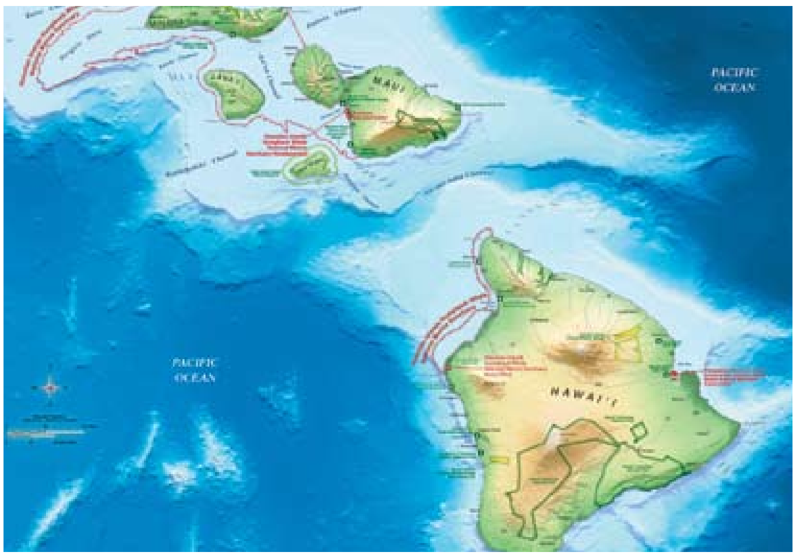
Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

Hawaiian Islands Humpback Whale National Marine Sanctuary

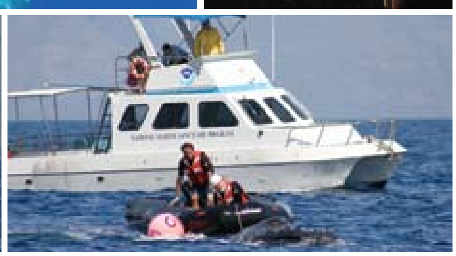
CONDITION REPORT 2010











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Map:
Bathymetric grids derived from multiple sources prepared by: The Coral Reef Ecosystem Division of NOAA's Pacific Islands Fisheries Science Center with funding from NOAA's Coral Reef Conservation Program.

Photos (from top right, clockwise):
Humpback whale breaching, D. Perrine (HWRF/Seapics.com/NOAA Fisheries Permit #882); students, B. Billand (HIHWNMS volunteer); humpback whale surfacing, E. Lyman (HIHWNMS/NOAA Fisheries Permit # 782-1719); disentangling humpback whale, HIHWNMS (NOAA MMHSRP Permit #932-1489); humpback whale fluke, HIHWNMS (NOAA Fisheries Permit #782-1438); mother and calf, E. Lyman (HIHWNMS/NOAA Fisheries Permit # 782-1719); whale-watchers, P. Wong (HIHWNMS).

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About this Report

The National Oceanic and Atmospheric Administration's Hawaiian Islands Humpback Whale National Marine Sanctuary (sanctuary) is currently a single-species sanctuary whose primary mission is the protection of humpback whales and their habitat in the main Hawaiian Islands. This "condition report" provides a summary of the status of humpback whales (*Megaptera novaeangliae*) and their related habitats in the sanctuary, pressures on those resources, current condition and trends, and management responses to the pressures that threaten the health of humpback whales and their habitat.

Condition reports are developed for each site in the National Marine Sanctuary System to provide information on the status and trends of water quality, habitat, living resources and maritime archaeological resources, and the human activities that may affect them. For this particular sanctuary, the references in this report concerning water quality are not necessarily a statement about the overall quality of the water within the sanctuary, but the relationship of the water quality specifically to humpback whales and any potential for the quality of the water to have an adverse affect on humpback whales. This document reports on the status and trends of resources by presenting responses to a set of questions that have been posed to all national marine sanctuaries (Appendix A). It is important to note that the responses to these questions may have been different if resource quality was not directly linked to humpback whales. Condition reports serve as report cards that describe the status of targeted resources within each sanctuary. Resource status is rated on a scale from good to poor, and the timelines used for comparison may 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 a working group of 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 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 comprehensively describe the status, pressures and trends of resources as they relate to the Hawaiian Islands Humpback Whale National Marine Sanctuary. Additionally, this 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 also provide guidance for future management challenges.

Summary and Findings

The Hawaiian Islands Humpback Whale National Marine Sanctuary (sanctuary) was designated to protect the humpback whale (*Megaptera novaeangliae*) and its habitat in Hawai'i. The sanctuary enables citizens and government to work collectively on safeguarding humpback whale breeding and calving ranges in waters around the main Hawaiian Islands, an area that supports more than half of the North Pacific humpback whale population. Encompassing 3,548 square kilometers (1,370 square miles) of federal and state waters surrounding the main Hawaiian Islands, the sanctuary extends from the shoreline to the 100-fathom isobath (183-meter or 600-foot depth) and is composed of five separate marine protected areas (MPAs) accessible from six of the eight main Hawaiian Islands. The sanctuary's configuration presents unique challenges and opportunities for protecting sanctuary resources, developing programs and increasing public awareness of humpback whales throughout the state. Through management, resource protection, education, outreach, research and cultural activities, the sanctuary strives to protect humpback whales and their habitat in Hawai'i. This continued protection is crucial to the long-term recovery and conservation of the species.

The sanctuary is supported by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and administered jointly through a compact agreement and memorandum of understanding with the state of Hawai'i. The sanctuary was congressionally designated in 1992 by the Hawaiian Islands National Marine Sanctuary Act and was fully established in 1997 with the approval of the sanctuary's first management plan and acceptance of the final environmental impact statement by the state of Hawai'i. The management plan for the sanctuary was last revised in 2002. In 2007, the sanctuary began a second management plan review process to review the effectiveness of site programs and policies relative to the sanctuary's mandated goals. Although this is a multi-year process, this condition report provides an important baseline for the status of sanctuary resources at the beginning of the management plan review process.

The responses to the set of questions found in this report focus primarily on the effects, or potential effects, of pressures on the sanctuary as they relate to humpback whales and their habitat, the primary resource targets of the sanctuary. This condition report primarily addresses resources and pressures on those resources over which the sanctuary has authority. The findings of this report conclude that the resources protected by the sanctuary appear to be in "good" to "fair/poor" condition. Water quality in the sanctuary as it relates to humpback whales appears to be in "good" to "good/fair" condition because it is not likely to pose a threat to humpback whales. This is because most water quality issues occur in nearshore waters, and humpback whales do not feed while wintering in Hawaiian waters. Habitats used by humpback whales in the sanctuary are in "good/fair" condition. Although humpback whale habitat remains widely available in the Hawaiian Islands, some preferred habitats could be removed due to offshore development activities.

The status of humpback whales is rated as "good/fair"; however, their health is rated as "fair." Although humpback whale abundance is increasing in the sanctuary, the overall health rating is "fair" because there has been an increase in the number of reported collisions, entanglements and associated impacts (e.g., lesions and impairment of movement and other important behaviors). Entanglement and whale-vessel collisions have been widely identified as the primary human cause of mortality for humpback whales, both in Hawai'i and around the world. Therefore, these two issues have been identified as immediate and pressing issues for the sanctuary.

This condition report also includes the most up-to-date information from the North Pacific-wide research project, Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH). SPLASH is the most comprehensive humpback whale research study ever undertaken for any population of whales in any ocean. The primary objectives of the SPLASH project are to improve the description of the stock structure of humpback whales in the North Pacific, to understand the abundance and trends of these stocks, and to assess the human impact on them. The program is a cooperative effort of researchers from the United States, Canada, Mexico, Japan, Russia, the Philippines and Central America. Data is collected primarily through photo-identification of whale flukes and genetic analysis of tissue samples in the humpback whales' breeding and feeding grounds. The Hawaiian Islands Humpback Whale National Marine Sanctuary has played a central role in initiating, funding and coordinating this project.

National Marine Sanctuary System and System-Wide Monitoring

The Office of National Marine Sanctuaries manages marine protected areas in both nearshore and open-ocean waters that range in size from less than one to almost 362,600 square kilometers (140,000 square miles). Each area has its own concerns and requirements for environmental monitoring, but ecosystem structure and function in all these areas have similarities and are influenced by common factors that interact in comparable ways. Furthermore, the human influences that affect the structure and function of these sites are similar in a number of ways. For these reasons, in 2001 the program began to implement System-Wide Monitoring (SWiM). The monitoring framework (NMSP 2004) facilitates the development of effective, ecosystem-based monitoring programs that address management information needs using a design process that can be applied in a consistent way at multiple spatial scales and to multiple resource types. It identifies four primary components common among marine ecosystems: water, habitats, living resources and maritime archaeological resources.

By assuming that a common marine ecosystem framework can be applied to all sites, the Office of National Marine Sanctuaries developed a series of questions that are posed for every sanctuary and used as evaluation criteria to assess resource condition and trends. The questions, which are shown on the following page and explained in Appendix A, are derived from both a generalized ecosystem framework and the Office of National Marine Sanctuaries 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 the reports is intended to contribute to management plan reviews at each site and also helps sanctuary staff identify monitoring, characterization and research priorities to address gaps, day-to-day information needs and new threats.

Hawaiian Islands Humpback Whale National Marine Sanctuary Condition Summary Table

The following table summarizes the "State of Sanctuary Resources" section of this report. The "Questions" column lists 17 questions used to rate the condition and trends for qualities of water, habitat, living resources and maritime archaeological resources as they relate to the sanctuary target resources. The "Rating" column consists of a color, indicating resource condition, and a symbol, indicating trend (see key for definitions). The "Basis for Judgment" column provides a short statement or list of criteria used to justify the rating. The "Description of Findings" column presents the statement that best characterizes resource status, and corresponds to the assigned color rating. The Description of Findings statements are customized for all possible ratings for each question. Please see Appendix A for further clarification of the questions and the Description of Findings statements. The "Response" column provides a summary of existing and proposed responses to pressures on marine resources of the Hawaiian Islands Humpback Whale National Marine Sanctuary. *

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

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

**The responses to the questions found in this report are based primarily on the effects or potential effects of pressures on the sanctuary as they relate to humpback whales and their habitat, which are the current responsibilities of the Hawaiian Islands Humpback Whale National Marine Sanctuary. With one exception (Question 3), they do not address concerns or resources over which the sanctuary does not have authority or other responsibility.*

#	Questions	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?	–	Most areas with problems (e.g., sedimentation) are nearshore and restricted to bays and harbors; therefore, these issues are unlikely to pose threats to humpbacks.	Conditions do not appear to have the potential to negatively affect humpback whales or habitat quality.	Humpback whales that visit Hawai'i feed in Alaska and northern British Columbia. Thus, any effect water quality might have on fish stocks in Hawai'i as a food resource is not relevant to humpback whales in Hawai'i. Regulations prohibit discharging or depositing any material in the state-regulated waters of the sanctuary (up to 3 nautical miles offshore). The sanctuary is working with agency partners to improve compliance with water quality regulations.
2	What is the eutrophic condition of sanctuary waters and how is it changing?	–	Locations with chronic nutrient enrichment and extensive algal blooms are limited to nearshore waters and may be increasing in extent or severity, but are not known to pose threats to humpbacks.	Conditions do not appear to have the potential to negatively affect humpback whales or habitat quality.	
3	Do sanctuary waters pose risks to human health?	–	With the exception of occasional closures of some nearshore swimming areas, conditions are not currently believed to consistently adversely affect compatible uses of 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?	–	Numerous activities occur, but management actions have reduced some impacts; therefore, overall levels do not appear to be changing.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on water quality.	

Table is continued on the following page.

Hawaiian Islands Humpback Whale National Marine Sanctuary Condition Summary Table (Continued)

#	Questions	Rating	Basis for Judgment	Description of Findings	Sanctuary Response
HABITAT					
5	What is the abundance and distribution of major habitat types and how is it changing?	▼	Potential increase in the number of existing and proposed structures related to aquaculture and offshore energy production could remove humpback whale habitat in the water column and along the seafloor.	Selected habitat loss or alteration has taken place, precluding full development of humpback whale assemblages, but it is unlikely to cause substantial or persistent degradation in humpback whale status.	Altering the seabed of the sanctuary is prohibited, unless authorized by permit.
6	What is the condition of biologically structured habitats and how is it changing?	N/A	There are no biologically structured habitats, such as coral reefs, that appear to be associated with or required by humpback whales in the sanctuary.	N/A	
7	What are the contaminant concentrations in sanctuary habitats and how are they changing?	–	The low levels of some contaminants in humpback tissues are believed to be acquired in feeding areas, not in the Hawaiian Islands.	Contaminants do not appear to have the potential to negatively affect humpback whales.	
8	What are the levels of human activities that may influence habitat quality and how are they changing?	▼	Land and ocean-based activities including coastal development, high-speed ocean recreation activities, whale watching, underwater noise, vessel-whale collisions, and military activities.	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?	N/A	The sanctuary is currently responsible for managing humpback whales and their associated habitat. The issue of biodiversity is not relevant at this time.	N/A	SPLASH project examines North Pacific humpbacks and human impacts. Education and outreach create learning opportunities, spread awareness and promote stewardship. Regulations reduce vessel and aircraft disturbance, and discharges in state-regulated sanctuary waters. The sanctuary provides training and tools, develops techniques, coordinates whale disentanglements, conducts workshops, and issues avoidance guidelines to reduce ship strike risks.
10	What is the status of environmentally sustainable fishing and how is it changing?	N/A	Extraction is not relevant to the status of humpback whales and their habitat.	N/A	
11	What is the status of non-indigenous species and how is it changing?	–	There are no known non-indigenous species that affect humpback whales or their habitats.	Non-indigenous species are not suspected or do not appear to affect status of humpback whales.	
12	What is the status of key species and how is it changing?	▲	Humpback whale population levels are still below historic estimates in the North Pacific, however, recent estimates indicate humpback whale population levels in Hawai'i have increased by 6 percent annually.	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.	
13	What is the condition or health of key species and how is it changing?	▼	Increased reported numbers of vessel collisions and entanglements and associated impacts (e.g., lesions and impairment of movement and other behaviors).	The diminished condition of selected key resources may cause a measurable but not severe reduction in ecological function, but recovery is possible.	
14	What are the levels of human activities that may influence living resource quality and how are they changing?	▼	Increased reported numbers of collisions and entanglements (often including fishing gear encountered elsewhere).	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.	

Table is continued on the following page.

Hawaiian Islands Humpback Whale National Marine Sanctuary Condition Summary Table (Continued)

#	Questions	Rating	Basis for Judgment	Description of Findings	Sanctuary Response
MARITIME ARCHAEOLOGICAL RESOURCES					
15	What is the integrity of known maritime archaeological resources and how is it changing?	▼	Gradual loss of maritime archaeological resource integrity due to natural and human impacts including biological, chemical and mechanical weathering; anchor and mooring damage; diver visitation; looting; sedimentation, etc.	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.	Gradual loss of maritime archaeological resources due to natural and human impacts including development, dredging, coastal erosion, deterioration, intentional damage, etc.
16	Do known maritime archaeological resources pose an environmental hazard and how is this threat changing?	?	Data on wrecks that may pose hazards are insufficient to determine status or trend.	N/A	
17	What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?	▼	Increasing diving activity due to technical advances provides greater uncontrolled access.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.	

Site History and Resources

The warm and shallow waters surrounding the main Hawaiian Islands constitute one of the world's most important humpback whale (*Megaptera novaeangliae)* habitats. Scientists estimate that more than 50 percent of the entire North Pacific humpback whale population migrates to Hawaiian waters each winter to mate, calve, and nurse their young (Calambokidis et al. 2008). The continued protection of humpback whales and their habitat is crucial to the long-term recovery of this endangered species (HIHWNMS 2002). The humpback whale is protected in Hawaiian waters by the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), and the Hawaiian Islands National Marine Sanctuary Act.

On Nov. 4, 1992, the Hawaiian Islands Humpback Whale National Marine Sanctuary was designated by the Hawaiian Islands National Marine Sanctuary Act (Subtitle C of Public Law 102-587, the Oceans Act of 1992). In 1997, the sanctuary's management plan and final environmental impact statement were completed. Later that year, the governor of the state of Hawai'i approved the plan and its regulations as applied within state waters. Through a memorandum of agreement, the sanctuary is co-managed by the National Oceanic and Atmospheric Administration (NOAA) and the Hawai'i Department of Land and Natural Resources (DLNR). Section 2304 of the Hawaiian Islands National Marine Sanctuary Act established the purpose of the sanctuary, which is to protect humpback whales and their habitat in Hawai'i. Section 2304(b)(4) and the subsequent revised management plan of 2002 require the sanctuary to identify and evaluate other resources and ecosystems of national significance for possible inclusion in the sanctuary. The Office of National Marine Sanctuaries is required by law to periodically review sanctuary management plans to ensure that sanctuary sites continue to best conserve, protect and enhance their nationally significant living and cultural resources. Management plans are developed to be dynamic and adjust to new and emerging issues, although recent scientific discoveries, advancements in managing marine resources, and new resource management issues may not always be addressed in existing plans.

As stated above, the identification of other marine resources in addition to humpback whales and their habitat was stipulated by Congress in the sanctuary's 1992 designating act. During the 2002 management plan review and revision process, numerous public comments were received requesting that the sanctuary increase its scope to include the conservation and management of other resources and species. To meet the requirements of the congressional mandate and to respond to public input, the sanctuary undertook a process to identify new marine resources appropriate for protection by the sanctuary, which resulted in the development of an assessment that was submitted to the governor of Hawai'i in 2007 (HIHWNMS and SOH 2007a). The marine resources listed for evaluation by state and community partners include dolphins, other whales, Hawaiian monk seals, sea turtles and maritime heritage resources, such as historic downed aircraft and sunken ships. The governor responded by expressing support for consideration of other marine mammals and sea turtles for possible inclusion into the sanctuary.[1]

The sanctuary has begun a second management plan review process to address current and emerging issues and to increase management effectiveness. The Office of National Marine Sanctuaries recognizes the public as a key resource management partner and values its input in helping to shape and manage marine sanctuaries. The sanctuary is committed to engaging communities and keeping the public informed during its current management plan review process. Additionally, the public is provided with many opportunities to participate and submit comments throughout this multi-year process.

Location

Encompassing 3,548 square kilometers (1,370 square miles) of federal and state waters, the sanctuary extends from the shorelines of Hawai'i to the 100-fathom isobath (183-meter or 600 foot depth), and is composed of five separate marine protected areas (MPAs) accessible from six of the main Hawaiian Islands. The boundary of the sanctuary consists of the submerged lands and waters off the coast of the Hawaiian Islands seaward from the shoreline, cutting across the mouths of rivers and streams. All commercial ports and small boat harbors in the state of Hawai'i are excluded from the sanctuary (HIHWNMS 2002).

The five non-contiguous marine protected areas that comprise the sanctuary are distributed across the main Hawaiian Islands, each area with its own distinct natural and cultural character and social significance (Figure 1, page 8). The largest contiguous portion of the sanctuary, encompassing about half of the total sanctuary area, is delineated around Maui, Lāna'i, and Moloka'i. The four smaller portions are located off the north shore of Kaua'i, off the Kona coast of the island of Hawai'i, and off the north and southeast coasts of

[1]Because these additional marine resources are not currently protected under sanctuary authority, their condition is not rated in this report.

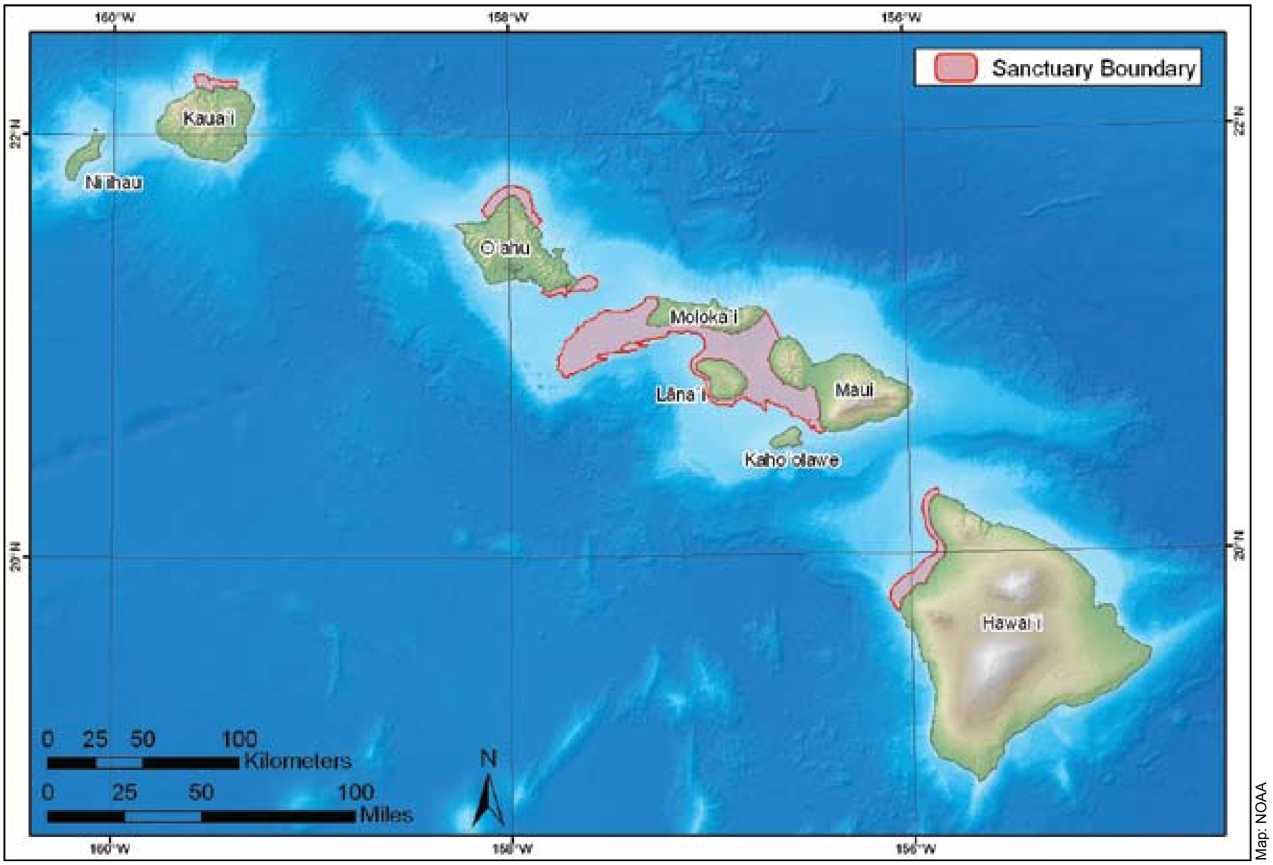


Figure 1. The sanctuary is comprised of five separate marine protected areas abutting six of the main Hawaiian Islands.

O'ahu. The five areas of the sanctuary cover relatively shallow offshore areas created over geologic time during the development of the Hawaiian island chain (HIHWNMS 2002).

Geology

Over the past 70 million years or more, the combined processes of magma formation, volcano eruption and growth, and continued movement of the Pacific Plate over a magmatic "hotspot" have left an extensive trail of volcanoes across the Pacific Ocean floor (Figure 2, page 9). The Hawaiian Ridge-Emperor Seamounts chain extends 6,000 kilometers (3,728 miles) from the "Big Island" of Hawai'i to the Aleutian and Kamchatka trenches off Alaska and Siberia, respectively (Figure 3, page 9). The main Hawaiian Islands are a very small part of the chain and are the youngest islands in the immense, mostly submarine mountain chain composed of more than 80 volcanoes.

A sharp bend in the chain indicates that the motion of the Pacific Plate abruptly changed about 43 million years ago, as it took a more westerly turn from its earlier northerly direction. It is unknown why the Pacific Plate changed direction, but it may be related in some way to the collision of India into the Asian continent, which began about the same time.

As the Pacific Plate continues to move west-northwest, the island of Hawai'i will be carried beyond the hotspot by plate motion, setting the stage for the formation of a new volcanic island in its place. In fact, this process may currently be underway. Lō'ihi Seamount, an active submarine volcano, is forming about 35 kilometers (22 miles) off the southern coast of Hawai'i. Lō'ihi already has risen about 3.2 kilometers (two miles) above the ocean floor to within 1.6 kilometers (one mile) of the ocean's surface. According to the hotspot theory and assuming Lō'ihi continues to grow, it will become the next island in the Hawaiian chain. In the distant geologic future, Lō'ihi may eventually become fused with the island of Hawai'i, which itself is composed of five volcanoes knitted together: Kohala, Mauna Kea, Hualālai, Mauna Loa and Kīlauea.

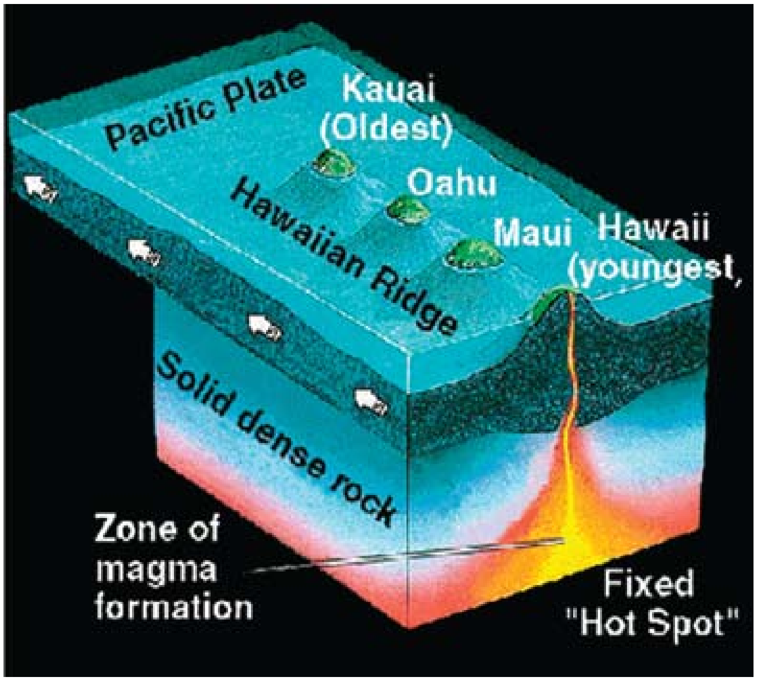
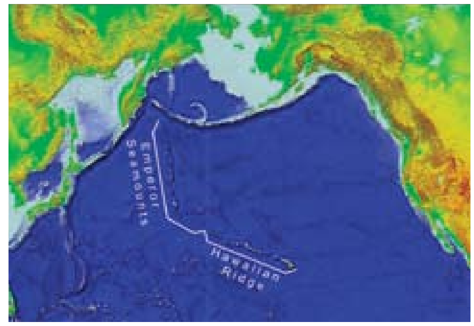


Diagram: U.S. Geological Survey

Figure 2. The Pacific plate moves slowly over the Hawaiian hotspot to the northwest. The area directly over the hotspot is volcanically active. The activity decreases and eventually stops as the plate moves on. The result is the Hawaiian island chain. Geologists have long assumed that the Hawaiian hotspot was stationary. However, current research suggests that it actually drifted southward between 47 and 81 million years ago.



Data: ESRI® Data & Maps, 2004; Map: K.E. Keller, Papahānaumokuākea Marine National Monument

Figure 3. Map of part of the Pacific basin showing the volcanic trail of the Hawaiian hotspot – 6,000-km-long (3,728 mi) Hawaiian Ridge-Emperor Seamounts chain.

Photo: I. Masterson, NOAA National Weather Service

Figure 4. Hawaiian Islands Humpback Whale National Marine Sanctuary, Waimea Bay, North Shore of O'ahu.

Water: Oceanographic Conditions

The waters surrounding Hawai'i are affected by seasonal variations in climate and ocean circulation. The surface temperature of the oceans around the main Hawaiian Islands follow a north-south gradient and range from 24°C (75°F) in winter and spring to 26-27°C (79-81°F) in late summer and fall. The depth of the thermocline, where water temperature reaches 10°C (50°F), is 450 meters (1,500 feet) northwest of the islands and 300 meters (1,000 feet) off the island of Hawai'i. Surface currents generally move from east to west and increase in strength moving southward. With the exception of some lee areas (e.g., between Maui, Moloka'i, Lāna'i and Kaho'olawe), the seas are rougher between islands than in the open ocean, because wind and water are funneled through the channels. Waves are larger in the winter months than in the spring and are generally larger on the northern shores of the islands than the southern shores (Mitchell et al. 2005).

The northeast trade winds predominate throughout the year in Hawai'i, but reach maximum intensity between spring and fall. These winds can produce substantial waves as they move across the Pacific toward Hawai'i (Figure 4). Trade winds diminish during the night and gradually increase throughout the morning to maximum wind speeds in the afternoon. Increased wind speed results in an increase in the size of wind-driven waves (Jokiel 2006).

A unique aspect of the geographic location of Hawai'i is direct exposure to long-period swells emanating from winter storms in both the northern and southern hemispheres. Breaking waves from surf generated by Pacific storms is the single most important factor in determining the community structure and composition of exposed reef communities throughout the main Hawaiian Islands (Dollar 1982, Dollar and Tribble 1993, Dollar and Grigg 2004, Jokiel et al. 2004). The exception to this general rule is sheltered embayments that make up less than 5 percent of the coastal areas of the main Hawaiian Islands (Friedlander et al. 2005).

Habitat

Hawai'i is one of the most isolated archipelagos in the world. Because the islands are located in the middle of the Pacific Ocean, the coral reefs of Hawai'i are exposed to large open-ocean swells and strong trade winds that have a major impact on the structure of these coral reef communities. The main Hawaiian

Islands consist of populated, volcanic islands with non-structural reef communities and fringing reefs abutting the shore (Friedlander et al. 2005).

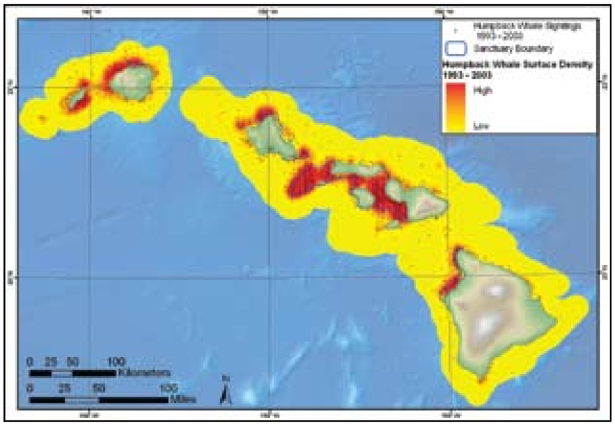
With its boundaries including waters from the shoreline to depths of 183 meters (600 feet) in many areas, the sanctuary encompasses a variety of marine ecosystems, including seagrass beds and coral reefs. Much of the sanctuary has fringing coral reefs close to shore and deeper coral reefs offshore. The coral reefs of Hawai'i are noted for their isolation and endemism. Corals and coralline algae are the dominant reef-building organisms in the Hawai'i ecosystem. The corals found in the sanctuary include finger coral (*Porites compressa*), cauliflower coral (*Pocillopora meandrina*) and lobe coral (*Porites lobata*). The deeper reefs lie in the "twilight zone" of the sanctuary below 60 meters (200 feet). These deep reef ecosystems have their own unique assemblages, many of which are depth-adapted versions of species found at shallower depths (HIHWNMS 2002).

The waters around the main Hawaiian Islands (Ni'ihau, Kaua'i, O'ahu, Moloka'i, Maui, Lāna'i, Kaho'olawe and Hawai'i) constitute one of the world's most important North Pacific humpback whale habitats and serve as a primary region in the U.S. where humpback whales reproduce. Although humpback cows with newborn and nursing calves are seen throughout the winter, to date, neither mating nor birthing of humpback whales have actually been witnessed (Clapham 2000, Pack et al. 2002). However, the 11 1/2-month gestation period combined with the sighting of many small calves throughout the winter season suggests that both mating and calving does occur during the winter season and possibly in late fall or early spring.

Humpbacks are not equally distributed among the islands. The largest concentrations may be found in the waters between the islands of Maui, Moloka'i, Lāna'i and Kaho'olawe, as well as the area known as Penguin Bank — a bank extending approximately 46 kilometers (28 miles) southwest of west Moloka'i. Both locations consist of expansive areas of shallow (less than 183 meters or 600 feet) water and are preferred by mothers with calves (Herman et al. 1980). This general habitat pattern has remained fairly consistent since characterization began in the 1970s (Mobley et al. 1999, Mobley et al. 2001). Additionally, there appears to be preferential habitat use by some female humpbacks based on their reproductive state (Craig and Herman 2000). Cows with calves appear to preferentially use leeward, nearshore waters within the 10-fathom isobath (18 meters or 60 feet), particularly along the northern coast of Lāna'i (Herman et al. 1980, Forestell 1986), Mā'alaea Bay, Maui (Hudnall 1978), and the west Maui area (Glockner-Ferrari and Ferrari 1985, Glockner-Ferrari and Venus 1983). This distribution of mothers and calves, primarily closer to shore, has been consistent since first studied (Herman and Antinoja 1977, Smultea 1994). The finding is consistent with humpback whale breeding ground studies conducted throughout their global range.

Living Resources: Humpback Whales

Throughout the winter season (roughly October through May), thousands of humpback whales of all age classes can be found in Hawaiian waters (Craig et al. 2003) (Figure 5). The primary activities of adult humpbacks during the winter season is mating and calving.



Data: J.R. Mobley, Jr., Ph.D, University of Hawai'i, NOAA Permit #810

Figure 5. Humpback whale surface sightings and estimated surface density based on aerial survey data from 1993 to 2003. The aerial survey data used in this map only counts whales at the ocean surface. Also, note that the lower density areas (in yellow) should not be viewed as areas where there are no whales, rather as areas where density is lower than in higher density areas (orange/red); also the terms in the map key: "high" and "low," are relative terms.

Photo: D. Perrine, Hawai'i Whale Research Foundation, NOAA Fisheries Permit #882

Figure 6. Mother and calf.

Sexual maturity in this species is about five years of age (Chittleborough 1965, Clapham 1992)[2]. Sexually mature female humpback whales produce a single calf on average every two to three years, though some females have been recorded to calve in consecutive years. Although the overall sex ratio is one male to one female, within the breeding grounds the observed sex ratio is approximately two males to one female. Consequently, female humpbacks are a limiting resource for which male humpbacks compete. Within breeding grounds, female humpbacks are rarely observed alone and single females — both with or without a calf (Figure 6, page 10) — are often "escorted" by one or more male humpbacks presumably in search of mating opportunities. In addition to escorting females and competing with other males for access to females, male humpbacks may produce a long and complex series of structured vocalizations termed "song" (Payne and McVay 1971). Singers are often, but not always, observed alone. The function of humpback whale song is still speculative (Herman et al. 1980, Darling et al. 2006). In general, the mating system of the humpback whale is poorly understood and the various factors involved have yet to be synthesized into a satisfactory model (for some attempts see Herman and Tavolga 1980, Clapham 1996, Cerchio et al. 2005, Darling et al. 2006).

As noted earlier, other than nursing calves, humpback whales do not feed while in Hawaiian waters and must rely on metabolizing their fat stores for energy. Thus, body size is important to this species (e.g., Sptiz et al. 2002, Pack et al. 2009), and residency duration is in part likely a function of body mass. Residency in Hawaiian waters by any individual humpback may range from several weeks to a month or more (Craig et al. 2001). By May, most humpback whales have begun the migration north towards nutrient-rich subarctic regions along the rim of the North Pacific, where after 4,000 kilometers (2,500 miles) or more of travel they will feed on krill and small schooling fish. Over the past 30 years, much has been learned by researchers about humpback whales in Hawai'i. However, more research is needed. Understanding the biology and behavior of this species is critical to developing effective strategies for its continued protection and conservation.

The Hawaiian Islands Humpback Whale National Marine Sanctuary was designated by Congress to protect humpback whales and their breeding habitat within Hawaiian waters. Commercial whaling during the first half of the 20th century dramatically reduced the numbers of humpbacks worldwide from an estimated 150,000 to around 10 percent of that number. Prior to the period of whaling, humpbacks in the North Pacific were thought to have numbered about 15,000 (Rice 1978). Although a moratorium on whaling for North Pacific humpbacks was put into place by the International Whaling Commission in 1965, Soviet whaling continued through 1971, leaving between 1,000 and 1,400 individuals in the population (Gambell 1976, Johnson and Wolman 1984). Through the Endangered Species Act of 1973, the United States government made it illegal to hunt, harm, or disturb humpback whales. Because of their perilous brush with near-extinction, the animals were officially listed in 1970 as endangered and remain so to this day. Several subsequent laws and policies, including the Marine Mammal Protection Act, have afforded additional protection by reducing human threats to humpback whales and other marine mammals. The sanctuary is unique among other sites within the sanctuary system in that its mission is to protect a single species, the humpback whale, and its habitat, through management, resource protection, scientific research, education, public outreach and by facilitating observance of federal and state laws that prohibit disturbing these endangered marine mammals throughout the main Hawaiian Islands (HIHWNMS 2002).

[2]A current summary of humpback whale ecology may be found in Clapham 2000.

Management Plan Review Process

The Management Plan Review Process

The sanctuary is seeking to engage local communities and partner agencies to help determine its future direction and scope. The term "management plan review" is used to describe this process. The management plan review will take several years to complete and will likely result in a revised management plan for the sanctuary. Management plans serve as "blueprints" for future sanctuary operations over the subsequent five to 10 years.

A management plan serves as framework for addressing critical issues facing the sanctuary. It lays the foundation for restoring and protecting the sanctuary's target resources, details the human pressures and threats impacting the sanctuary and recommends actions that should be taken now and in the future to better manage the area. Management plans are guiding documents that generally outline regulations, describe boundaries, identify staffing and budget needs, and set priorities for resource protection, research, and outreach and education programs. Management plans are designed to be dynamic and adjust to new and emerging issues and are periodically reviewed to ensure that they address current issues and resource protection needs.

For more information on the sanctuary management plan review process, please visit http://hawaiihumpbackwhale.noaa.gov/management/management_plan_review.html.

Additional Species

The primary purpose and mission of the sanctuary is to protect humpback whales and their habitat within the Hawaiian Islands. However, the sanctuary was mandated by Congress in 1992 by the Hawaiian Islands National Marine Sanctuary Act to identify and evaluate additional resources and ecosystems of national significance for possible inclusion in the sanctuary. The management plan process will thoroughly evaluate and consider the conservation and management of additional resources including spinner dolphins, other whales, Hawaiian monk seals (Figure 7), sea turtles, and maritime heritage resources including historic downed aircraft and sunken ships.

Maritime Archaeological Resources

Although the original purpose and mission of the sanctuary when it was designated did not identify cultural resources such as maritime archaeological resources as a target resource, the Office of National Marine Sanctuaries has conducted a limited number of surveys under the broader authority of the National Marine Sanctuaries Act, allowing some preliminary assessment of the status of these sites within the sanctuary. Efforts to discover, assess and protect these resources are, therefore, in the early stages. The Hawaiian archipelago has a long history of continuous and intensive maritime activity, and possesses many historic shipwrecks and other types of submerged archaeological sites. Not only do these sites represent a unique record of the past, they also provide many recreational divers a firsthand experience of history in the Pacific.

The existing inventory for maritime resources within the sanctuary's boundaries is comprised of two categories: 1) historic ves-

Photo: P. Doyle, HIHWNMS volunteer

Figure 7. Female Hawaiian monk seal and her pup.

Photo: NOAA ONMS

Figure 8. The sanctuary's recently discovered naval aircraft dive site near Kihei, Maui: an SB2C-1C Curtiss Helldiver, ditched on Aug. 31, 1944.

sels and aircraft (Figure 8) and other archaeological sites reported lost within the sanctuary; and 2) historic vessels and aircraft and other archaeological sites confirmed by survey within the sanctuary. The inventory currently lists 185 ship and aircraft losses in the sanctuary prior to 1960 (50 years old or older). Of these, some have been salvaged, while others have been completely broken up and lost over time. Twenty-five of these sites have been confirmed by some level of field investigation, and the "located" list is continuing to expand. The sanctuary also encompasses many sites of ancient coastal stone fish ponds, once prominent features in the Hawaiian landscape. Sixty-three of these have been documented by the state within the sanctuary (DMH 1989, Inc., DMH, Inc. 1990). Some nearshore waters have traces of fishing tools and artifacts associated with coastal settlements (HIHWNMS and SOH 2007a).

These sites are representative of important phases in Hawaiian history, ranging from the original discovery and occupation of the islands, to the historic whaling period, to inter-island commerce and the plantation era, to World War II. The U.S. Navy has an important history in the islands. More than 80 naval ships and submarines, and more than 1,480 naval aircraft have been lost in local waters. Of the many aircraft, more than 70 historic civilian, army, and navy aircraft were lost within the current sanctuary boundaries alone. Many of these navy wrecks and aircraft crashes are also wartime grave sites that deserve appropriate respect and protection (Van Tilburg 2003, HIHWNMS and SOH 2007a). The variety of vessel types reflects the Hawaiian, American, and Pacific/Asian multicultural setting among the islands (HIHWNMS and SOH 2007a).

When discovered on the seafloor, maritime archaeological sites can serve as windows into the past, providing opportunities for historians, archaeologists, sport divers and the general public to experience and appreciate these public resources in a responsible manner. Efforts which spread awareness, protect sites and facilitate responsible public access have been shown in other sanctuaries to enhance resource preservation and stewardship. However, in Hawai'i, the combination of lack of preservation management, continuing impacts, and increasing human access and activities contributes to the overall negative resource assessment. The addition of maritime archaeological resources to the sanctuary's management plan is being considered within the context of the management plan review process.

Pressures on the Sanctuary

The same coastal waters of Hawai'i that serve as humpback breeding grounds are also subjected to heavy human use by both residents and visitors. Ocean-related industries include recreation, tourism, ocean science and technology, military activities, commercial fishing, existing and proposed alternative energy projects, aquaculture, and seafood marketing. Many tourism activities, the state's primary economic driver, are based around the use of ocean resources; therefore, good water quality and the aesthetic beauty of clean and open coasts are vital to this industry. Ocean transportation is also vital to the state's economy. Approximately 1,200 kilometers (750 miles) of Hawaiian Islands coastline are served by 10 commercial ports and 21 small boat harbors in the main Hawaiian Islands. Hawai'i residents place a high value on everyday access to the ocean, not just for economic livelihoods, but to also maintain a high quality of life.

Despite their economic significance, Hawaiian coastal waters are coming under ever-increasing population pressures that threaten the health of the marine environment (Dollar and Grigg 2004). Ocean-related human uses have the potential to increase pressure on the sanctuary's mission to effectively protect humpback whales and their habitat.

Whale-Vessel Collisions and Entanglement

Entanglement in marine debris and collisions with vessels have been widely identified as the primary human–caused sources of mortality for humpbacks, both in Hawai'i and elsewhere. For example, up to 60 percent of mortalities for humpback whales along the United States' mid-Atlantic and southeastern coasts were determined to have resulted from either gear entanglements or vessel collisions (Wiley et al. 1995). Recent studies suggest that entanglement alone might be responsible for a 3.7 percent annual mortality for humpback whales off the northeastern United States, and North Pacific humpbacks have recently been shown to have entanglement scar rates that are comparable to this population (Robbins et al. 2009). For these reasons, these two activities have been identified as immediate, pressing issues for the sanctuary.

Photo: HIHWNMS / NOAA MMHSRP Permit #923-1489

Figure 9. A humpback whale calf displays injuries to its pectoral fin that experts believe were caused by a ship propeller.

Vessel Traffic

As the population of Hawai'i increases, dependence on ocean transportation is expected to increase. About 80 percent of food and merchandise is imported to Hawai'i, of which 98 percent arrives by ship to commercial harbors around the state (Lee and Olive 1994). Some commercial port facilities would already be at capacity without ongoing adjustments to the shipping lines' operations and efforts to optimize land use by the State of Hawai'i Department of Transportation (DOT) Harbors Division. Such adjustments extend terminal capacities, but ultimately without the expansion of commercial harbors to accommodate the growing demand of imported goods, residents of Hawai'i may experience delays in the delivery of essential commodities, as well as higher shipping costs (HCZMP 2006).

Heavy vessel traffic creates the possibility of collision with humpback whales (Figure 9), and noise from vessels may also affect whales. Discharge of oil, sewage and other non-biodegradable materials from vessels in and outside the sanctuary pose a threat to sanctuary resources. Spills may also result from vessel groundings or sinkings. Herman et al. (2003) assessed the history of whale-vessel encounters and the threat of collision from vessel types including whale watch boats, private vessels and large cargo ships. This study classified the threat and seriousness of ship strikes and concluded that mitigation measures such as visual, radar, sonar and infrared observation, and a reduction of speed in high-density whale areas, could lower the threat level and reduce the probability of a collision.

The operation of commercial and recreational thrill-craft (e.g., water sledding, parasailing vessels and high-speed motorcraft) may also adversely affect humpback whales in Hawaiian waters. Small, fast and highly maneuverable, these craft increase collision risk between whales and vessels. Their small size increases risk of injury to vessel operators and passengers, while their high speed reduces the time for animal and operator to detect and maneuver in order to avoid collision. The state of Hawai'i prohibits parasailing and certain other boating activities in areas off the western and southern shores of Maui during the humpback whale breeding season (Supreme Court of the United

High Speed Vessel Operations

High-speed vessel operation has been and continues to be an area of interest for sanctuary managers. Historically, ferry systems have operated in Hawaiian waters (Herman et al. 2003). For approximately 10 months between 2008 and 2009, Hawaii Superferry (Figure 10) ran ferry service between O'ahu and Maui with future plans to provide service between O'ahu and Kaua'i and the island of Hawai'i. Hawaii Superferry discontinued service in April 2009. The Hawaii Superferry operation highlighted sanctuary issues regarding new vessel operations and potential impacts on humpback whales as well as issues being faced by the Department of Transportation (DOT) Harbors Division regarding adequate harbor space to accommodate existing and new harbor users. The DOT Harbors Division is currently updating its long-range master plans to address harbor issues. The Hawaiian Islands Humpback Whale National Marine Sanctuary Advisory Council was engaged with Hawaii Superferry prior to and during its brief operation and followed it closely. For example, the council passed a resolution regarding operational concerns and provided comment on the "Draft Statewide Large-Capacity Ferry Environmental Impact Statement," specifically regarding large-capacity ferry operations within the sanctuary.

There continues to be interest in operating high speed vessels in Hawaiian waters. A recent example appears in the Federal Register /Vol. 75, No. 24 / Friday, February 5, 2010 /Notices, where the Department of Defense published a notice of intent entitled, "Preparation of a Programmatic Environmental Impact Statement (PEIS) for the Stationing and Operation of Joint High Speed Vessels (JHSVs)." The notice states, "The Army intends to prepare a PEIS for the proposed stationing and operation of up to 12 JHSVs. The JHSV is a strategic transport vessel that is designed to support the rapid transport of Army Soldiers, other military personnel and equipment in the U.S. and abroad. The PEIS will assess the potential environmental impacts associated with the proposed stationing of JHSVs at the following military port locations: Virginia Tidewater area; San Diego, CA area; Seattle-Tacoma, WA area; Pearl Harbor, HI area; and Guam. …". This study will determine appropriate locations to operate high speed vessels and the sanctuary will coordinate with the Department of Defense to minimize impacts to sanctuary resources.

Figure 10. The Hawaii Superferry's vessel Alakai (no longer in operation).

States No. 07-1427, 2007). However, thrill-craft continue to operate in other Hawaiian waters where humpback whales are found.

Ocean resource use conflicts are increasing. Resource allocation issues, user conflicts and stress on the marine ecosystem will become more prevalent without proactive management and the setting aside of significant and appropriate areas for conservation and public access (HCZMP 2006).

Marine Debris and Fisheries Interactions

Each year, tons of marine debris drift (Figure 11) through waters surrounding the Hawaiian Islands and wash onto their shorelines, posing a threat to humpback whales, Hawaiian monk seals, sea turtles, seabirds and other wildlife through entanglement or ingestion. The debris, including but not limited to ropes, cargo nets and derelict fishing gear, significantly damages seafloor habitat such as coral and algae communities as it washes over the reefs. While some of the marine debris is generated from land-based sources (e.g., storm water runoff,

Photo: NOAA Marine Debris Program

Figure 11. The southeastern Waiohinu-Ka Lae coast on the island of Hawai'i is a known area of accumulation for marine debris within the main Hawaiian Islands. During 2005-2006, the NOAA Marine Debris Program funded a cleanup of this area.

dumps and landfills, streams, sewer overflow, storm drains, and litter), marine-based sources (e.g., trawl nets, gill nets and other lost or discarded fishing gear) can produce substantial amounts of debris that may cause significant damage to the coral reefs of Hawai'i and pose serious threats to marine mammals and other organisms. The impacts of marine debris are particularly apparent because atmospheric and oceanographic forces cause ocean surface currents to converge on Hawai'i, bringing the vast amount of debris floating throughout the North Pacific to the islands (Wilkinson 2004, HCZMP 2006).

Marine mammal entanglement in marine debris is a significant threat to the central North Pacific stock of humpback whales migrating to Hawai'i each winter. Recent analyses of entanglement scarring from the SPLASH project indicate that almost 40 percent of the Hawaiian population have been entangled at least once in their lives (Robbins 2009).

Since 2002, the sanctuary has received more than 144 reports of whales entangled in gear. A total of 83 reports were confirmed as truly involving entangled humpback whales, representing as many as 57 different animals (Lyman 2010). The actual number of entangled whales is likely to be considerably higher, as many go undetected or unreported. Humpback whales in Hawai'i become entangled in fishing gear (both active and derelict) while in their feeding grounds, during migration from higher latitudes of the North Pacific, or locally from fishing gear in Hawaiian waters. Entanglement in active fishing gear, marine debris, and other types of gear (e.g., mooring gear) may result in drowning, starvation, physical trauma, systemic infections, or increased susceptibility to other threats such as ship strikes. Overall, scientists still do not know exactly how many whales die each year from this threat, but studies estimate that entanglement is the most significant cause of human-caused death among all cetaceans (Read et al. 2006), and may be especially true of humpback whales (Robbins et al. 2009, IWC 2010).

Throughout the main Hawaiian Islands and the Northwestern Hawaiian Islands, derelict or "ghost" nets are often found in large conglomerations washed up on shorelines, snagged on reefs, or drifting in offshore waters. Since 1996, NOAA divers have removed over 600 metric tons (660 tons) of nets from the reefs and shorelines of the Northwestern Hawaiian Islands. Since humpbacks are known to use and migrate through the Northwestern Hawaiian Islands, this debris can pose a risk to their health. Much of the debris seen fouling reefs and shorelines in Hawai'i is from fisheries sources elsewhere in the Pacific; the types of gear used in Hawai'i-based fisheries (e.g., longline and pot (trap) gear) are rarely seen (Donohue et al. 2001).

Fishing has been a way of life for people in Hawai'i for generations, with fish and shellfish providing the major protein source for the Hawaiian people (Kamakau 1839, Titcomb 1972). However, the coastal fisheries in Hawai'i have undergone significant changes over the past 100 years with respect to target species and gear type (Shomura 1987, Pooley 1993, Friedlander 2004). Entrapment and entanglement in active fishing gear is one of the most frequently identified sources of human-caused injury or mortality to humpback whales (O'Hara et al. 1986, Wiley et al. 1995) (Figure 12). Humpback whales are large enough to sometimes break through netting before becoming entangled, but they occasionally entangle in the lead or anchor ropes, which are more difficult to break. Entangled whales may starve or drown if humans do not intervene to free the whales. The incidence of entanglements could hamper and perhaps prevent population recovery, especially if human efforts to rescue the whales were reduced or if fishing effort increased. (Clapham et al. 1999, Robbins et al. 2009)

Photo: HIHWNMS / NOAA MMHSRP Permit #932-1489

Figure 12. Humpback whale entangled in fishing gear believed to be used for trapping crabs. This suggests the whale dragged the gear from Alaska to Hawai'i. The animal is emaciated, collapsing inward, and is an unhealthy light gray rather than the usual dark gray to black color.

Noise Pollution

Humpback whales occur adjacent to human population centers and are affected by human activities throughout their range. Their habitat is, therefore, subject to disturbance by human-caused noise (Herman et al. 2003).

According to Herman et al. (2003), the major sources of human-generated sound in Hawaiian waters are local vessel traffic, military underwater communication, and sonar. Noise may affect humpback whales both physiologically and behaviorally. If sounds are loud enough within the hearing range of whales, they may impact the animals' hearing. Physiological impacts may include temporary or permanent hearing threshold shifts, hemorrhaging or other direct physical damage. Changes in the distribution or movements of animals can also be caused by sound (Herman et al. 2003). For example, anthropogenic noise could potentially adversely affect humpback whales by disrupting resting, feeding, courtship, calving, nursing, migration or other activities. Large ships may create disturbing levels of noise for many kilometers around the vessel (Tyack 1989). Herman et al. (2003) reported on noise levels of various types of ships, including cruise ships, merchant ships and whale watching vessels. They concluded that ship traffic and ship noise posed low- to medium-level threats to humpback whales, and both disturbance probability and noise levels are reduced with decreased vessel speed. They recommended studies be conducted to determine areas or routes of travel where reduced vessel speeds may be practical for vessels and beneficial for whales during times when whales are present.

Coastal Pollution

Seven major wastewater treatment plants discharge into the coastal ocean in Hawai'i. All but two of the plants discharge through deepwater outfalls (below 40 meters or 130 feet). Several studies have been undertaken to determine the impact, if any, of the outfalls on the health of aquatic animals and plants. Other discharges permitted through the National Pollutant Discharge Elimination System, such as those from aquaculture facilities, shipyards and power plants, release waste and cooling water through outfalls into estuaries or coastal waters (Friedlander et al. 2005).

Sedimentation runoff is a leading cause of changes to reef community structure in the main Hawaiian Islands (Figure 13). As several coastal areas in the Hawaiian Islands have been reported to have major issues with coastal erosion and sediment transport to adjacent coral reefs in Maunalua Bay on O'ahu (Wolanski et al. 2009) and southern Moloka'i (Field et al. 2008), it is apparent that a land-based management approach is necessary to remediate these water quality issues. However, there is no documented evidence suggesting that sediment runoff significantly impacts humpback whales' use of their breeding habitat. Several major sources of erosion have ceased or are reversing, which will likely lower the potential for negative effects in the future. Examples include the closure of large agricultural plantations, cessation of live-fire training on the island of Kaho'olawe, and culling programs of feral ungulates on the islands of Lāna'i and Moloka'i (Friedlander et al. 2005).

In many areas of the Hawaiian Islands, nearshore water chemistry is a mixture of oceanic water and fresh water emanating from both submarine groundwater discharge at or near the shoreline and surface water runoff. Groundwater in Hawai'i typically contains concentrations of dissolved nitrogen and phosphorus two to three orders of magnitude higher than seawater. Thus, groundwater nutrients are an important natural factor of nearshore marine water chemistry. The groundwater nitrogen levels reflect natural background and human-generated sources from wastewater and fertilizers (Friedlander et al. 2005).

Photo: Georeferenced NOAA/NOS aerial photography by Pacific Disaster Center in 2000

Figure 13. A sediment plume in this aerial photograph off the coast of Kaua'i. The sediment was transported by runoff from fields where soil is exposed.

Cesspools are a potentially harmful source of untreated wastewater, containing nutrients and pathogens that seep into the ocean along the shoreline. Hawai'i has an estimated 100,000 cesspools, more than any other state in the U.S. (Friedlander et al. 2005).

Stormwater runoff has the potential to be a threat to the marine environment during heavy rains. In 2006, O'ahu endured 42 days of nonstop rain that caused sewers to overflow through manholes and contributed to the break of the beachwalk sewer main in Waikiki. In March 2006, there were as many as 16 sewer overflows happening at the same time. These heavy rains resulted in a 182 million liter (48 million gallon) spill into the Ala Wai Canal. As a result, more than 1,600 temporary beach closures or advisories were issued due to bacteria levels that exceeded federal public health standards. In 2006, beaches in Hawai'i saw 1,073 rain advisories and 32 posted warnings. Total advisory and warning days for events lasting six consecutive weeks or less at beaches in Hawai'i tripled from 2,228 in 2005 to 6,507 in 2006 (Dorfman and Stoner 2007).

The U.S. Geological Survey (USGS) recently completed an assessment of water quality of streams and groundwater on the island of O'ahu from 1999 to 2001. Anthony et al. (2004) found toxic contaminants in streams that drain urban and agricultural land and in groundwater supplies (although few chemicals exceeded the drinking water standards in groundwater). In the urban streams of O'ahu, some of the highest levels of termite-treatment chemicals in the U.S. were reported. The USGS conducted no analyses in the marine environment, where ocean mixing and dilution must be considered. Based on USGS screenings, toxic contaminants in estuaries and coastal waters are easily transported to the ocean with storm flows and may be deposited at stream mouths and on reef flats (Friedlander et al. 2005). Because humpback whales fast while in Hawaiian waters, any exposure to manmade toxins comes from the food they consume in the summer feeding grounds, and their exposure to any contaminants in Hawai'i will be minimal (Elfes et al. 2010).

Coastal Development

Coastlines of Hawai‘i continue to be developed for a variety of land uses (Figure 14). Agricultural land on each island, primarily used for sugarcane and pineapple, is transitioning to residential and resort uses. Coastal development can bring a suite of social and environmental consequences, including conflicts over shoreline access and view planes, requirements for floodwater storage and protection, infrastructure demands, and degradation of coastal waters from cumulative increases in runoff and groundwater contamination. Human impacts to adjacent watersheds, including creation of impervious substrates such as pavement, channelization of streams, construction of sea walls and destruction of coastal wetlands all contribute to sediment transport to coral reefs in Hawai‘i (Wolanksi et al. 2009). However, changes in land use from large-scale agriculture, which periodically exposes land to erosion, may result in an overall decrease in sediment delivery to the ocean (Friedlander et al. 2005).

Photo: University of Hawai‘i

Figure 14. Satellite image of Waikiki’s heavily developed shoreline.

Harbor facilities on all the main Hawaiian Islands are being modified or have been modified to accommodate new large cruise ships, large container ships and the Hawaii Superferry (an inter-island car/cargo ferry no longer in operation). Harbor improvements involve dredging to deepen and widen entrance channels and turning basins, as well as construction of new piers, waterfront work areas, jetties and breakwalls. The harbor improvements have the potential to impact coral reefs and areas used for recreation such as surfing and canoeing. Proposed expansions can affect longshore transport of sand and sediment and water quality, as well (Friedlander et al. 2005).

It is uncertain whether nearby intensive human activities have inhibited occupation by or repopulation of humpback whales in their habitats. However, this may have occurred on O‘ahu. Herman (1979) summarized evidence from newspaper reports and other sources to suggest that humpbacks occurred along the coast of O‘ahu from the 1930s to 1950s, but less so after the later 1960s, until recent increases in overall population. Although the apparent disappearance could be related to increased commercial hunting in the North Pacific during the early 1960s, Herman (1979) speculated that accelerated coastal development of O‘ahu may have displaced the whales, citing potential disturbance by pile drivers and other construction noises, increased runoff, and increases in boat and air traffic. This interpretation is complicated by the lack of documentation on the existence of humpback whales around the Hawaiian Islands prior to about 1850 (Herman 1979).

Climate Change

Most of the world’s scientists agree that global warming caused by human activity is occurring. The exact implications of these changes are unknown, but it is predicted that there will be reduced productivity of Southern Ocean ecosystems and unpredictable weather events caused by increasing ocean water temperatures, changing ocean currents, rising sea levels and reductions in sea ice (IPCC 2007a, IPCC 2007b).

The potential impacts of climate and oceanographic change on humpback whales are twofold:

- ***Habitat availability***: Humpback whale migration, feeding, resting, and calving site selection may be influenced by factors such as ocean currents and water temperature. Any changes in these factors could affect humpback whale population recovery by rendering currently used habitat areas unsuitable or undesirable.

- ***Food availability***: Changes to climate and oceanographic processes may also lead to decreased productivity and different patterns of prey distribution and availability. Such changes would certainly affect the feeding grounds of dependent predators such as humpback whales. While humpback whales do not feed in Hawaiian waters, preliminary evidence suggests that some baleen whales may migrate further poleward in order to find the food resources they require. This could result in either longer migrations, with subsequent energetic and timing consequences, or a shift in breeding grounds to shorten the transit (Simmonds 2009).

- ***Increasing diseases***: Changes in climate could potentially expose humpback whales to new or resurging diseases, although these would be most likely to manifest in the feeding grounds. Currently, most of the concern about emerging or resurging cetacean diseases associated with climate change has focused on their feeding grounds, as some scientists around the world have indeed noticed increases in diseases in those habitats that may be associated with climate change (IWC 2007). While humpback whales fast during their season in Hawaiian waters, as a breeding ground, this is where any increase in sexually transmitted diseases could manifest themselves.

Emerging Issues

Alternative Energy Production

In 2008, a wind and wave energy project covering up to 725 square kilometers (280 square miles) of open ocean was proposed for construction in the Penguin Bank area of the sanctuary. This particular area is an important habitat for humpback whales during the breeding and calving season. The project proposed the construction of 100 offshore fixed three-leg platforms standing on the seabed that would rise approximately 15 meters (50 feet) above sea level. The design included wave energy converters to be built into each leg of the structure. Wind turbines were also proposed for installation on the platforms. The proposal was later withdrawn in 2009 (Grays Harbor Ocean Energy Company Web site).

In 2009, another alternative energy project was put forward. The proposed project could include a 200-megawatt wind farm on Lāna'i, a 200-megawatt wind farm on Moloka'i and an inter-island undersea cable system connecting the wind farms to O'ahu. As currently proposed, cable routes would be placed on the ocean floor within the sanctuary (Interisland Wind Web site).

Open Ocean Aquaculture

Open ocean aquaculture (also known as mariculture or cage culture) involves the production of fish in floating pens or submerged cages (Figure 15). A typical system includes a land-based hatchery or other source of juvenile fish coupled with pens or cages placed in the ocean, where the juvenile fish are fed and allowed to "grow out" to a size suitable for harvest, sale and consumption.

Open ocean aquaculture has gained increased popularity in Hawai'i for the production of fish protein. Two open ocean aquaculture facilities are currently in operation in Hawaiian waters, with one located within the sanctuary. Additional projects have been proposed both within and adjacent to sanctuary boundaries. As the open ocean aquaculture industry in Hawai'i continues to grow, the sanctuary, in collaboration with state agencies, continues to closely monitor whether facilities, both existing and proposed, can effectively minimize or, ideally, prevent interactions with humpback whales and maintain existing water quality and habitat conditions. The sanctuary will continue to work with partnering organizations and seek input from community members and industry representatives to minimize any potential for habitat loss for humpback whales in areas where existing or proposed development activities would occupy space in the water column. These include, but are not limited to, submerged and surface fish cages and associated mooring lines that have the potential to obstruct humpback whale preferred migration routes and displace individuals from preferred surface and water column habitat utilized for resting, mating behaviors, calving and nursing.

All proposed open ocean aquaculture projects to date have been proposed in state waters (within five kilometers or three miles off shore) and it is likely that most future projects will also be proposed in state waters, considering the oceanographic characteristics of the Hawaiian archipelago. Hawai'i state law requires project developers to obtain a conservation district use permit and an associated open ocean lease from the Department of Land and Natural Resources. The sanctuary has the responsibility to consult with various state and federal permitting agencies to minimize any potential threats that this growing industry may pose to humpback whales and compatible use activities that are permitted within sanctuary boundaries. Any party that wishes to engage in offshore aquaculture within state marine waters must obtain a series of permits and authorizations from both federal and state agencies, including the U.S. Army Corps of Engineers and the Hawai'i Department of Health and Department of Land and Natural Resources, the sanctuary's state co-management partner.

Research and monitoring related to humpback whale impacts resulting from aquaculture activities are minimal, due to this form of ocean use being relatively new. Therefore, the extent to which open ocean aquaculture adversely impacts humpback whales in Hawai'i is not known. Currently, due to the relatively low number of existing aquaculture facilities, this activity does not appear to pose a major threat to humpback whales in Hawai'i. However, concerns over possible increases in aquaculture activities in the future have been raised. Experiences elsewhere and the physical removal of habitat occupied by these projects have led to concerns regarding potential unwanted impacts. The sanctuary will continue to closely monitor and be actively involved in this emerging issue and associated concerns that include:

- *Displacement from habitat and/or habitat loss*
- *Entanglement (Australia 2005)*
- *Attraction of predators (Kemper and Gibbs 2001)*
- *Increased disturbance from vessels*

Photo: NOAA

Figure 15. Offshore aquaculture structure.

State of Sanctuary Resources

This section provides summaries of the condition and trends of water, habitat, living resources, and maritime archaeological resources in the Hawaiian Islands Humpback Whale National Marine Sanctuary, and specifically, how these resources relate to humpback whales. Sanctuary staff and selected outside experts considered a series of questions about each resource area. These questions have been posed to all national marine sanctuaries (Appendix A). It is important to note that the responses to the questions may have been different if resources in addition to humpback whales had been considered.

The set of questions derive from the mission of the Office of National Marine Sanctuaries, and a system-wide monitoring framework (NMSP 2004) developed to ensure the timely flow of data and information to those responsible for managing and protecting resources in the ocean and coastal zone, and to those that use, depend on, and study the ecosystems encompassed by the sanctuaries. Appendix A (Rating Scheme for System-Wide Monitoring Questions) clarifies the set of questions and presents statements that were used to judge the status and assign a corresponding color code on a scale from Good to Poor. These statements are customized for each question. In addition, the following options are available for all questions: " N/A" - the question does not apply; and "Undetermined" - resource status is undetermined. In addition, symbols are used to indicate trends: "▲" - conditions appear to be improving; "–" - conditions do not appear to be changing; "▼" - conditions appear to be declining; and "?" – trend is undetermined.

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

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

The responses to the questions found in this report are based primarily on the effects or potential effects of pressures on the sanctuary as they relate to humpback whales and their habitat, which are the current responsibilities of the Hawaiian Islands Humpback Whale National Marine Sanctuary. With one exception (Question 3), they do not address concerns or resources over which the sanctuary does not have authority or other responsibility.

Water

1. ***Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality and how are they changing?*** Because water quality problems observed in some nearshore waters of the sanctuary do not appear to have affected the majority of sanctuary waters or the humpback whales inhabiting these waters, the response to this question is rated as "good" and "not changing."

   Broad global issues such as climate change, storm intensity and natural variations in weather patterns, as well as regional and localized anthropogenic impacts, have all threatened water quality in Hawai'i. As populations of humans grow in coastal areas, the use of the surrounding land increases, and thus the threat of land-based impacts may increase. Marine debris, sedimentation, freshwater input and biological contaminants all threaten coral reefs. Waters within and adjacent to the sanctuary are vulnerable to these issues; however, available information suggests that sedimentation, eutrophication, algal blooms and biological contaminants have been reported to be of primary concern (Draut et al. 2009).

   The majority of water quality issues in Hawai'i occur in nearshore waters. For example, sediment deposition, retention and naturally driven resuspension (as well as associated contaminants) may be a concern in the coastal waters of northern Kaua'i (Draut et al. 2009), southeast O'ahu (Wolanski et al. 2009), western Maui and southern Moloka'i (Field et al. 2008). However, although there is the possibility that poor water quality in the coastal zone could impact mothers and their calves that occasionally utilize this area, actual impacts to humpback whales have not been documented by the sanctuary (Animal in Distress Database and E. Lyman, HIHWNMS, pers. comm. 2010).

   Ocean acidification and increasing water temperature (Würsig and Gailey 2002) have been identified as issues which may affect changes in water quality, but have not been systematically assessed.

2. ***What is the eutrophic condition of sanctuary waters and how is it changing?*** Similar to Question 1, eutrophication and associated benthic algal blooms observed in some nearshore waters of the sanctuary do not appear to have affected the majority of sanctuary waters or the humpback whales inhabiting these waters. Therefore, the response to this question is rated as "good" and "not changing."

   Chronic nutrient enrichment and potentially associated planktonic and/or benthic algal blooms are known to occur in some nearshore areas with groundwater input to sanctuary waters. For example, in the coastal waters of Maui, macroalgal blooms (of both native and alien invasive species) occur in areas where there is substantial human-caused nutrient input originating from sources such as wastewater effluent from injection wells, leaking or failing wastewater disposal systems or cesspools, and runoff from agricultural fertilizers (Smith et al. 2005, Dailer et al. 2010). Algal overgrowth and other competitive interactions have led to geographically isolated shifts in dominance in benthic assemblages. Nutrient enrichment is likely a major factor driving these changes. Although little work has been done to assess the impacts of eutrophication on water column productivity in Hawai'i, nutrient enrichment may contribute to stimulating harmful algal blooms, which can affect human health via fish consumption. There is hope that recent changes in agricultural practices and improvements in wastewater treatment and disposal (e.g., large capacity cesspools were banned in 2006 by the state of Hawai'i) will limit the future extent of these threats.

   While increases in harmful algal blooms have been linked to increases in marine mammal disease and mortality elsewhere (Gulland and Hall 2007), these events have been associated with biotoxins transferred in the food web. Because humpback whales do not feed while in Hawaiian waters, they are not likely to be impacted by local algal blooms via diet, though the impacts from incidental ingestion are unknown.

3. ***Do sanctuary waters pose risks to human health and how are they changing?*** Although occasional closures of some nearshore swimming areas occur due to pollutant concentrations that may adversely affect human health, the response to this question is rated as "good/fair" and "not changing" because beach closures have had a limited effect on access to sanctuary resources, and there is no evidence to suggest that these conditions are changing. It is important to note, however, that water quality monitoring data are limited or lacking in many streams and coastal segments, and most offshore areas of the sanctuary. Additionally, water quality issues such as polluted runoff, injection wells and vessel discharges have raised concerns of ocean users.

   Water quality at beaches in Hawai'i is monitored by the Department of Health (DOH) for bacteria that would indicate a risk to human health. The DOH regularly monitors ocean and stream water, focusing on recreational waters where people swim and play, for the indicator bacteria *Enterococcus spp.* and *Clostridium perfringens*. Levels of these bacteria are used to detect the presence of human sewage in the water, which can result in gastrointestinal

Improving Water Quality

From approximately the 1950s to the 1970s poorly treated sewage was discharged on the shallow offshore areas of Sand Island (Dollar 1979) and in Kaneohe Bay (Smith et al. 1981). In the 1980s Hawai'i took significant action to improve coastal water quality by removing most wastewater outfalls from bays and shallow waters. Moving sewage outfalls to deeper offshore waters (approximately 40 –75 m (130 – 250 ft)) has allowed for significant recovery to the previously stressed areas (Smith et al. 1981, Dollar and Grigg 2003).

illnesses. In some cases, beach notification and closure decisions are made when samples exceed state water quality standards. However, in general, the DOH does not consider coastal waters with high levels of *Enterococcus spp*. to represent a threat to human health. This is because in tropical waters *Enterococcus spp*. may result from animal waste or soils, as well as human sewage (DOH 2008). In recent years, DOH has also collected data on turbidity, nutrients and chlorophyll at specified shoreline stations and in perennial streams. DOH uses these data, and other available data that meet specific quality criteria, to identify streams and coastal segments that are "water quality impaired" (e.g., where state water quality criteria are regularly exceeded). Turbidity is typically the most common pollutant to trigger a coastal water listing (DOH 2008).

In general, islands with larger population sizes have more water bodies where ambient pollutant concentrations regularly exceed state water quality criteria (Friedlander et al. 2005) (Table 1). In addition, pollutant concentrations normally decrease sharply with distance from shore, and offshore water quality is generally good. Impaired coastal waters as identified by the DOH are primarily harbors, semi-enclosed bays, and protected shorelines, where mixing is reduced and resident time of pollutants is long when compared with exposed coasts. Many bays outside the sanctuary that have coral reefs, such as Kāne'ohe Bay, Pearl Harbor (O'ahu), Nawiliwili Bay (Kaua'i) and Hilo Bay (Hawai'i), have been identified as impaired. The most widely distributed coastal pollutants are nutrients, sediments and *Enterococcus spp* (Friedlander et al. 2005).

There is also concern about bacterial and biotoxicological contamination in fish intended for human consumption. In 1998, the DOH issued a fish and shellfish consumption advisory for all O'ahu urban streams (including those that drain into sanctuary waters). From 2003 to 2004, the DOH issued fish contamination advisories concerning high levels of mercury for 16 fish species in marine waters statewide. All of these fish consumption advisories remain in effect (see EPA National Listing of Fish Advisories at http://134.67.99.49). Ciguatera fish poisoning can result in gastrointestinal and neurological symptoms following the ingestion of fish containing ciguatoxin. The ciguatoxin responsible for this poisoning is produced by the benthic dinoflagellate *Gambierdiscus toxicus*, which lives freely and in association with various algae on coral reefs and hard surfaces in tropical waters (Hokama 1988). Ciguatera is the most common marine toxin poisoning worldwide, with more than 50,000 cases reported annually (Lehane and Lewis 2000). The incidence of ciguatera fish poisoning in Hawai'i is low, with approximately 3.6 cases per 100,000 people (Campora et al. 2010). The leeward coasts of the main Hawaiian Islands often report the majority of cases.

Pollutants	Maui	O'ahu	Kaua'i	Hawai'i	Moloka'i
Sediments	41	45	7	14	2
Enterococcus	3	23	9	8	ND
Nutrients	11	54	5	4	1
Chlorophyll a	22	34	2	8	ND
Toxics: Metals, pesticides, PCBs	ND	ND	ND	ND	ND
Total Coastal Stations Listed	41	61	16	20	2
Population Size	148,677	876,156	58,463	128,241	7,404

Source: Friedlander et al. 2005

Table 1. Number of water bodies by island where ambient pollutant concentrations regularly exceed State water quality criteria. ND = No data.

4. ***What are the levels of human activities that may influence water quality and how are they changing?*** Because some human activities are known to have had localized impacts on water quality, the response to this question is rated as "good/fair." Management actions have reduced the levels or threats posed by some activities, while other activities primarily related to urbanization continue to increase. Therefore, the overall trend is rated as "not changing." Continued monitoring of water quality will be necessary to determine whether these trends are, in fact, offsetting.

Discharges that may directly affect water quality in sanctuary waters include vessels, a few mariculture facilities, a single sewage outfall (east of Honolulu), O'ahu municipal separate storm sewer systems, and other land-based point sources that have yet to be inventoried. Due to prevailing atmospheric circulation patterns, deposition of airborne chemicals at sea from global sources may be significant, as well. Dredging and trawling activities are of limited scope and generally occur well outside of sanctuary waters; and dredging operations are tightly regulated to minimize resuspension impacts. Human activities that generate nonpoint source diffuse pollution (e.g., groundwater-associated nutrient enrichment) and polluted runoff (during both dry and wet weather conditions) are of greatest overall concern due to their possible association with changes in water quality parameters such as temperature, salinity, pH, oxygen, light availability and nutrient levels; as well as bacterial contamination, toxic contamination, particulate loading, reef sedimentation and their combined impacts. Multiple bodies of water within and adjacent to sanctuary waters exemplify this, as water quality is impaired by excessive pollutants (see Question 1), according to the Hawai'i State Department of Health (DOH) and the U.S. Environmental Protection Agency (DOH 2008).

Increasing levels of urbanization are likely to lead to higher levels of point source (e.g., industrial facilities) and non-point source (e.g., deposition from fossil fuel burning) pollution. However, a reduction in the number of large cesspools (large capacity cesspools were banned in 2006 by the state of Hawai'i), and greater use of sewage pump-outs by vessels may help to reduce the input sources of sewage waste. The destructive terrestrial impacts of feral ungulates in Hawai'i remain a concern in upland ecosystems and to the associated watersheds.

Water Quality Status & Trends

#	Issue	Rating	Basis for Judgment	Description of Findings
1	Stressors	–	Most areas with problems (e.g., sedimentation) are nearshore and restricted to bays and harbors; therefore, these issues are unlikely to pose threats to humpbacks.	Conditions do not appear to have the potential to negatively affect humpback whales or habitat quality.
2	Eutrophic Condition	–	Locations with chronic nutrient enrichment and extensive algal blooms are limited to nearshore waters and may be increasing in extent or severity, but are not known to pose threats to humpbacks.	Conditions do not appear to have the potential to negatively affect humpback whales or habitat quality.
3	Human Health	–	With the exception of occasional closures of some nearshore swimming areas, conditions are not currently believed to consistently adversely affect compatible uses of the sanctuary.	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.
4	Human Activities	–	Numerous activities occur, but management actions have reduced some impacts; therefore, overall levels do not appear to be changing.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on water quality.

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

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

Habitat

5. ***What are the abundance and distribution of major habitat types and how are they changing?*** Due to the slowly increasing number of existing and proposed structures related to aquaculture and offshore energy production, and impacts associated with these facilities, the response to this question is rated as "good/fair" and "declining."

   Humpback whales in the Hawaiian region prefer waters less than 180 meters (600 feet) in depth and are especially concentrated in waters with expansive shallow areas, typically with sandy bottoms and low rugosity (minimal variations in the seafloor habitat) (Herman et al. 1980, Mobley et al. 1999). There is evidence that shallow waters are preferred for calf rearing (Smultea 1994, Craig and Herman 2000). This habitat preference may be due to improved sound transmission and visual cues associated with animal interactions. Water clarity in both offshore and the preferred shallow-water habitat areas do not appear to have been significantly affected by human activities. However, an emerging issue that should be monitored is the increase in the number of existing and proposed structures related to aquaculture and offshore energy production. These structures should be monitored because they remove habitat in the water column and along the seafloor bottom that humpback whales prefer.

6. ***What is the condition of biologically structured habitats and how is it changing?*** There are no biologically structured habitats that appear to be associated with or required by humpback whales in the sanctuary. For this reason, this question is not addressed.

7. ***What are the contaminant concentrations in sanctuary habitats and how are they changing?*** Because there is no evidence that contaminants exist at substantial levels in humpback whales in Hawai'i, or in their habitats in the sanctuary, the response to this question is rated as "good" and "not changing."

   Contamination resulting from pollutants could result in impaired immunity, increased susceptibility to disease, neurotoxicity, and reproductive impairment (Elfes et al. 2010) in marine mammals. However, studies conducted through the SPLASH project (see text box, page 26) have demonstrated that contaminants that are found in humpback whales are low and are assumed to have been acquired in their feeding grounds, particularly if the feeding grounds are near highly urbanized areas with inputs from treated municipal and industrial wastewater and stormwater discharges (Elfes et al. 2010). Hawaiian waters are not feeding grounds for humpbacks, and investigators are not concerned about this method of acquisition of toxicants by whales when they are in sanctuary waters. In addition, results from the SPLASH project found that these whales feed in Alaska and northern British Columbia, and they have the lowest levels of contaminants found in any humpback populations studied (Elfes et al. 2010).

   Data on contaminants in humpback whale habitat in the Hawaiian Islands are limited. However, in a study testing the utility of semi-permeable membrane devices to monitor water quality, investigators found low concentrations of pesticides, including chlordane (an organochlorine pesticide), dieldrin (a persistent, bioaccumulative, toxic insecticide that was used from 1950 to 1974) and chlorpyrifos (an organophosphate insecticide), and low concentrations of polycyclic aromatic hydrocarbons (PAHs; a pollutant where some compounds can be carcinogenic or mutagenic) in nearshore waters off Maui adjacent to a large tract of agricultural land. The levels were considered unlikely to exert adverse effects on ecosystem resources (GERG 2001).

8. ***What are the levels of human activities that may influence habitat quality and how are they changing?*** Due to human activities that have had, or are likely to have localized impacts on humpback whale habitats in the Hawaiian Islands, the response to this question is rated as "fair" and "declining".

   There are a number of land- and ocean-based human activities in the Hawaiian Islands which may affect humpback whale habitats. On land, development in Hawaiian watersheds continues to increase. The impacts to the marine environment include those associated with runoff and its effects on water and habitat quality, as well as increased levels of contaminant delivery. Furthermore, patterns of runoff could be affected by the combined effects of increasing urbanization and greater acreage of fallow agricultural land (e.g., pineapple and sugarcane fields). In coastal and marine areas, activities that either do or could affect humpbacks and their habitats include high-speed ocean recreation activities, on-the-water whale watching, noise in the environment, vessel-whale collisions, and the use of acoustic-based monitoring by the military. Shifts in local habitat use by cows with calves have been noted and attributed to increasing coastal development and increasing use of high-speed boats, parasail boats and jet skis near shore (Glockner-Ferrari and Ferrari 1985, Forestell 1986).

Habitat Status & Trends

#	Issue	Rating	Basis for Judgment	Description of Findings
5	Abundance/ Distribution	▼	Potential increase in the number of existing and proposed structures related to aquaculture and offshore energy production could remove humpback whale habitat in the water column and along the seafloor.	Selected habitat loss or alteration has taken place, precluding full development of humpback whale assemblages, but it is unlikely to cause substantial or persistent degradation in humpback whale status.
6	Structure	N/A	There are no biologically structured habitats, such as coral reefs, that appear to be associated with or required by humpback whales in the sanctuary.	N/A
7	Contaminants	–	The low levels of some contaminants in humpback tissues are believed to be acquired in feeding areas, not in the Hawaiian Islands.	Contaminants do not appear to have the potential to negatively affect humpback whales.
8	Human Activities	▼	Land and ocean-based activities including coastal development, high-speed ocean recreation activities, whale watching, underwater noise, vessel-whale collisions, and military activities.	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized, not widespread.

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

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

Living Resources

9. ***What is the status of biodiversity and how is it changing?*** The Hawaiian Islands Humpback Whale National Marine Sanctuary is currently responsible for managing humpback whales and their associated habitat. The issue of biodiversity is not relevant at this time. For this reason, this question is not addressed.

10. ***What is the status of environmentally sustainable fishing and how is it changing?*** Experts involved in evaluating resources of the sanctuary were of the opinion that this question is not relevant to the status of humpback whales and their habitat. For this reason, this question was not addressed.

11. ***What is the status of non-indigenous species and how is it changing?*** The response to this question is rated as "good" and "not changing" because there are no known instances of non-indigenous species impacting or being affected by Pacific humpback whale populations in Hawai'i. Non-native species do occur in Hawaiian waters (primarily invertebrates), but they do not appear to have affected humpback whale habitats, nor do they interfere with the health or activities of whales in any known way.

12. ***What is the status of key species and how is it changing?*** Considering historical reductions in the abundance of humpback whales, and recent data showing measurable increases, the response to this question is rated as "good/fair" and "improving" because the abundance and recruitment of North Pacific humpbacks is increasing.

Humpback whales (*Megaptera novaeangliae*) were hunted commercially in the North Pacific until prohibited by the International Whaling Commission in 1966. Currently, humpback whales remain listed as "endangered" under the Endangered Species Act, and are designated as "depleted" under the Marine Mammal Protection Act. As a result, the central North Pacific humpback whale stock (the population in Hawai'i) is classified as a strategic stock[3] by the NOAA National Marine Fisheries Service (Angliss and Lodge 2003). It is difficult to determine the degree to which they have recovered from whaling because of the lack of accurate abundance estimates, both before and immediately after whaling (Calambokidis et al. 2008). North Pacific humpback whale populations were thought to have numbered about 15,000 prior to commercial exploitation in the 20th century, although this was only a rough calculation based on whaling data that may have been inaccurate (Rice 1978). Following the cessation of commercial whaling, population size was estimated to be between 1,000 and 1,400 individuals (Table 2, page 26) (Gambell 1976, Johnson and Wolman 1984), although the methods used for these estimates are uncertain and their reliability has been questioned (Calambokidis et al. 2008).

[3]A strategic stock, as defined by the Marine Mammal Protection Act (MMPA), is a marine mammal stock for which the level of direct human-caused mortality exceeds the potential biological removal level; which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the Endangered Species Act (ESA) within the foreseeable future; or which is listed as a threatened or endangered species under the ESA , or is designated as depleted under the MMPA.

Data collected between 1990 and 1993 yielded estimates of approximately 6,000 humpback whales in the North Pacific (4,000 for Hawai'i, 1,600 for Mexico and 400 for Japan) (Calambokidis et al. 1997). In an attempt to effectively understand the current population level of humpback whales, a highly migratory species, the SPLASH project was developed (Structure of Populations, Levels of Abundance and Status of Humpbacks, (see text box, page 26). Recent analyses from the SPLASH project show that migratory movements and population structure of humpback whales in the North Pacific are highly complex. An overall pattern shows that the wintering areas off Hawai'i are the primary wintering regions for the more central and northern latitude feeding areas (Calambokidis et al. 2008).

Results from the SPLASH project also demonstrate that the current abundance of humpback whales is estimated to be approximately 20,000 for the entire North Pacific with over 50 percent of this population estimated to winter in Hawaiian waters (Calambokidis et al. 2008, Calambokidis 2009). It is important to note that single individuals may stay in Hawaiian waters for as little as two weeks during the approximately six-month whale season (Mate et al. 1998, Craig et al. 2001). Therefore, at any one time, the abundance of humpback whales in Hawai'i is less than the total population size. Analyses from the SPLASH project suggest that the population of humpback whales for the overall North Pacific has shown a 4.9 percent annual increase since the 1990-1993 population estimates and a 6.8 percent annual increase over the 44-year period since the end of commercial whaling for humpbacks in 1966 when the population was estimated to be between 1,000 and 1,400 individuals (Gambell 1976, Johnson and Wolman 1985, Calambokidis et al. 2008, Calambokidis 2009). For Hawai'i specifically, trends since the early 1990s show an annual rate of increase of approximately 6 percent (Mobley et al. 1999, Mobley et al. 2001, Calambokidis et al. 2008). While there is some uncertainty over historic populations of humpbacks in Hawaiian waters, as well as debate over whether humpback whales migrated to the waters they currently use in Hawai'i prior to 200 years ago (Herman 1979), there is convincing evidence of increasing abundance basin-wide in the North Pacific Ocean (Calambokidis et al. 2008).

SPLASH

The Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) represents one of the largest international collaborative studies of any whale population ever conducted and is the most comprehensive humpback whale research study ever undertaken for any population of whales in any ocean. The primary objectives of the SPLASH project are to improve the description of the stock structure of humpback whales in the North Pacific, to understand the abundance, trends and movements of these stocks, and to assess the human impact on them. The program is a cooperative effort of researchers from over 50 research groups in 10 countries, including the United States, Canada, Mexico, Japan, Russia, Philippines, and Central America. Data is primarily collected through photo-identification of whale flukes and genetic analysis of tissue samples in the humpback whales' breeding and feeding grounds. The Hawaiian Islands Humpback Whale National Marine Sanctuary has played a central role in initiating, funding and coordinating this project.

Region	Previous		Current		Year	Annual
	Year	Estimate	Year	Estimate	span	incr.
Total N Pacific estimates	**Previous**		**SPLASH**			
NPAC study to SPLASH	1991-93	9,819	2004-06	18,307	13	4.9%
Rice estimate to SPLASH	1966	1,400	2004-06	18,307	39	6.8%
Hawai'i estimates						
NPAC study to SPLASH	1991-93	3,760	2004-06	8,034	13	6.0%
Asia						
NPAC study to SPLASH	1991-93	405	2004-06	943	13	6.7%

Source: Calambokidis et al. 1997

Table 2. Estimates of annual increases in humpback whale abundance based on comparison of SPLASH study to previous estimates with similar methods. Note that "NPAC" stands for North Pacific and "Rice" refers to his 1978 study.

It should be noted that new methods for estimating pre-whaling populations (Roman and Palumbi 2003) suggest that the methods used by Rice (1978) and others may have underestimated the pre-whaling population by an order of magnitude. Rice (1978) estimated that intensive commercial whaling removed more than 28,000 individuals from the North Pacific during the 20th century. This mortality estimate likely underestimates the actual kill as a result of under-reporting of Soviet catches (Yablokov 1994). Nevertheless, it is still estimated that the population currently appears to be increasing at a rate of about 6 percent per year (Calambokidis et al. 2008).

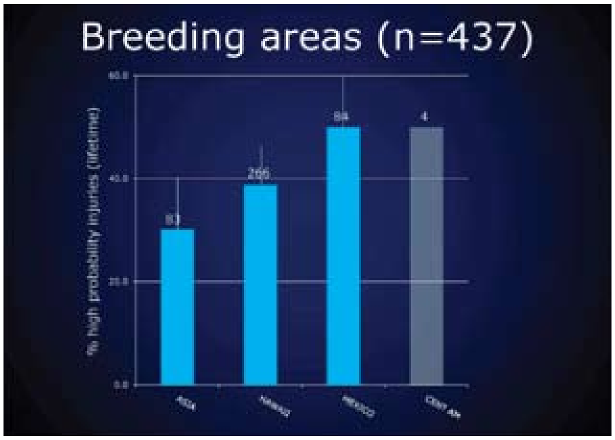
Increases in the abundance of humpback whales in the North Pacific could also affect the status of other species. For example, some species can feed on dead or dying newborn, juvenile or adult whales. Tiger sharks have been observed on numerous occasions preying on whales in the Hawaiian Islands over the last few years. Higher levels of humpback whale mortality (which accompanies higher population levels) results in an increase in the amount of whale biomass that can serve as a food source for benthic and pelagic organisms and marine bird communities. Other materials such as skin sloughing off the animals or placental remains are also density-dependent, and can serve as food for other species. Studies on these processes have not been conducted in the sanctuary; however, Antonelis et al. (2007) estimated that through all of these pathways, humpback whales currently represent a significant positive contribution of biomass to the ecosystem.

13. ***What is the condition or health of key species and how is it changing?*** Because of the high number of injuries and scars caused by entangling gear, debris and contact with vessels on whales, as well as the effects of these impacts on their behavior (e.g., swimming, courting, calving, nursing, etc.), the response to this question is rated as "fair" and "declining."

Entanglement in fishing gear is a known source of injury and mortality for humpback whales in Hawai'i and elsewhere throughout their range in the North Pacific (NMFS 1991, Robbins 2009, Lyman 2009). Entanglement can result in abrasions, lesions, debilitating injury or even death depending on the type, amount and location of entangled gear. Entanglement (in addition to ship strikes) has been implicated in up to 60 percent of known humpback mortalities, and may be causing an annual mortality of up to 5 percent of the population (Wiley et al. 1995, Volgenau et al. 1995). Even without injury, entanglement can impair swimming and feeding ability, leading to isolation of individual members from groups, and/or metabolic stress. Presumably, stressed animals would also likely alter normal behaviors associated with courting, breeding, giving birth and nursing their young (Robbins 2010).

Marine debris and active fishing gear that can lead to whale entanglement may originate from both local and non-local sources. For example, some may originate from the summer feeding grounds and may include traps with lines and surface floats and nets (e.g., trawls, gill nets). Gear might also be encountered during migration, where it collects along oceanic fronts (where debris carried from around the North Pacific accumulates). While methods are available to measure scars and other indications of physical and behavioral impacts by entanglement, it is more difficult to determine specifically to what extent these and other stressors are affecting the health of the whales. The sanctuary currently works in collaboration with both private and federal agencies to develop methods to assess these impacts through established techniques such as biopsy tissue sampling and experimental techniques such as visual assessment measures, skin collection and breath collection (the collection of respiratory gases from free-swimming humpback whales in order to determine metabolic state, or any abnormal conditions including evidence of disease).

The frequency of entanglement events, regions of concern and impacts to populations are not yet fully known. This is because the rates at which events are reported depend on several factors, including the actual number of events, the likelihood of event detection, and observer awareness and willingness to report (Robbins and Mattila 2004). As part of the SPLASH project, systematic sampling and scar interpretations were performed to provide insight into these issues across the North Pacific Ocean (Robbins 2009). Although sample sizes were not sufficient to rigorously compare all breeding grounds, results indicate that Hawai'i was not significantly different from other breeding grounds (Figure 16). Results also



Source: Robbins 2009

Figure 16. Frequency of entanglement injuries across North Pacific breeding grounds (bars). Sample sizes shown in white. Blue bars with 95% confidence intervals (vertical lines) were areas with sample sizes adequate for regional comparisons.

demonstrated that entanglement rates are higher in coastal feeding areas, particularly in the Eastern North Pacific, when compared to breeding areas.

Lyman (2009) assessed confirmed reports of large whale entanglement incidences in order to determine the frequency of entanglements and the types of gear found entangling humpback whales within much of the eastern and central North Pacific, before, during and after the SPLASH project. Results indicate that from the time period studied (2001 – 2009) there were 52 confirmed reports of entangled humpback whales in Hawai'i, averaging 5.8 cases yearly. Of the gear that was identified on entangled humpback whales in the eastern North Pacific, most (76 percent) involved passively set, fixed fishing gear, such as pots (traps) and gillnets (Figure 17). Also, some of the gear found entangling humpback whales was carried over long distances. For example, gear recovered and/or documented from eight entangled humpbacks within the Hawai'i breeding grounds came from Alaska or British Columbia. Seven of these reports were pot gear from crab, fish and shrimp fisheries. The average minimum straight-line distance the gear was carried was 4,030 kilometers (2,500 miles), with the longest distance being 4,540 kilometers (2,820 miles), involving a shrimp pot set near Wrangell, Alaska, that was later removed from the animal off Maui. Six percent of all confirmed reports of entangled humpback whales involved mortality. The most lethal gear based on reports received and ability to confirm type was seine gear, with gillnet and pond gear being the next deadliest gear types. It should be noted that sample sizes were small across all gear types.

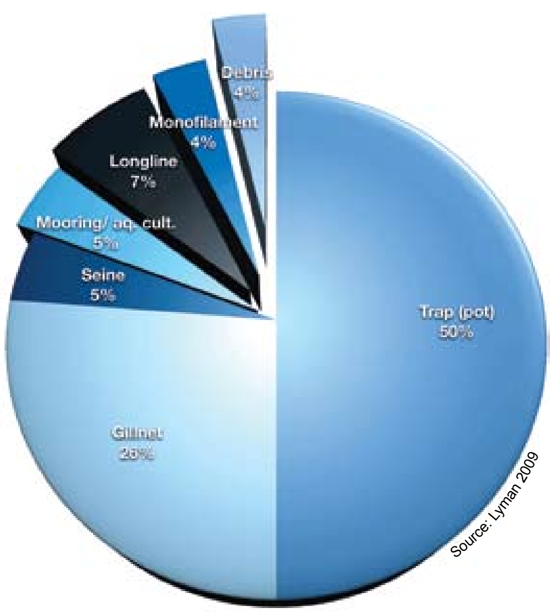


Figure 17. Of the gear identified, most (76 percent) reported entangling humpback whales in the eastern North Pacific involved passively set, fixed fishing gear, like pots (traps) and gillnets.

Vessel traffic creates the potential for collisions with humpback whales. Over the last decade, the number of *reports* involving confirmed vessel-whale collisions has increased, likely the result of increased awareness from boat operators. While it is difficult to gauge the percentage of vessel-whale collisions that are reported to the media and authorities, it is clear that not all incidents are reported. Lammers et al. (2003) have documented that the annual number of confirmed collision reports has generally increased over the past 20 years; however, there is currently insufficient data to confirm whether collisions between whales and vessels have actually increased, or if the increasing number of reports is due to increased awareness and reporting. At least 10 collisions occurred in Hawai'i from 1998 to 2004, including five that resulted in the death of or serious injury to the whales. From 2005 through the end of the 2010 whale season, at least 42 confirmed collisions occurred, with at least 14 animals showing signs of injury (Lammers et al. 2003, Lyman 2010). Vessel-whale collisions also have serious safety consequences for vessel operators and their passengers. For example, in 2003, a three-year-old boy was killed when the tour boat his family was on struck a whale off O'ahu. Serious damage to vessels can also result from vessel-whale collisions. In 2006, after colliding with at least one humpback off Maui, a large whale watching vessel required extensive repairs to its steering and propulsion systems.

Contamination resulting from pollutants is also a cause of concern for the health of marine mammals and other top-level predators. Persistent organic pollutants (POPs) entering the marine environment are absorbed by organic matter and are taken up by plankton at the base of marine food webs. Bioaccumulation of POPs through the food chain is of concern, particularly for long-lived, top-level predators including marine mammals. POP contamination could result in impaired immunity, increased susceptibility to disease, neurotoxicity, and reproductive impairment (Elfes et al. 2010). Studies conducted through the SPLASH project (see text box, page 26) have demonstrated that contaminants that are found in humpback whales are low and are assumed to have been acquired in their feeding grounds, particularly if the feeding grounds are near highly urbanized areas with inputs from treated municipal and industrial wastewater and stormwater discharges (Elfes et al. 2010). Hawaiian waters are not feeding grounds for humpbacks, and investigators are not concerned about this method of acquisition of toxicants by whales when they are in sanctuary waters. In addition, because humpbacks and other baleen whales feed on small organisms, they are believed to be at a much lower risk of ingesting contaminants than toothed whales, which feed on organisms with higher levels of bioaccumulated contaminants (Clapham et. al. 1999). For these reasons, the sanctuary does not currently conduct regular assessments of contaminant or pathogen levels in humpback whales in Hawai'i. However, the SPLASH project found that the humpback whales that visit Hawai'i feed in Alaska and northern British Columbia, and they have the lowest levels of contaminants found in any humpback populations studied (Elfes et al. 2010).

14. What are the levels of human activities that may influence living resource quality and how are they changing? Due to reports of entanglement and whale-vessel collisions, as well as emerging issues such as existing and proposed nearshore development activities, some of which occur outside of Hawaiian waters, the response to this question is rated "fair/poor" and is considered to be "declining."

The challenge in addressing the issue of entanglement in both fishing gear and marine debris (see Question 13) is that the majority of marine debris and entanglement incidents may originate in places outside Hawaiian waters (Lyman 2009). Entanglement and marine debris also pose a threat to other marine mammals, sea turtles and birds. Humpback whales are especially vulnerable because they often transit and inhabit regions with growing amounts of both fishing gear and debris. It has been estimated that more than 300,000 whales, dolphins and porpoises die every year as "bycatch" or become entangled (Read et al. 2006). Together, entanglement and ship strikes have been implicated in up to 60 percent of known humpback mortalities, and may be causing an annual mortality of up to 5 percent of the population (Wiley et al. 1995, Volgenau et al. 1995, Robbins et al. 2009).

Reports of whale-vessel collisions have also increased over the last decade. The higher speed and number of vessels both large and small, combined with the increasing population of humpback whales, makes collisions more and more likely, and potentially more lethal (Laist et al. 2001) for whales and ocean users. Ships also affect the acoustic environment of the ocean, resulting in an uncertain level of impact on species like humpbacks, which are highly dependent on vocalization for communication and feeding.

It is unclear what level of impact might be associated with an increasing number of aquaculture facilities. Beyond the risks of entanglement and habitat loss, further study is necessary to determine how humpbacks might be affected.

Living Resources Status & Trends

#	Issue	Rating	Basis for Judgment	Description of Findings
9	Biodiversity	**N/A**	The sanctuary is currently responsible for managing humpback whales and their associated habitat. The issue of biodiversity is not relevant at this time.	N/A
10	Extracted Species	**N/A**	Extraction is not relevant to the status of humpback whales and their habitat	N/A
11	Non-Indigenous Species	–	There are no known non-indigenous species that affect humpback whales or their habitats.	Non-indigenous species are not suspected or do not appear to affect status of humpback whales.
12	Key Species Status	▲	Humpback whale population levels are still below historic estimates in the North Pacific; however, recent estimates indicate humpback whale population levels in Hawai'i have increased by 6 percent annually.	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
13	Key Species Condition	▼	Increased reported numbers of vessel collisions and entanglements and associated impacts (e.g., lesions and impairment of movement and other behaviors).	The diminished condition of selected key resources may cause a measurable but not severe reduction in ecological function, but recovery is possible.
14	Human Activities	▼	Increased reported numbers of collisions and entanglements (often including fishing gear encountered elsewhere).	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.

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

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

Maritime Archaeological Resources

15. What is the integrity of maritime heritage resources and how is it changing? The response to this question is rated as "fair" and "declining" because of the gradual loss of integrity of maritime archaeological resources due to natural and human impacts. These impacts include various factors of natural deterioration, as well as both inadvertent and intentional damage from human impacts.

The sanctuary does not have jurisdiction over maritime archaeological resources, but the sanctuary system, through the Pacific Islands Region office, is assisting in surveying and monitoring some of these resources to a limited extent. Further, part of the sanctuary mission is to "facilitate uses compatible with the primary purpose of resource protection, including those traditional and customary uses of native Hawaiians." For these reasons, it is important to monitor the integrity of these resources.

Maritime archaeological resources in the marine environment are subject to different rates of deterioration from biological, chemical and mechanical processes. Organic material (wood in particular) is subject to internal bacterial decay, and in warm marine waters provides food for the shipworm (*Teredo navalis*); therefore, exposed wooden ship components on historic sites are rare, and only exist buried in sediments. Most of the historic shipwreck sites within the sanctuary feature iron or steel elements (e.g., hull, engine, boiler components, etc.). These ferrous metals are subject to chemical deterioration through the corrosion process; however, over time, ferrous artifacts become encrusted by sediment or coralline algae and other marine organisms, and this barrier greatly slows the rate of chemical deterioration. Mechanical deterioration, through the processes of surface wave, storm surge and hurricane impacts, can affect both buried and exposed features of historic and archaeological resources. Historic wrecks in shallow waters are slowly broken up over time, with components often being washed up onto the shore (see Shipwreck Beach on Lāna'i). Local divers report that deeper sites, such as shipwrecks and aircraft in 25 to 30 kilometers (80 to 100 feet) of water, have been broken or moved by infrequent hurricane events. These natural processes are ubiquitous and, for the most part, not subject to practical remediation.

Human impacts to maritime archaeological resources fall into two categories: inadvertent and intentional. Inadvertent impacts include anchor and mooring damage and improper diving activities. Historic sites within the sanctuary show evidence of both. Popular dive sites without proper established moorings are subject to anchor damage. Divers who unwittingly "clean" wrecks remove the encrusted algae and sediment and initiate renewed corrosion. Possible inadvertent impacts include high sedimentation rates (possibly resulting from coastal development), which obscure coastal resources such as fishponds, and sand dredging for channel or beach replenishment projects, which (without proper archaeological surveys) can destroy resource sites. Intentional human impacts include the damage and removal of historic artifacts from shipwreck and aircraft sites. Unfortunately, despite existing state and federal laws to the contrary, there have been a number of known incidents of this sort within the sanctuary. For example, naval aircraft have been damaged by non-permitted commercial boat moorings attached to propeller shafts, cockpit instruments have been removed, 50-caliber machine guns have been illegally recovered, and compass housings have been taken from historic World War II landing craft. On steamship wreck sites, compasses have been removed, deck lights have been stolen, and brass and copper and bronze fittings have been looted.

A resource survey within the sanctuary is only in the preliminary stages, as the sanctuary does not have direct jurisdiction over maritime archaeological resources, and survey capacity is limited. However, enough information exists from the 25 located and visited historic sites (out of approximately 115 reported lost historic ships and aircraft) and the many archaeological sites of marine coastal Hawaiian fishponds (some 61 sites documented by the state) to indicate that these human and natural processes are affecting the integrity of the overall resource.

16. Do maritime heritage resources pose an environmental hazard and is this threat changing? Because of a lack of information on the locations or threats posed primarily by World War II sunken vessels, both the status and trend for the response to this question is rated as "undetermined."

Maritime archaeological resources do not usually represent immediate threats to humpback whales and their habitat. In some cases, long term impacts from chemical leaching (e.g., iron from hulls) can occur, and there is the potential for World War II-era shipwrecks to release hazardous material such as fuel into the environment as they disintegrate. Neither has been quantified at the present time in the sanctuary due to the lack of survey data. Numerous ordnance or military munitions were lost in the area, but their locations and threat level within the sanctuary have not been assessed. At this time, there is no evidence that these submerged maritime resources impact the physiology or behavior of humpback whales in the Hawaiian waters.

17. What are the levels of human activities that may influence maritime heritage resource quality and how are they changing? In the sanctuary, many recreational divers responsibly visit and enjoy known shipwreck and historic aircraft wreck sites with minimal impact to the quality of the resources. However, due to the lack of resource preservation knowledge and resource protection, a few divers and boat operators apparently have damaged known sites. These impacts include the damage and removal of historic artifacts from shipwreck and aircraft sites. This, in combination with increased access to deeper sites provided by new diving technologies (e.g., technical mixed-gas diving and closed-circuit rebreathers), leads to the response of "fair/poor" and "declining" for this question. Greater access to deeper archaeological resources, given that these resources are not effectively managed or protected, may lead to increased inadvertent and intentional damage. Both of these kinds of impacts have already been documented within the sanctuary.

Maritime Archaeological Resources Status & Trends

#	Issue	Rating	Basis for Judgment	Description of Findings
15	Integrity	▼ (Fair)	Gradual loss of maritime archaeological resource integrity due to natural and human impacts including biological, chemical and mechanical weathering; anchor and mooring damage; diver visitation; looting; sedimentation, etc.	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific or educational value and may affect the eligibility of some sites for listing in the National Register of Historic Places.
16	Threat to Environment	? (Undet.)	Data on wrecks that may pose hazards are insufficient to determine status or trend.	N/A
17	Human Activities	▼ (Fair/Poor)	Increasing diving activity due to technical advances provides greater uncontrolled access.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.

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

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

Response to Pressures

This section provides a summary of existing and proposed responses to pressures on marine resources of the Hawaiian Islands Humpback Whale National Marine Sanctuary. Existing sanctuary responses and management actions are enacted to implement the final regulations issued by NOAA and to protect natural resources of the sanctuary.

Sanctuary Management

The sanctuary covers approximately 3,550 square kilometers (1,370 square miles) of federal and state territory within the main Hawaiian Islands. To ensure fair management of this multi-jurisdictional area, the National Oceanic and Atmospheric Administration (NOAA) and the state of Hawai'i signed an intergovernmental compact agreement in 1997. This enables the sanctuary to operate as a partnership between NOAA and the Hawai'i Department of Land and Natural Resources (DLNR).

The sanctuary has sought to strengthen its working relationships with other government agencies and organizations involved in protecting humpback whales and their habitat in Hawai'i. This approach is aimed at increasing flexibility, mobilizing staff resources, avoiding duplication and broadening opportunities for citizen participation in ocean stewardship. A cooperative management strategy has been very effective in capitalizing on the sanctuary's strengths in education and public outreach. While many agencies share the mission of protecting humpback whales, the sanctuary is unique in its vigorous efforts to communicate the public interests at stake in humpback whale habitat in Hawai'i.

Existing Regulations

There are three federal acts, as well as multiple state statutes, that protect humpback whales in the Hawaiian Islands. The federal acts are the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA) and the Hawaiian Islands National Marine Sanctuary Act. The ESA of 1973 provides for the conservation of species at risk of extinction throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. The MMPA of 1972 established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, as well as the importing of marine mammals and marine mammal products into the United States.

Hawaiian Islands National Marine Sanctuary Act regulations prohibit the following activities in Hawaiian Islands Humpback Whale National Marine Sanctuary waters:

- Approaching, or causing a vessel or other object to approach, within the sanctuary, by any means, within 100 yards of any humpback whale except as authorized under the MMPA and the ESA;
- Operating any aircraft above the sanctuary within 1,000 feet of any humpback whale, except as authorized under the MMPA and the ESA;
- Taking any humpback whale in the sanctuary except as authorized under the MMPA and the ESA;
- Possessing within the sanctuary (regardless of where taken) any living or dead humpback whale, or part thereof, taken in violation of the MMPA or the ESA;
- Discharging or depositing any material or other matter in the sanctuary;
- Altering the seabed of the sanctuary; and
- Discharging or depositing any material or other matter outside the sanctuary if the discharge or deposit subsequently enters and injures a humpback whale or humpback whale habitat, provided that such activity: (i) requires a federal or state permit, license, lease or other authorization; and (ii) is conducted without such permit, license, lease or other authorization, or not in compliance with the terms or conditions of such permit, license, lease or other authorization.

Sanctuary Education and Outreach Programs

The sanctuary's mission is to enhance public awareness, understanding and appreciation of the marine environment (Figure 18). The sanctuary has focused its education program on making its constituents aware of humpback whales and the ocean they live in, with the understanding that ocean-literate citizens will help protect not only endangered humpback whales, but also all natural resources. To address the issue of ocean literacy, the sanctuary implements a variety of activities that focus on three major areas: enhancing learning opportunities, increasing ocean awareness, and promoting ocean stewardship (HIHWNMS 2007).

Photos: NOAA

Figure 18. Students learn about marine science on an in-the-field experience on the NOAA ship Hi'ialakai.

Sanctuary Volunteer-Based Water Quality Monitoring Program: Utilizing Citizen Science

Water quality has been identified as an important issue among the general public across Hawai'i. Beach users and community-based groups have stated concerns over injection wells, vessel discharge and water quality conditions throughout the waters of Hawai'i. The sanctuary also recognizes water quality as an important issue, and sanctuary outreach and education specialists actively pursue ways to better engage the public and inform them about issues relating to water quality.

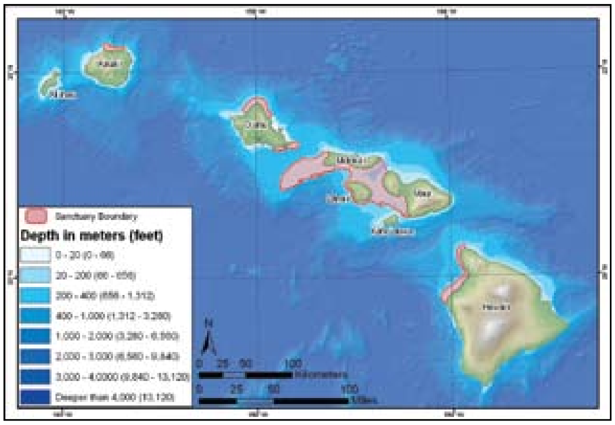
The sanctuary volunteer-based water quality monitoring program was started in 2008 and has been funded by equipment donations, small grants and the commitment of a core group of volunteers. The monitoring program is focused on four sites along south Maui's coastline. Volunteers test each site weekly for salinity, temperature, pH, turbidity and Enterococcus spp. bacteria (indicator bacteria that are used to detect the presence of human sewage in the water, which can cause gastrointestinal illnesses). The data collected by these efforts are entered online through the newly established online Coral Reef Monitoring Data Portal website, http://monitoring.coral.org).

These data serve multiple purposes. At the end of the year, the findings are submitted to the EPA as an additional measure of county water quality trends. The bacterial readings that breach regulatory thresholds are sent to the Hawai'i Department of Health as they are collected to alert them of potential water quality conditions that may be of concern to human and environmental health. The continual monitoring of basic water quality parameters also helps to establish baseline data, which assist in tracking trends in coastal water quality conditions.

Currently, state monitoring efforts of all waters around Maui consist of only one person. Community-based programs can serve an important role in helping to fill in the gaps in existing data, as well as raise awareness among the community members.

Habitat Mapping of the Sanctuary

Bathymetry is the study of the underwater depth of ocean or lake floors. Figure 19 is an example of a bathymetric map of the sanctuary. Mapping cruises were conducted over the past five years, and it is estimated that 87 percent of the sanctuary has now been mapped. This advancement in documenting the sanctuary includes the complete mapping of Penguin Bank, an important habitat for humpback whales in Hawai'i. The characteristics of the area bounded by Maui, Moloka'i, Lāna'i and Kaho'olawe, along with the extension of the shallow Penguin Bank southwest of Moloka'i, represent a unique, semi-enclosed, shallow protected sea in the midst of an expansive ocean. In 1997, at the time of the initial sanctuary Environmental Impact Statement and Management Plan, very little information had been published about the specific characteristics of this inter-island area. The bathymetry data collected during a research cruise in 2005 were added to the synthesis in order to make a preliminary assessment of seafloor characteristics across the state. The synthesis, begun by the Hawai'i Underwater Research Lab (HURL), incorporates data from a wide variety of mapping groups, including academic, state and federal sources (HIHWNMS and SOH 2007a).



Source: Hawaiian Islands Humpback Whale National Marine Sanctuary

Figure 19. Bathymetric map of the Hawaiian Islands Humpback Whale National Marine Sanctuary.

Sanctuary Research

The primary sanctuary research effort over the past several years has been coordinating and partially funding the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project. The primary objectives of the SPLASH project are to improve the description of the stock structure of humpback whales in the North Pacific, to understand the abundance and trends of these stocks, and to assess the human impact on them. The program is a cooperative effort of researchers from the United States, Canada, Mexico, Japan, Russia, the Philippines and contributors from several Central American countries. Data is collected primarily through photo-identification of whale flukes and genetic analysis of biopsy tissue samples in the humpback whales' breeding and feeding grounds. The sanctuary, in partnership with the Hawai'i Department of Land and Natural Resources (DLNR), coordinated seven SPLASH teams in Hawai'i, while conducting its own fieldwork on Penguin Bank and assisting with Maui, Kaua'i and the island of Hawai'i. Between 2004 and 2006, researchers in Hawai'i encountered 3,624 groups of whales, resulting in the identification of 6,478 individuals through photographs of their distinct tail patterns. In addition, SPLASH researchers collected 2,382 skin biopsies for gender identification and various other genetic and chemical analyses over the project's duration (Calambokidis et al. 2008). Some the results of this project have been reported throughout this document, while other data are still being analyzed.

In addition to SPLASH, the sanctuary has worked in partnership with the NOAA Fisheries Marine Mammal Health and Stranding Response Program and private institutions such as the Provincetown Center for Coastal Studies and the Cascadia Research Collective to develop new techniques to assess the health of free-swimming humpback whales and the impact from and circumstances leading to humpback whale entanglement in fishing gear and marine debris. Most of the results from this research have been presented in various national and international venues.

Whale-Vessel Collisions and Entanglement

Vessel Traffic

To address a growing concern regarding the increased occurrence of collisions between vessels and humpback whales, sanctuary response and rescue experts currently investigate reported vessel-whale collisions whenever possible. The goal is to ascertain the true impact to the individual whale, as well as potential impacts to the population as a whole.

In 2003, the sanctuary advisory council vessel strike working group and its partners sponsored a workshop to assess ship strike risks to whales in Hawai'i and to identify possible actions to reduce the occurrence of vessel-whale collisions in Hawaiian waters and throughout the National Marine Sanctuary System (Figure 20). More than 75 resource managers, scientists, industry leaders and representatives of the marine community participated. Discussions and presentations during the workshop generally agreed that vessel collisions with whales are an issue to be aware of in Hawaiian waters, but it is not a critical problem at the present time. However, participants strongly supported monitoring efforts in order to improve management, including conducting assessments of whale population growth, whale behavior trends and increased ship traffic in waters surrounding the Hawaiian Islands. Improving data collection and storage of information on the occurrence of vessel strikes and "near misses" with whales was also widely supported. In addition, the participants were also strongly in favor of increased education and outreach efforts as an important management tool for decreasing the incidence of whale-vessel collisions (NMSP 2003).

Since the 2003 workshop, the sanctuary has disseminated collision avoidance guidelines that have been featured annually in newspaper articles, lectures, workshops, harbor signs and outreach events and products. In 2006, the sanctuary implemented an Ocean Etiquette Campaign with targeted outreach activities including a brochure and seven boater workshops held throughout the islands (HIHWNMS and SOH 2007a).

Photo: NOAA

Figure 20. Participants prioritize recommendations at a workshop on management needs to minimize whale-vessel collisions.

Marine Debris and Fisheries Interactions

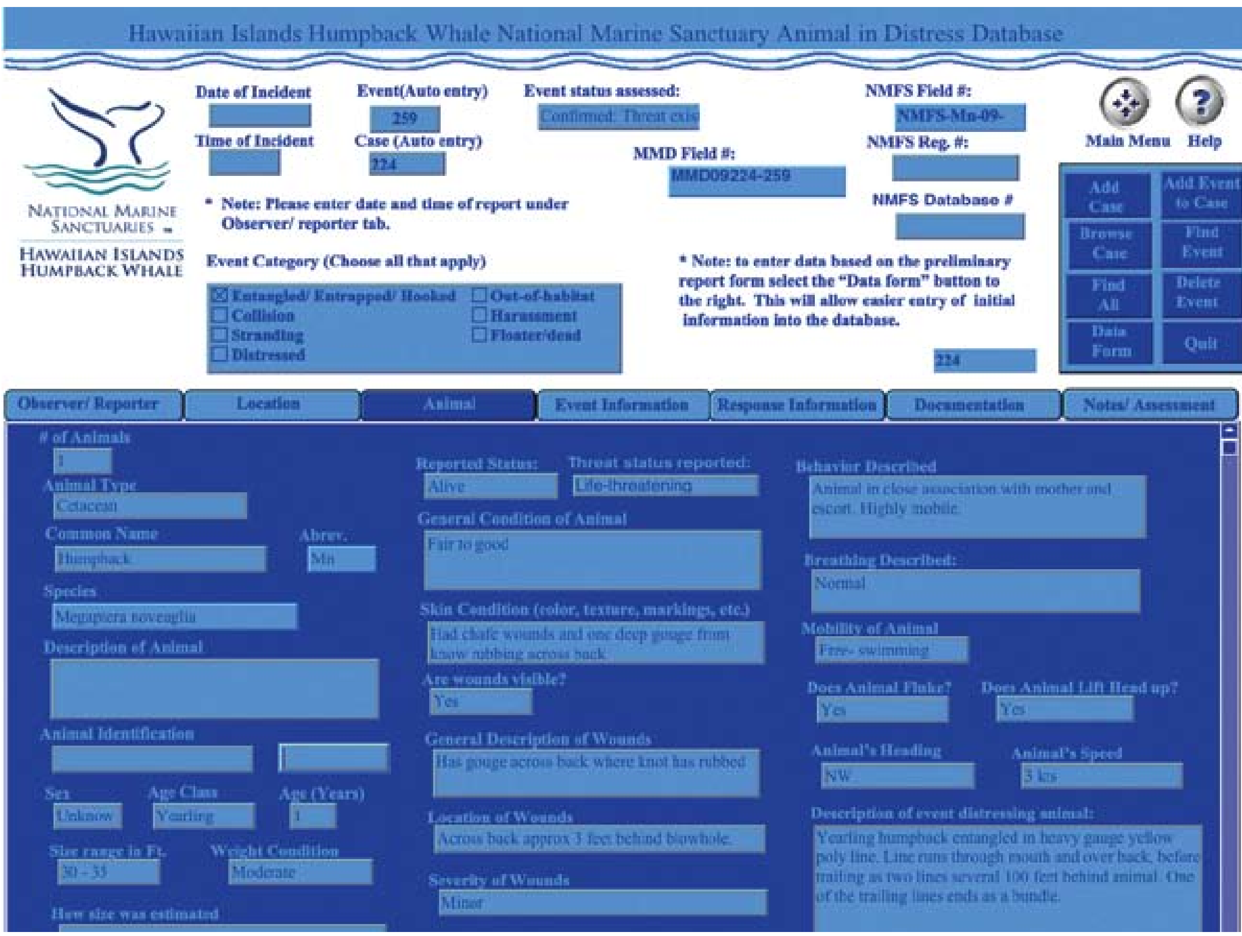
In order to address a growing concern regarding humpback whale entanglement, sanctuary response and rescue experts currently conduct on-water responses to reported entanglements whenever weather conditions and safety concerns permit. Additionally, follow-up investigations of reported entanglements are conducted whenever possible. In addition to freeing whales from what are sometimes life-threatening entanglements (Figure 21, page 35), the goals are to ascertain the true impact to the individual whale and potential impacts to the population as a whole. To date, sanctuary experts have removed over 1,900 meters (6,500 feet, or more than a mile) of line that has entangled humpback whales. Responders have also freed 15 whales from life-threatening entanglements, significantly increasing their chances for survival.

In 2002, the sanctuary, working with state and federal partners, spearheaded the creation of the Hawaiian Islands Entanglement Re-

Photo: HIHWNMS / NOAA MMHSRP Permit #932-1489

Figure 21. Efforts to disentangle a humpback whale in Hawaiian waters on Feb. 12, 2005. Rescuers position themselves to remove entangled gear from the whale.

sponse Network. At the end of 2009, the network had more than 170 trained participants. Since 2002, the network has conducted more than 60 on-water entanglement responses, and successfully disentangled 15 humpback whales from life threatening entanglements. Locally, sanctuary personnel train others, help develop unique tools and techniques to free entangled large whales, and coordinate and participate in humpback whale entanglement response efforts in Hawaiian waters. Nationally, sanctuary personnel advise the NOAA National Marine Fisheries Service on entanglement threat and response; lead whale disentanglement trainings; participate in fishermen and health assessment workshops; provide general outreach on entanglement threat; assist with disentanglement efforts in other regions (e.g., Alaska and New England); investigate gear removed from disentangled animals; study entanglement scarring as a mea-



Source: E. Lyman, HIHWNMS

Figure 22. The sanctuary's Animal in Distress Database records reports of humpback whale entanglements and contact with vessels. The database is important in that while response efforts may help in saving a few whales, it is the information gained from these response efforts that might ultimately reduce or mitigate the threat overall.

sure of entanglement threat; and work with fishermen and others to reduce the threat of entanglement to humpback whales in Hawai‘i. Internationally, sanctuary personnel have conducted disentanglement workshops in Mexico and New Zealand, and participate on the bycatch subcommittee of the International Whaling Commission's Scientific Committee (HIHWNMS and SOH 2007a).

In 2003, the sanctuary increased its efforts in marine mammal response and, as a result, started receiving more reports of marine mammals in distress. To better record and analyze these reports, the sanctuary designed and fabricated its own database (Figure 22, page 35). The purpose of the database is to record reports of humpback entanglements and contact with vessels; however, other marine mammal species are also covered, as well as other events such as strandings and general harassment activities that might compromise the well-being of the animal or humpback whale population. To date, the sanctuary's Animal in Distress Database contains 224 cases and 326 events. At the end of each humpback whale season, records are sent to the NOAA Fisheries Pacific Islands Regional Office. The database is extremely important in that while response efforts may help in saving a few whales, it is the information gained from these response efforts that might ultimately reduce or mitigate the threat overall. The sanctuary's database records and organizes this data to allow for better use. Most of the information within the database is available to the public, and is typically posted on the sanctuary's website, included in reports and provided at presentations and workshops.

In 2010, the sanctuary co-convened with the NOAA National Marine Fisheries Service a three-day, International Whaling Commission-sponsored workshop on large whale entanglement. The workshop covered a broad range of topics, including the global scope of the problem, the nature of entangling gear, the impacts on both the individual whale and the population, the efforts to respond, and the difficult decisions involved. The sanctuary hosted the workshop at its Maui site and invited participants from many countries including those that have well-established whale disentanglement programs (e.g., Australia, Canada, South Africa and the U.S.). The workshop highlighted U.S. concern and leadership on this important issue, which is currently the most significant human-generated cause of mortality in many large whale populations.

Noise Pollution

Acoustic impacts are not clearly understood; however, it is thought that human-caused noise could potentially adversely affect humpback whales by disrupting resting, feeding, courtship, calving, nursing, migration or other activities. Researchers suggest that increased background noise and specific sound sources might impact marine animals in several ways. The effects vary depending upon the intensity and frequency of the sound, and other variables. The potential impacts include sounds that: 1) cause marine animals to alter their behavior; 2) prevent marine animals from hearing important sounds (masking); and 3) cause temporary or permanent hearing loss or tissue damage in marine animals. The sanctuary currently plays a supporting role through collaborative research activities, which have measured received levels of sound from coastal construction, demolition and typical vessel noise.

Coastal Pollution and Coastal Development

The condition of the marine and coastal waters of the sanctuary is vulnerable to both land-based and marine sources of pollution. Sources of concern include pollutant runoff from impervious surfaces, farms, feedlots, golf courses and others. Marine sources of pollution result from human activities that discharge water or wastes in the ocean, including shipping, fishing and boating (DLNR-DAR 2005).

When the sanctuary was designated in 1997, NOAA received comments from the public that the sanctuary should, in cooperation with boat operators, promote proper disposal of sewage from vessels, encourage compliance with existing laws and help implement existing regulations and programs to address water quality issues. To this end, the sanctuary supports efforts by the state of Hawai‘i to develop more pump-out facilities at major harbors on every island. Currently, boat operators find the process of using existing facilities, or contracting with private companies for pumping at their harbor, both costly and time-consuming. Because of this, many discouraged boat owners dump their waste at sea. The practice of vessels discharging sewage in the ocean outside of the three-mile limit that delineates state waters has been an ongoing concern for a number of ocean enthusiasts, especially off Maui (Kira et al. 2003).

Discharges in the sanctuary are prohibited if they do not comply with an existing federal or state permit, license, lease or other authorization. These regulations prohibit discharging or depositing any material or matter inside or outside the sanctuary if the discharge or deposit subsequently enters the sanctuary and could injure a humpback whale or humpback whale habitat. Any exception to these regulations would require a federal or state permit, license or other authorization. Because there is no existing state or federal rule that prohibits discharges from vessels outside the three-mile limit, the practice is currently legal within the federal waters of the sanctuary.

At this time, NOAA is working with its agency partners — the U.S. Coast Guard, Environmental Protection Agency, Hawai‘i Department of Health and Maui County — and the community to find workable solutions to ensure better compliance with existing water quality regulations. Up to this point, NOAA has taken the approach that the best workable solution is to support and supplement existing state and federal programs that will provide improvements to harbor facilities and the installation of pump-out facilities at all harbors — a solution that will encourage boaters to adopt practices that are friendlier to the marine environment of Hawai‘i. The sanctuary has also provided funding to the Hawai‘i Department of Land and Natural Resources to support the county of Maui's interim efforts to subsidize costs for pump-out trucks for commercial vessels at Mā‘alaea Harbor on Maui. The effort is intended to accommodate vessels until the state of Hawai‘i is able to complete harbor improvements, which will include a pump-out facility at Mā‘alaea Harbor. The project is several years from completion. Finally, the sanctuary works closely with the NOAA Fisheries National Marine Mammal Health and Stranding Response Program to monitor the health of humpbacks in state waters and there is currently no evidence of significant pollutant transfer to humpbacks in the sanctuary.

Climate Change

Changes in climate could potentially affect aspects of humpback whale migration, such as distance and timing. Exposure to new diseases is also a possibility, although these would be most likely to manifest in the feeding grounds. Currently, most of the concern about emerging or resurging cetacean diseases associated with climate change has focused on their feeding grounds, as some scientists around the world have noticed increases in diseases that may be associated with climate change in those habitats (IWC 2007). While humpback whales fast during their season in Hawaiian waters, as a breeding ground, this is the time and place where any increase in sexually transmitted diseases would show up. Sanctuary scientists have documented the apparent emergence of skin lesions on humpback whales in Hawai‘i not documented in past decades (Mattila and Robbins 2008). However, it is not yet known if these lesions are reactions to parasites or potentially sexually transmitted, as the lesions are most numerous around the genitals. However, these lesions are found in greater percentages of South Pacific humpbacks and do not seem to be impairing population growth.

Maritime Archaeological Resources

In recognition of the variety of maritime archaeological resources in Hawai‘i, as well as the current threats and acknowledged lack of resource management in this area, the chair of the Hawai‘i Department of Land and Natural Resources addressed a letter to the sanctuary co-managers (Doc No 0606AJ14) in 2006, recommending that the program consider adding maritime archaeological resources to the sanctuary's management plan through the management plan review process. The state's letter noted that these kinds of resources are of national significance and can provide valuable information about various facets of maritime heritage in Hawai‘i. Letters of support have also been received from the Marine Option Program at the University of Hawai‘i, the Naval Historical Center, the National Park Service Submerged Resources Center, and sport diving organizations. A brief maritime archaeological assessment document was subsequently developed by the Office of National Marine Sanctuaries Pacific Islands Region for the sanctuary, addressing the existing inventory, current threats and resource management efforts, and the potential for joint management and future collaboration in this preservation field (HIHWNMS and SOH 2007b).

Concluding Remarks

It is important to reiterate that the responses to the questions found in this report are based primarily on the effects or potential effects of pressures on the sanctuary as they relate to humpback whales and their habitat, the primary resource targets of the Hawaiian Islands Humpback Whale National Marine Sanctuary. These responses may or may not be relevant to other threatened, endangered or culturally significant resources that exist within sanctuary waters. However, identifying additional marine resources for inclusion in the sanctuary was stipulated by Congress when the sanctuary was designated in 1992. In response to this congressional mandate, and with the support from the governor of Hawai‘i and overwhelming public backing, the sanctuary is currently implementing a process to identify new marine resources appropriate for protection by the sanctuary. As part of the current management plan review process, the public will be provided with numerous opportunities to comment on this process.

This condition report is intended to comprehensively describe the status, pressures and trends of resources in the sanctuary. By doing so, this report helps to identify the pressures and their impacts on marine ecosystems that may warrant monitoring and remediation in the years to come. It is important to understand the factors that help structure the resources of the sanctuary, and how uses of its resources may affect their health, viability and longevity. The information presented in this report enables managers to look back and consider past changes in the status of the resources, and provides guidance for continued resource management as we face future challenges imposed by existing and emerging threats such as increasing interaction with shipping, marine debris, aquaculture, coastal development, alternative energy production, artificial reefs and climate change.

It is noteworthy that nine of the questions addressed in this condition report received a ranking of “good” or “good/fair,” reflecting the relatively unimpaired condition of natural resources in the sanctuary. However, equally important to note is that five of the issues were rated as “declining.” These five issues dealt with the impacts of human activities on habitat and living and maritime archeological resources and are of particular concern because their ratings suggest a need for greater attention.

A focus of the sanctuary in the future will be to continue to provide research-based public outreach and education to reduce unwanted human-impacts on sanctuary resources. Additionally, the sanctuary will continue to work towards strengthening the bond between the land, sea, and the people of Hawai‘i. Recognizing both traditional Native Hawaiian values and place-based knowledge in natural resource management decisions will help ensure the continued success of the Hawaiian Island Humpback Whale National Marine Sanctuary.

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Additional Resources

Bishop Museum: http://www.bishopmuseum.org

Cascadia Research Collective: http://www.cascadiaresearch.org

Coral Reef Monitoring Data Portal: http://monitoring.coral.org

Endangered Species Act: http://www.nmfs.noaa.gov/pr/laws/esa

Grays Harbor Ocean Energy Company: http://www.graysharboroceanenergy.com

Hawai'i Coral Reef Initiative Research Program: http://www.hawaii.edu/ssri/hcri

Hawai'i Department of Health: http://hawaii.gov/health

Hawai'i Department of Transportation, Harbors Division: http://hawaii.gov/dot/harbors

Hawai'i Institute of Marine Biology: http://www.hawaii.edu/HIMB

Hawai'i Undersea Research Laboratory: http://www.soest.hawaii.edu/HURL

Hawaiian Islands Humpback Whale National Marine Sanctuary: http://hawaiihumpbackwhale.noaa.gov

Interisland Wind: http://www.interislandwind.com

International Whaling Commission: http://iwcoffice.org

Marine Conservation Biology Institute: http://www.mcbi.org

Marine Mammal Protection Act: http://www.nmfs.noaa.gov/pr/laws/mmpa

Marine Option Program at the University of Hawai'i: http://www.hawaii.edu/mop/site

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

Migratory Bird Treaty Act: http://www.fws.gov/laws/lawsdigest/migtrea.html

National Marine Sanctuaries Act: http://sanctuaries.noaa.gov/about/legislation

National Oceanic and Atmospheric Administration: http://www.noaa.gov

National Park Service: http://www.nps.gov

National Park Service Submerged Resources Center: http://www.nps.gov/applications/submerged

Naval Historical Center: http://www.history.navy.mil

NOAA Coral Reef Conservation Program: http://www.coralreef.noaa.gov

NOAA Coral Reef Information System (CoRIS): http://www.coris.noaa.gov

NOAA Fisheries Marine Mammal Health and Stranding Response Program: http://www.nmfs.noaa.gov/pr/health

NOAA Hawai'i Undersea Research Laboratory: http://www.nurp.noaa.gov/HURL.htm

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

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

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

NOAA Pacific Islands Fisheries Science Center: http://www.pifsc.noaa.gov

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

State of Hawai‘i Department of Land and Natural Resources: http://hawaii.gov/dlnr

State of Hawai‘i: http://www.ehawaii.gov

State of Hawai‘i’s Department of Land and Natural Resources: http://www.hawaii.gov/dlnr

Structures of Population, Levels of Abundance and Status of Humpback Whales (SPLASH project): http://hawaiihumpbackwhale.noaa.gov/science/splashinfo.html

The Dolphin Institute: http://www.dolphin-institute.org

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

U.S. Environmental Protection Agency National Listing of Fish Advisories: http://134.67.99.49

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

U.S. Geological Survey: http://www.usgs.gov

United States Coast Guard: http://www.uscg.mil

University of Hawai‘i: http://www.hawaii.edu

University of Hawai‘i School of Ocean and Earth Science and Technology (UH SOEST): http://www.soest.hawaii.edu

UH SOEST Main Hawaiian Islands Multibeam Synthesis: http://imina.soest.hawaii.edu/HMRG/multibeam/index.php

Western Pacific Fishery Management Council: http://www.wpcouncil.org

Woods Hole Oceanographic Institution: http://www.whoi.edu

Appendix A: Rating Scheme for System-Wide Monitoring Questions

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

The questions derive from the National Marine Sanctuary System's mission, and a system-wide monitoring framework (NMSP 2004) developed to ensure the timely flow of data and information to those responsible for managing and protecting resources in the ocean and coastal zone, and to those that use, depend on and study the ecosystems encompassed by the sanctuaries. They are being used to guide staff and partners at each of the 14 sites in the sanctuary system in the development of this first periodic sanctuary condition report. Evaluations of status and trends may be based on interpretation of quantitative and, when necessary, non-quantitative assessments and observations of scientists, managers and users.

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

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

The responses to the questions found in this report are based primarily on the effects or potential effects of pressures on the sanctuary as they relate to humpback whales and their habitat, which are the current responsibilities of the Hawaiian Islands Humpback Whale National Marine Sanctuary. With one exception (Question 3), they do not address concerns or resources over which the sanctuary does not have authority or other responsibility.

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

Water Stressors

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

This is meant to capture shifts in condition arising from certain changing physical processes and anthropogenic inputs. Factors resulting in regionally accelerated rates of change in water temperature, salinity, dissolved oxygen, or water clarity, could all be judged to reduce water quality. Localized changes in circulation or sedimentation resulting, for example, from coastal construction or dredge spoil disposal, can affect light penetration, salinity regimes, oxygen levels, productivity, waste transport, and other factors that influence habitat and living resource quality. Human inputs, generally in the form of contaminants from point or non-point 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 al, living resources and habitats.

Water Eutrophic Condition

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

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

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

Water
Human Health

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

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

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

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

Water
Human Activities

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

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

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

Habitat Abundance & Distribution

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

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

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

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

Habitat Structure

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

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

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

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

Habitat Contaminants

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

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

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

Habitat
Human Activities

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

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

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

Living Resources
Biodiversity

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

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

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

Living Resources Extracted Species

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

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

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

Other issues related to this question include whether fishers are using gear that is compatible with the habitats being fished and whether that gear minimizes 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.

Living Resources Non-Indigenous Species

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

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

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

Living Resources
Key Species

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

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

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

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

Living Resources
Health of Key Species

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

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

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

Living Resources
Human Activities

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

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

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

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

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

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

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

Maritime Archaeological Resources Integrity

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

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

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

Maritime Archaeological Resources Threat to Environment

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

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

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

Maritime Archaeological Resources Human Activities

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

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

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

Appendix B:
Consultation with Experts and Document Review

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

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

In order to address the 17 questions, sanctuary staff selected and consulted outside experts familiar with water quality, living resources, habitat, and maritime archaeological resources. A small workshop (around 10-20 participants) was convened where experts participated in facilitated discussions about each of the 17 questions. Experts represented various affiliations including Clancy Environmental Consultants, U.S. Environmental Protection Agency, Hawai‘i Department of Land and Natural Resources, Kalaupapa National Historical Park, Maritime Archaeology and History of the Hawaiian Islands Foundation, Regional Counsel Navy Region Hawai‘i Environmental Division, and the University of Hawai‘i Marine Option Program.

At the workshop, each expert was introduced to the questions, was then asked to provide recommendations and supporting arguments, and the group supplemented the input with further discussion. In order to ensure consistency with Delphic methods, a critical role of the facilitator was to minimize dominance of the discussion by a single individual or opinion (which often leads to “follow the leader” tendencies in group meetings) and to encourage the expression of honest differences of opinion. As discussions progressed, the group converged in their opinion of the rating that most accurately describes the current resource condition. After an appropriate amount of time, the facilitator asked whether the group could agree on a rating for the question, as defined by specific language linked to each rating (see Appendix A). If an agreement was reached, the result was recorded and the group moved on to consider the trend in the same manner. If agreement was not reached, the facilitator instructed sanctuary staff to consider all input and decide on a rating and trend at a future time, and to send their ratings back to workshop participants for individual comment.

The ratings and text found in the report are intended to summarize the opinions and uncertainty expressed by the experts, who based their input on knowledge and perceptions of local conditions. Comments and citations received from the experts were included, as appropriate, in text supporting the ratings.

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

The second phase of review, called Invited Review, involved particularly important partners in research and resource management, including representatives from the Hawai‘i Cooperative Fishery Research Unit, University of Hawai‘i, Maritime Archaeology and History of the Hawaiian Islands Foundation, NOAA Marine Debris Program, NOAA National Marine Fisheries Service, Office of National Marine Sanctuary Pacific Islands Region, Hawai‘i Department of Health, and the U.S. Navy. These bodies were asked to review the technical merits of resource ratings and accompanying text, as well as to point out any omissions or factual errors. The comments and recommendations of invited reviewers were received, considered by sanctuary staff, and incorporated, as appropriate, into a final draft document.

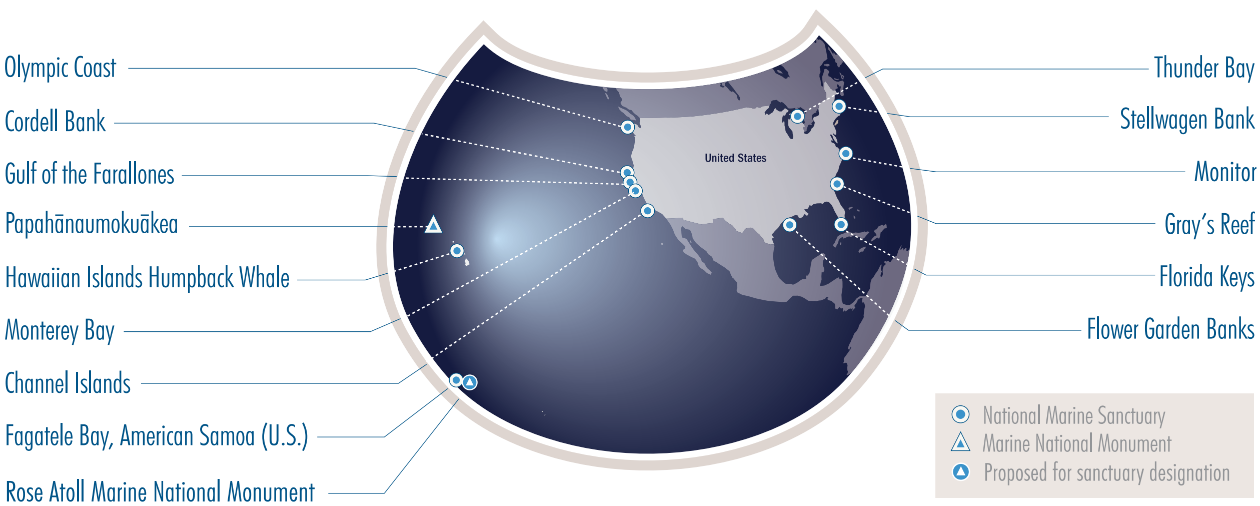
A draft final report was then sent to Dr. Robin W. Baird (Cascadia Research Collective), Dr. Cynthia Hunter (University of Hawai‘i), Dr. Marc O. Lammers (Hawai‘i Institute of Marine Biology) and Dr. Adam A. Pack (University of Hawai‘i at Hilo and The Dolphin Institute) who served as external peer reviewers. This External Peer Review is a requirement that started in December 2004, when the White House Office of Management and Budget (OMB) issued a Final Information

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

Notes

THE NATIONAL MARINE SANCTUARY SYSTEM

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



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

The Office of National Marine Sanctuaries is part of NOAA's National Ocean Service.

VISION – People value marine sanctuaries as treasured places protected for future generations.

MISSION – To serve as the trustee for the nation's system of marine protected areas to conserve, protect and enhance their biodiversity, ecological integrity and cultural legacy.