchovy and Pacific Sardine on prey availability for Brown Pelicans; b) bycatch from gill-net fishing on cormorants and alcids; c) bycatch of pelicans from recreational fishing and subsequent mutilations; and d) disturbance of colonial surface-nesting seabirds and roosting seabirds by fishing, diving, and other boats 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 cause collisions with lighted structures or vessels (Gress and Anderson 1983; Carter et

al. 2000, 2008). Studies are needed to better assess the indirect effects of fishingon seabirds, especially boat disturbance and light pollution.

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In recent years many new regulations have gone into effect including a federal abalone fishery closure, 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. However, fishing is still allowed in most of the sanctuary and there are significant gaps in our knowledge of fishery effects and basic life history that impede management.

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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 considered to be "good and declining", 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 recorded at one site at Anacapa Island. If these species become established and widespread at the islands they could outcompete native species.

Comment [J26]: And may adversely affect species richness and diversity patterns in the invaded habitats. There is a clear need to develop monitoring programs designed to target certain invasive species so that early detection is 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 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 that are dominated by echinoderms, particularly red and purple urchins, many fish species, such as sheephead and rockfish, have declined (Lafferty and Kushner 2000) and there is little indication that these abundances have improved sanctuary-wide in recent years. However, in areas where kelp forests are present, some of these fish species have increased (D. Kushner Pers.Comm. 2007). Giant sea bass populations 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 2004). Kelp may be reduced as a result of fishing impacts to other species, such as spiny lobster, which prey on sea urchins (Lafferty 2004). Sea urchins can increase and graze down kelp when predators are removed. 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 harvesting. Both species are now protected but recovery has not yet been observed.

Comment [J27]: What about giant kelp??? Is this not the species responsible for actually making the habitat that all other kelp forest species depend upon? What about surfgrass & eelgrass?

Deep water 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 deep water can not be identified at this time.

Seabirds feed at a high trophic level and are good indicators of ecosystem health. There are a variety of threats to seabird populations. More than thirty years after DDT was banned, there have been dramatic improvements in brown pelicans (Gress 1995, unpubl. data). The U.S. Fish and Wildlife Service proposed to remove California Brown Pelicans from the U.S. endangered species list in 2008. Brandt's Cormorant populations fluctuate dramatically, with population declines during major El Nino events (1992-93, 1998) and population increases in intervening years (Carter et al. 1996, Capitolo et al. 2004, 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). 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) although recent rat eradiction from Anacapa Island is helping the nesting population at this location to recover (Whitworth et al. 2006). About a third to a half of the world population of this species occurs in the sanctuary (Karnofsky et al. 2005; Carter unpubl. data) and it was state listed as threatened in 2004(Burkett et al. 2003) and federal listing is pending. 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 (Wolf 2007), and light

pollution (Carter et al. 2008). Ashy Storm-Petrels are almost endemic to California 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. After an absence of breeding for many years, Tufted puffins bred at San Miguel Island from 1991-1997 but no longer breed there today (Carter unpubl. data) This charismatic seabird species has been lost from the sanctuary. 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 visiting breeding habitats since 1999 and may soon recolonize (H.R. Carter, unpubl. data).

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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 pollutants. 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. Osprey have not yet been reintroduced.

Four species of whales use the sanctuary for significant feeding grounds or migration routes: Fin, Humpback, 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. However, data on this is very limited and increased sightings could indicate shifts in distribution resulting in some animals being seen (J. Calambokidis personal communication 2008). Humpback abundance off the U.S. West Coast appears to be increasing steadily at about 8% per year although there was a dip after the 1998 El Nino (Calambokidis and Barlow 2004, Calambokidis et al. 2005). They are now expected to number close to 20,000 in the North Pacific, approaching the numbers thought to exist pre-whaling (Calambokidis et al. 2008). In recent years, humpback whales off California have switched from feeding predominantly on krill to fish (J. Calambokidis personal communication 2007). This switch may reflect declines in available krill which 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. The blue whale population status over the longer period has been improving but there have been indications of declining conditions in more 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 appears related to increased evidence of blue whales using feeding areas outside California including Mexico and waters off British Columbia and Alaska (Calambokidis et al 2007). Blue whales are exclusively krill feeders and may be more vulnerable to declines in krill abundance which appear to have occurred and affected some krill-feeding bird species and which also may have caused the switch in prey of humpback whales. At this point it is not possible to tell if this switch in distribution is part of a natural cycle or more seriously related to climate change. 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 around a quarter of the population during this period (J. Calambodokidis personal communication 2007).

Comment [J28]: Why is there no mention of the multitude of whale deaths that have occurred in or around the sanctuary over the last several years?

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

The overall health of key species in the sanctuary is rated as "fair," however a trend is "unknown." For example, overall abalone populations remain depressed at the Islands, 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 slight increases in recent years, disease events for this important key intertidal species continue. In 2008, black abalone were petitioned for listing under the federal Endangered Species Act. Echinoderm diseases (especially in sea urchins and seastars) are also common and little is known about the cause or effects. The size of spiny lobster has noticeably increased inside the state marine reserves, but not elsewhere and many individuals outside of reserves are small.

Comment [J29]: What is a disease event?

Though several species of fish (sheephead and kelp bass) appear to have increased in abundance recently (probably due to favorable oceanographic conditions), their size distribution has not, (presumably due to fishing pressure), and these fish remain noticeably small at several of the Islands (mainly Santa Barbara, Anacapa and the eastern portion of Santa Cruz Island (D. Kushner personal communication 2007).

Though some seabird populations are recovering from the effects of DDT, others are experiencing declines from various pressures. Cassin's Auklets have had high nesting failures in recent years and this may be a result of reduced food sources as a result of changing oceanographic conditions (Adams 2008). Xantus's Murrelet nested later in 2005-2007, though nesting was earlier in 2008(Whitworth et al. 2006, unpubl. data) and Ashy Storm Petrels at Santa Cruz Island have had declines in nesting at

some locations as a result of skunk predation and light pollution (Carter et al. 2007, 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 are rated as "fair and not changing." Sanctuary-wide harvest of animals has led to severe declines in some exploited species, such as abalone, lobster and urchins?. Non-consumptive visitor use of the sanctuary has also had an effect on living resources. There has been a recent noticeable increase in recreational kayak use which could bring potential harm by disturbing wildlife not accustomed to people. People that 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. Shipping traffic continues to increase in the Santa Barbara Channel, potentially increasing the risk of the introduction of invasive species. a wreck, spill, or collision with marine mammals or other vessels.

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Pollutants and debris from the mainland enter the channel, though the rate at which and amount of pollution that reaches the sanctuary is thought to be low. However, increases in runoff and storm events occurring on the mainland could affect the sanctuary. Increased boating may lead to wildlife conflicts and anchor damage. Eelgrass beds in high-use anchorages such as Scorpion and Prisoners at Santa Cruz Island experience frequent scarring from anchoring (Altstatt, personal communication). More visitors to the islands increase the likelihood for disturbance; mechanisms of disturbance include anchoring, noise, lights, trash, increased harvest pressure and illegal fishing

Living Resources Status & Trends

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

▲ = Improving ▬ = Not changing ▼ = Getting worse
? = Undetermined trend N/A = Question not applicable

#	Status	Trend	Basis for Judgment	Description of Findings
9	Biodiversity	?	Extraction of key species has decreased biodiversity and simplified community structures.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
10	Extracted Species	▲	High levels of extraction of key species; 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 invasive species have become established; 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; some birds have shown recent recovery from historic 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	—	Extraction, localized effects of boaters and visitors at Santa Cruz and Anacapa Islands, increase in shipping activity.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.

Comment [J30]: Need to demonstrate this to some degree…where are the data?

Comment [J31]: They have not been detected but this does not mean they are not there. What about invertebrates?

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 considered to be "good/fair and declining." 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 may in exist in the sanctuary that include ship and aircraft wrecks (Morris and Lima 1996). A comprehensive inventory of archaeological resources began at the time of designation in 1980 and continues today. Most of the known shallow water sites are reported 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. Submerged cultural material associated with Native American terrestrial sites has been recorded nearshore as a result of coastal land erosion. Some sites are regularly visited by divers and in some cases artifacts have been removed from accessible sites. It is assumed relic hunting has declined today due to enforcement, education, and most of the accessible sites have already been pilfered.

However, 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 one deeper offshore archaeological site location inventory has been conducted in the Channel Islands National Marine Sanctuary by NOAA (WWII era TBF Avenger military aircraft near Anacapa Island). No other evaluations of deep water 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. One probable impact in offshore waters is from bottom trawling, but because the majority of wreck locations are unknown, the impacts from historical and recent trawling are unknown.

The sanctuary works in collaboration with the Channel Islands National Park Service, 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.

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

Maritime archaeological resources are considered to have a "good/fair" rating with a "declining" trend in terms of posing an environmental hazard. Channel Islands National Marine 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. Shipwrecks that once had the capacity to hold bunker fuel and hazardous cargoes have been surveyed and no longer pose a threat. A greater threat to sanctuary resources is from shipwrecks in the contiguous waters just outside the sanctuary boundaries. For example, the bulk-carrier *Pacbaroness* sunk approximately 10 nautical miles northwest of the sanctuary after a collision in 1987; and carried a cargo of 21,000 metric tons finely powdered copper concentrate, 339,360 gallons of fuel oil, and 10,015 gallons of lubricating oil. Due to the prevailing current and wind in the region, the oil was transported in close proximity of San Miguel Island, considered to be one of most biologically rich of the islands within the sanctuary. A northerly flowing current becoming predominant over the wind, carried the oil away from the sanctuary before reaching shore. An expedition in 2002 took sediment samples in the area; the study is now in final analysis (Schwemmer 2002). Other vessels 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 "good/fair and improving." Site looting (where objects are intentionally pilfered from submerged sites) has posed a major threat to submerged archaeological resources and these sites include historic shipwrecks (e.g. California Gold Rush passenger steamer *Winfield Scott* lost 1853, 19th century built sailing ship *Aggi* lost 1915, 19th century bark *Goldenhorn* lost 1892, 19th century built cargo/passenger steamer *Cuba* lost 1923, 19th century steamship collier *Crown of England* lost 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 site disturbance has declined (Schwemmer 2001). Other potential impacts to archaeological sites include sport divers inadvertently causing injury through poor diving techniques, inadvertently holding onto fragile artifacts or striking them with scuba tanks. Vessel activity can also cause serious injury to submerged archaeological resources such as anchor drags or modern ship groundings.

Comment [kb32]: I must be less sanguine than the report, giving a best a "fair" to questions 15 and 17 (I do agree with the response to question 16), and I would add that, unfortunately, we just don't know. Correcting this situation will be difficult and expensive, requiring the deployment of costly technologies to plumb the deeper waters of the Sanctuary. I hope your efforts meet with success in these areas.

Comment [kb33]: This report relies heavily upon Morris and Lima (1996) for an assessment of the extant resources within the Sanctuary. That report, a reasonable effort in its day, is now rather long in the tooth. There are many aspects of the maritime resource that M&L did not discuss – the Spanish/Mexican period (lack of access to Spanish archives) and less than complete evaluation of recent recreational vessel wrecks (lack of time). I would love to see what Robert Schwemmer, a skilled and adroit researcher, could do to improve on Morris and Lima, especially with an adequate budget and support.

Comment [kb34]: The report discusses prehistoric material in question 15, where it asserts that cultural material is submerged only as a result of coastal land erosion. There is a growing body of evidence that strongly indicates the presence of submerged sites as deep as 100 meters below present sea level, the logical consequence of human occupation of the islands over the past 13,000 years.

I know of at least two archaeologists attempting discovery of this material around the islands. My gut feeling is that the eventual discovery and investigation of very early and deeply submerged sites will place extremely significant sites within the administrative control of CINMS. The Sanctuary should be prepared for this eventuality.

Comment [J35]: How is it in final analysis if it was published in 2002???

Comment [kb36]: In summary, I must be less sanguine than the report, giving a best a "fair" to questions 15 and 17 (I do agree with the response to question 16), and I would add that, unfortunately, we just don't know. Correcting this situation will be difficult and expensive, requiring the deployment of costly technologies to plumb the deeper waters of the Sanctuary. I hope your efforts meet with success in these areas.

Comment [kb37]: Overall, this is an excellent summary of the condition of the resources with the Channel Islands National Marine Sanctuary. I will confine my comments to those historical and archaeological resources of which I have some knowledge and experience.

With respect to maritime archaeological resources, the report states that looting has declined as a result of successful prosecution and outreach programs. Having been heavily involved in the 1987 prosecution, I am skeptical about this conclusion. Prior to the 1987 case, I was in contact with the wreck diving community in an attempt to win their hearts and minds toward a more legal approach to shipwrecks. Many wreck divers impressed me with their technical diving competence, their dedication, and their hard work, along with their belief in their ...

Historical and recent bottom trawling is one probable impact to offshore maritime archaeological resources from which these resources can not 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 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.

Maritime Archaeological Resources Status & Trends

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

▲ = Improving ▬ = Not changing ▼ = Declining
? = Undetermined trend N/A = Question not applicable

#	Status	Rating	Basis for Judgment	Description of Findings
15	Integrity	▼	Past looting activities 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.	Selected archaeological resources exhibit indications of disturbance, but there appears to have been little or no reduction in historical, scientific or educational value.
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	▲	Increases in education and enforcement overall; decreased trawling as a result of regulatory actions.	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.

Response to Pressures

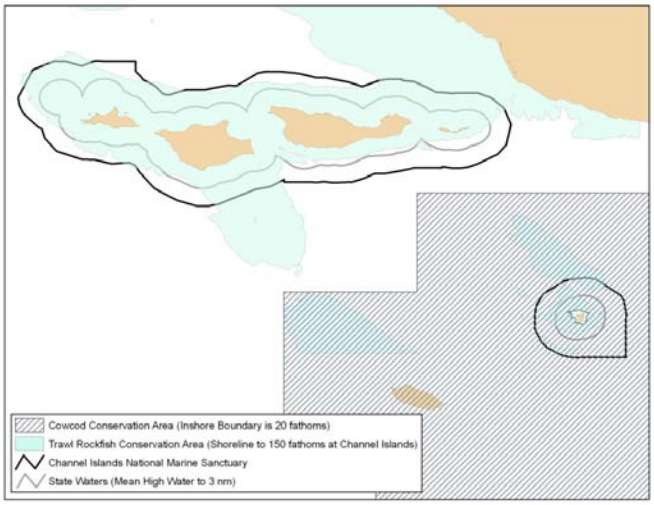
Regulatory Setting

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 and the non-profit organization The Nature Conservancy also own some of the land. Other government agencies that operate in the sanctuary and exercise authority over portions of the resources include: NOAA's National Marine Fisheries Service, Pacific Fishery Management Council (PFMC), United States Coast Guard (USCG), Minerals Management Service (MMS), US Environmental Protection Agency, US Fish and Wildlife, 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 County 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 website (http://channelislands.noaa.gov/drop_down/reg.html) and in the sanctuary's management plan (http://channelislands.noaa.gov/manplan/overview.html). The management plan is currently undergoing a revision process and NOAA is considering updates to management and operational strategies and regulations. As of this writing, a revision of the management plan is underway and is expected to be finalized in 2009.

Commercial and Recreational Fishing

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 2 conservation areas that allow some forms of fishing. The first phase of implementation for these marine zones established marine reserves that extend to the state water boundary at three miles in 2003. In July 2007, some of these zones were extended to the federal boundary and one new zone was established. To ensure compliance with these regulations, the Channel Islands sanctuary has a cooperative agreement 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 a high level of compliance. 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. Preliminary results suggest reserves may have higher density and higher biomass of targeted species. Continuing to monitor living marine resources in terms of marine reserves effectiveness, and developing synthetic, comprehensive monitoring is a priority

Over the last decade, bottom-trawling activities were restricted in sanctuary waters. The California state legislature passed a bill in the 1990s prohibiting bottom-trawling out to three nautical miles (5.5 km) offshore. Revision of this legislation in 2006 extended the prohibition to all state waters. In 2003 the California Fish and Game Commission prohibited directed trawling for spot prawns in California. Since some of this trawling had occurred on hard bottom, this action resulted in protection of sensitive benthic habitat. The Pacific Fishery Management Council together with the National Marine Fisheries Service has prohibited bottom trawling in two types of zones – a Trawl Rockfish Conservation Area and Essential Fish Habitat. The Trawl Rockfish Conservation Area was closed, beginning in 2002, to prevent by-catch of depleted rockfish species. The upper and lower boundaries of this closure have changed slightly over time, but generally encompasses the seafloor between 100 and 150 fathoms (180 and 275 meters). NMFS 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.



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

Comment [J38]: Insert figure number…

Shipping and Boating

The U.S. Coast Guard enforces federal shipping and boating regulations. In addition, the Sanctuary and the State regulate discharge of sewage and greywater. The Sanctuary also monitors the spatial distribution of 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 addition, the sanctuary works with Dr. John Hildebrand and his lab from Scripps Institution of Oceanography researchers to monitor Automated Identification System (AIS) signals from commercial shipping traffic in the shipping lanes that pass through the sanctuary. AIS, required on commercial vessels 300 gross tons or larger, transmit information such as name, heading, speed, and destination. Receivers , including one at Santa Barbara Harbor, log this information on software operated by sanctuary staff and researchers at Scripps Institution of Oceanography.

In 2004, the Sanctuary Advisory Council unanimously adopted and forwarded to the Sanctuary Superintendent a report created by the Conservation Working Group on anthropogenic noise in the sanctuary which focused on ship noise and noise from other sources such as military activities, construction, oil and gas production, and smaller boats. Sanctuary staff took this report under advisement and began implementing some of the recommendations, including developing research partnerships. In addition to the work monitoring the ship traffic, researchers from Dr. Hildebrand's Lab monitor marine mammal noise and marine mammal response to noise in the sanctuary. The Channel Islands sanctuary provides vessel support for Hildebrand to service High Frequency Recording Packages in the Santa Barbara Channel. This equipment records noise from ships and marine mammal vocalizations. Using the AIS information and noise recordings from the 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. The sanctuary looks forward to continuing this partnership and to developing new projects.

Offshore Oil and Gas Industry

Minerals Management Service regulates oil and gas activities in federal waters. The sanctuary prohibits new oil and gas exploration. There are 39 federal leases in the Channel Islands region, two of which pre-date sanctuary designation and overlap the sanctuary at the 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

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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, ship wrecks and aircraft wrecks.

Climate Change

We can expect the magnitude of global-scale climate change to be significant and local-scale effects to be profoundly transformative. However, precise local-scale forecasts of global climate change are uncertain. Uncertainty results from incomplete understanding of our local ecosystem and how it is coupled to the global climate system on the one hand and, on the other hand, the continuing expectation - based on documented past experience – that our ability to forecast climate change drivers is primitive. This forecast uncertainty makes it difficult to prioritize responses to climate change at the CINMS scale. Indeed, what little we do know about climate change is that almost all driving processes and many responses operate on hemispheric and global scales (i.e. far outside CINMS's jurisdiction) making CINMS's scope to develop management strategies that impact drivers of climate change limited if not non-existent.

Comment [J39]: Please define how and why local effects are going to be "profoundly transformative"…

Our current responses to these pressures are principally to develop a synthetic and comprehensive monitoring program that is designed to inform 1) a more mature understanding of how local-scale ecosystem process 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, CINMS staff has significant expertise in climate process impact on local ecosystem responses 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 climate impacts monitoring will inform the development of management tools for mitigation and response to climate alteration, but there is no guarantee that local scale management alternatives exist. The one thing we can predict with certainty is that we will fail to manage successfully and economically the effects of climate change if we fail to increase our understanding of how the CINMS system works.

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Pollutants and Marine Debris

There are numerous state and federal statutes relating to water quality. 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 exceptions for some vessels and lawful fishing activity. Although discharge of untreated sewage is prohibited throughout the sanctuary (and within the three mile boundary of all state waters), this regulation is still met with some confusion. It is the intent of the sanctuary to prohibit all untreated sewage within the six nautical mile boundary, and the Draft Management Plan is being revised to make this clearer. In sanctuary waters vessels may discharge waste that has been treated with a type I or type II marine sanitation device. A proposed regulation would prohibit large ships (300 gross tons or larger) from any discharge in the sanctuary, regardless of treatment. However, this does not preclude pollution or marine debris released outside sanctuary boundaries from entering. The U.S. EPA regulates water quality and discharges in federal waters and the State Water Resources Control Board regulates state water. The State Department of Public Health maintains a monitoring program to track blooms and disseminate information: http://www.cdph.ca.gov/healthinfo/environhealth/water/Pages/shellfishreports.aspx

The Conservation Working Group of the Sanctuary Advisory Council developed a water quality needs assessment that was subsequently unanimously adopted by the council. 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 Southern California Coastal Water Research Project.

In 2006, the SeaDoc Society at UC Davis initiated a lost fishing gear removal project that recovered ten tons of fishing gear, mainly lobster traps, from the sanctuary. The SeaDoc Society hopes to continue this project and to find a sustainable way to ensure it continues. CINMS 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, or those on charter cruises and concessionaire boats. 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. 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 2006, the Naturalist Corps volunteered over 16,000 hours interpreting the resources in the Channel Islands National Marine Sanctuary, Channel Islands National Park, and Santa Barbara Channel to visitors. CINMS, the Sanctuary Advisory Council, and the Sanctuary Education Team (a working group of the Council), continue to look for opportunities to reach visitors.

Comment [J40]: How is the sanctuary helping to prevent the impacts to the islands from visitor's? For example how will the CINMS prevent the spread and establishment of invasive species that are known to inhabit local habors?

Concluding Remarks

This initial report on resource status and trends for 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 had "fair" ratings. In addition, one living resources category had a "fair/poor" rating. On the other hand, the general status for water quality and maritime archaeological resources appears to be good/fair. The report suggests that habitats and living resources need to be closely monitored and restored.

The 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. CINMS 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 Channel Islands National Marine Sanctuary. Through a evision of the management plan and condition reports, the site 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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Acknowledgements

We thank the scientific experts for their contribution to evaluating sanctuary resources, and the Research Activities Panel, Sanctuary Advisory Council, and external reviewers for comments that improved the document.

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Additional Resources

Census of Marine Life – Gulf of Maine
http://www.usm.maine.edu/gulfofmaine-census/

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

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

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

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

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

NOAA National Marine Sanctuary Program
http://www.sanctuaries.nos.noaa.gov/welcome.html

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

NOAA Ocean Explorer

http://www.oceanexplorer.noaa.gov/welcome.html

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

Appendix:
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.

Comment [J43]: How are the different ratings summarized?

The questions derive from the National Marine Sanctuary System's mission, and a system-wide monitoring framework (National Marine Sanctuary Program 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. 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. The questions are meant to set the limits of judgments so that responses can be confined to certain reporting categories that will later be compared among all sites and combined. 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.

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.

Question 1 (Water/Stressors): 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.

Question 2 (Water/Eutrophic Condition): 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.

Question 3 (Water/Human Health): 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.

Question 4 (Water/Human Activities): 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.

Question 5 (Habitat/Abundance/Distribution): 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.

Question 6 (Habitat/Structure): 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.

Question 7 (Habitat/Contaminants): 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.

Question 8 (Habitat/Human Activities): 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.

Question 9 (Living Resources/Biodiversity): 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.

Question 10 (Living Resources/Extracted Species): 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 by-catch 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.

Question 11 (Living Resources/Non-Indigenous Species): 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.

Question 12 (Living Resources/Key Species): 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.

Question 13 (Living Resources/Health of Key Species): 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.

Question 14 (Living Resources/Human Activities): 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.

Question 15 (Maritime Archaeological Resources/Integrity): 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.

Question 16 (Maritime Archaeological Resources/Threat to Environment): 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.

Question 17 (Maritime Archaeological Resources/Human Activities): 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.