Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

National Marine Sanctuary System

CONDITION REPORT 2013

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REBECCA BLANK
Acting Secretary, U.S. Department of Commerce

KATHRYN SULLIVAN, Ph.D.
Acting Under Secretary of Commerce for Oceans and Atmosphere, National Oceanic and Atmospheric Administration

HOLLY BAMFORD, Ph.D.
Assistant Administrator, National Ocean Service

DANIEL J. BASTA
Director, Office of National Marine Sanctuaries

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AUTHORS ..... Stephen R. Gittings
Mitchell Tartt
Kathy Broughton

LAYOUT ..... Matt McIntosh

COPY EDITOR ..... Rosemarie McKeeby

National Marine Sanctuaries

Report in Short

Condition reports of the 13 national marine sanctuaries and Papahānaumokuākea Marine National Monument reveal general trends in resource condition, pressures and concerns, ways of addressing each, and accomplishments and gaps in conservation science for each sanctuary.

In this report, the status and trends of resource condition are evaluated across the National Marine Sanctuary System (system). Among the many pressures on the natural and archaeological resources in the system, a number stand out: marine debris entanglement, trapping and ingestion, loss of biodiversity, wildlife disturbance, ship strikes and water quality, to name a few. Sanctuaries report changes in key species, which warrant special attention because of their integral role in a balanced ecosystem. Most have documented troubling invasions by non-indigenous species that can displace native species, disrupt ecosystems and damage fisheries. Many present concerns about the effects of tourism, visitation and coastal development, which can cause intentional and unintentional impacts to sanctuary resources.

In the face of these pressures, sanctuaries are making important strides in resource protection through progressive, science-based management, targeted resource protection programs and engaging education and outreach activities. Developments in conservation science capabilities across the system continue to support significant management actions addressing pressures on sanctuary resources. However, limited budgets continue to prevent the conservation science program from reaching its full potential as an ONMS asset. It is clear that prioritization of and support for targeted monitoring and research is not only strategic, but imperative. Numerous monitoring, education and outreach programs that do occur could not be accomplished without the help of dedicated citizens who volunteer their time and talents. Partnerships and improved coordination with communities and local, state, federal, and territorial governments are uniformly recognized as vital to success in identifying and protecting our nation's special marine places.

Sanctuaries in Time

Milestones that changed our understanding of special ocean places and the resources they harbor.

TIMELINE

1760s

“Never doubt that a small group of thoughtful, committed citizens *can change the world;* indeed, it’s the only thing that ever has.”

— Margaret Mead

1778

British cartographer George Gauld begins mapping the Florida Keys and its reefs

English explorer Captain James Cook sailed the Olympic Coast

1840

Earliest suspected sightings by Pacific whalers of humpback whales in Hawaiian waters

1844

First recorded mass die-off of sponges in the Florida Keys

WHY A National Condition Report?

In 2013, NOAA's Office of National Marine Sanctuaries (ONMS) completed its first round of sanctuary condition reports for the National Marine Sanctuary System (system), with 14 individual condition reports now published. Each condition report describes the pressures facing the individual sanctuaries; the status and condition of water quality, habitat, and living and archaeological resources; and the ways in which managers are addressing pressures and problems. These reports are produced periodically to evaluate progress toward protecting and restoring resource quality and ecological integrity.

This report summarizes the pressures on and condition of the system's natural and archaeological resources. This report is based on the 14 individual sanctuary condition reports, and offers a summary of actions taken and planned in response to findings in those reports. The purpose of this report is to inform ONMS and its partners on priority issues and challenges facing the system as a whole, and to recommend actions to address them. ONMS intends to use the document to engage partners, political interests and academic organizations in discussions about challenges and opportunities facing the national marine sanctuaries; promote a better understanding of the system; and solicit support that furthers the program mission and addresses its priorities and needs.

Individually and collectively, sanctuary condition reports are used to direct the course of development and support for conservation science across the national system, as well as guide sanctuary-level conservation science programming, investment and decision making. By tracking the emergence of new pressures, the evolution of responses to existing

1853

Cordell Bank discovered by George Davidson, U.S. Coast Survey

1857

King Kamehameha IV voyages to Nihoa. Captain Paty explores islands to the northwest - Mokumanamana, Gardner Pinnacles, Laysan, Lisianski, and Pearl and Hermes

1885

Hawaiian Princess Lydia Lili'uokalani and a scientific expedition visit Nihoa on the ship *Iwalani*

pressures and successful mitigation efforts, ONMS can effectively prioritize and manage investments in science to support resource protection and management requirements. Condition reports serve as a powerful management tool to support that effort and keep the public informed and engaged in conservation efforts.

Unlike the individual condition reports, this report presents issues, findings, and solutions that are applicable to multiple sanctuaries, or are significant to the entire system. In addition to specific geographies, some discussions address conditions of specific resource types (e.g., non-indigenous species, maritime archaeological resources), or specific activities (e.g., fishing, shipping). The information presented summarizes the findings that were documented in sanctuary condition reports at the time of their publication. Some condition reports are now being updated in conjunction with the review and update of sanctuary management plans. Additional up-to-date information regarding a given sanctuary can be found at the end of this report, in sanctuary management plans, and on individual sanctuary websites.

Taken together, condition reports offer *insight* into the sanctuary system's most pressing ocean problems and their *solutions*.

1902

The Albatross Expedition conducts deep-water trawling in the Northwestern Hawaiian Islands and discovers new species of fishes and corals and takes the only photographs of the flightless, now extinct, Laysan Rail

1905

Start of more than 50 years of intense worldwide commercial whaling targeting humpback whales

Carnegie Institution Marine Laboratory established on Loggerhead Key, Dry Tortugas, Florida

1911 - 1912

'11 - Sea otters extirpated off the Washington coast by commercial pelt hunters

'12 - First canopy kelp survey in Olympic Coast

System-Wide Monitoring and Condition

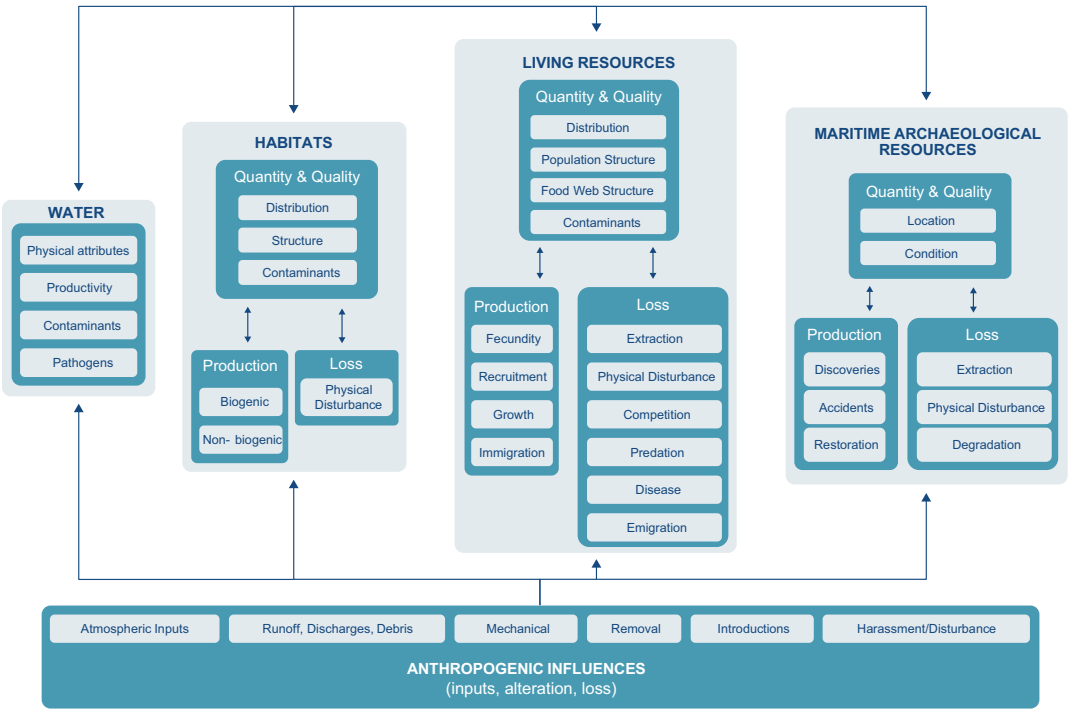


Figure 1: This diagram depicts the connectivity among four key areas of ecosystem structure and function, and the human influences that affect each. This concept is the backbone of the ONMS Condition Reports and the associated 17 resource questions.

Every marine protected area in the system has its own concerns and unique requirements for environmental monitoring, but ecosystem structure and function in all areas have many similar components that interact in comparable ways. Water quality, habitat, living resources, and archaeological resources represent four common areas of interest, regardless of geography or ecosystem. Each of these can be assessed based on resource quantity and quality and resource production and loss. Furthermore, the human influences that affect the structure and function of these areas are similar and need to be considered with respect to each component of the framework (Figure 1).

For these reasons, in 2001 ONMS developed a Monitoring Framework for the National Marine Sanctuary System, a document that proposes an approach to system-wide monitoring (SWiM). The implementation includes a design phase where existing and emerging issues are assessed with respect to current management and monitoring programs. From this, monitoring program design and implementation requirements are identified. This process was applied in several sanctuaries, including Flower Garden Banks, Gray's Reef, and Channel Islands. However, full implementation of monitoring programs at these sanctuaries has not taken place due to budget constraints. At other national marine sanctuaries, the SWiM design process has not been completed due to budget shortfalls. Nevertheless, where monitoring activities occur, they target requirements such as those identified in condition reports using either short- or long-term efforts. Numerous sanctuaries have monitoring efforts underway; however, no sanctuaries have in place a comprehensive SWiM program.

Despite the lack of a comprehensive monitoring program, ONMS has developed an approach for consistent reporting of resource conditions across sanctuaries. This includes the four primary components of the SWiM framework: water, habitats, living resources and maritime archaeological resources (Figure 1). For these resource types, specific questions are posed about their condition and the human activities that affect them. Each condition report addresses these questions and answers those that are relevant to the sanctuary. The questions allow for a consistent reporting

1922 - 1936

'22 - Last confirmed U.S. sighting of Caribbean monk seal, killed by a fisherman near Key West, Florida

'23 - The Tanager Expedition conducts biological surveys in the Northwestern Hawaiian Islands

'36 - First recorded discovery of Flower Garden Banks

1940 - 1960

'40 - Florida sponge fishery collapses when a disease decimates sponge populations.

'46 - International Convention for the Regulation of Whaling regulates commercial whaling of humpback whales

'60 - First diving exploration at Flower Garden Banks

1961 - 1969

'61 - Milton "Sam" Gray conducts biological surveys off the Georgia coast; Gray's Reef later named in his honor

'66 - International Whaling Commission Treaties ban harvesting of humpback whales

'69 - First reintroduction of Alaska sea otters to Washington State

Reports

> "When one tugs at a single thing in *nature*, he finds it attached to the rest of the *world*."
>
> — *John Muir*

method and help ONMS assess performance in relation to its resource protection mandates. In addition, the questions can be the starting point for designing a monitoring program or developing and directing partnerships that address them.

Responses to the 17 SWiM questions were prepared for each unit in the system. The responses were then presented in condition reports in a Pressure-State-Response model. Each report provides an overview characterization of resources at the sanctuary, the pressures on those resources, current resource status and trends, and management responses to pressures that threaten resource integrity (Figure 2). Resource status is rated in five categories on a scale from Good to Poor. Trends were also reported, indicating whether the status is improving, declining, or stable (Figure 3). All the condition reports can be found at: http://sanctuaries.noaa.gov/science/condition.

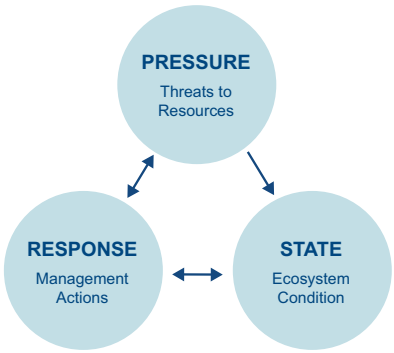


Figure 2: The Pressure-State-Response model that frames the structure of each ONMS Condition Report

CONDITION REPORT QUESTIONS

Water Quality

1. *Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality and how are they changing?*
2. *What is the eutrophic condition of sanctuary waters and how is it changing?*
3. *Do sanctuary waters pose risks to human health and how are they changing?*
4. *What are the levels of human activities that may influence water quality and how are they changing?*

Habitat Resources

5. *What are the abundance and distribution of major habitat types and how are they changing?*
6. *What is the condition of biologically-structured habitats and how is it changing?*
7. *What are the contaminant concentrations in sanctuary habitats and how are they changing?*
8. *What are the levels of human activities that may influence habitat quality and how are they changing?*

Living Resources

9. *What is the status of biodiversity and how is it changing?*
10. *What is the status of environmentally sustainable fishing and how is it changing?*
11. *What is the status of non-indigenous species and how is it changing?*
12. *What is the status of key species and how is it changing?*
13. *What is the condition or health of key species and how is it changing?*
14. *What are the levels of human activities that may influence living resource quality and how are they changing?*

Maritime Archaeological Resources

15. *What is the integrity of known maritime archaeological resources and how is it changing?*
16. *Do known maritime archaeological resources pose an environmental hazard and how is this threat changing?*
17. *What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?*

1970 - 1972

'70 - Humpback whales designated as "endangered" under the Endangered Species Conservation Act

'70 - Start of excavation of Ozette archaeological site, a Makah Tribe village on the Olympic Coast

'72 - Earliest assessment at East and West Flower Garden Banks indicate live hard coral cover of nearly 50 percent

1973 - 1976

'73 - Scientists locate USS *Monitor* 16 miles off Cape Hatteras, N.C.

'75 - White plague and white-band diseases begin to cause coral mortality throughout the Caribbean and Florida Keys

'76 - East Flower Garden Bank Brine Seep discovered

1977

Crown-of-Thorns starfish outbreak kills 90 percent of the corals in Fagatele Bay

Cordell Expeditions begins ten-year documentation of Cordell Bank

Acropora, the dominant reef-building coral on most Pacific reefs, discovered in the Northwestern Hawaiian Islands

> "Science is a *way of thinking* much more than it is a body of knowledge."
>
> — *Carl Sagan*

Status:	Good	Good/Fair	Fair	Fair/Poor	Poor	Undetermined
Trend:	▲ Improving	— Not changing	▼ Declining	? Undetermined trend	N/A Question not applicable	

Figure 3: Color coded ratings and directional arrows indicate the status and trends of sanctuary resources in site condition reports. These results are explored in detail in each condition report.

To answer the questions and prepare each condition report, sanctuary staff consulted experts (usually in a workshop setting) who were familiar with the resources and had knowledge of previous and current scientific investigations in the sanctuary. Evaluations of status and trends were based on interpretation of quantitative and, when necessary, non-quantitative assessments, as well as the observations of scientists, managers and users. The final ratings were decided by sanctuary staff, and authorship and responsibility remain with the sanctuary, with full acknowledgment of the experts.

In addition to reporting on the pressures, resource status and trends, and management responses, the reports identify strengths and successes in sanctuary management, gaps in current monitoring efforts, and causal factors that may require monitoring and man-

1978 - 1979

'78 - NOAA's National Marine Fisheries Service, U.S. Fish and Wildlife Service, and the State of Hawai'i initiate program to document the resources on islands, banks, reefs and seamounts of the Northwestern Hawaiian Islands

'79 - First large scale coral bleaching recorded in the lower Florida Keys

1980 - 1981

'80 - Research shows that the majority of humpback whales are found in the shallow waters (<100 fathoms) off the main Hawaiian Islands

'81 - Partnership with National Park Service established to conduct Channel Islands research, interpretation, education and enforcement

1982 - 1983

'82 - First assessments of fish and benthic communities at Gray's Reef

'83 - Caribbean-wide mass die off of long-spined sea urchin *Diadema antillarum*

'83 - First hydrographic survey of Gray's Reef

CONTRIBUTORS TO CONDITION REPORTS

Federal Programs (non-NOAA)

- *National Park Service*
- *U.S. Geological Survey*
- *Environmental Protection Agency*
- *U.S. Navy*

NOAA Program Offices

- *National Marine Fisheries Service and its regional science centers*
- *Marine Debris Program*
- *National Centers for Coastal Ocean Science*

State and Territorial Agencies and Programs

- *Departments of natural resources: fish and game, wildlife resources, enforcement*

Tribes

- *Intergovernmental Policy Council*

Private Organizations

- *Consulting companies*
- *Museums*
- *Non-profit organizations*

Academic Institutions

- *Universities*
- *Colleges*
- *Research institutions*

For complete information on all contributors to sanctuary condition reports, see Acknowledgments and/or Appendix B in each report.

agement action. Reports were commonly used to support sanctuary management plan reviews, inform sanctuary advisory councils and working groups, train volunteers, and educate the public.

Limitations of Method

Ratings within the Good-to-Poor system (Figure 3) used for condition reports may not necessarily indicate that the experts agreeing to those ratings did so with equal confidence. Combining expert judgment with data and information of different levels should provoke caution in interpreting the findings. A rating based on a large amount of published data is likely to be more reliable, for example, than one based on anecdotal observations alone, even if those observations are made by experts. ONMS strives to use the best available data and information when drafting each condition report and determining the findings, ratings, and basis for judgments. Inevitably, however, there is variability in quantity and quality of data and information, and this must be considered when drafting the reports and subsequently using them to inform management decisions. To assist readers, we attempted to state clearly in the reports the types of information used to decide ratings, and, in many cases, asked experts to rate both their basis for judgment and confidence in those ratings. This is intended to help those who use the information in making management and program development decisions to critically compare findings that are, in varying degrees, subjective.

1984

Point Reyes Bird Observatory begins shoreline surveys for beached birds following spill from T/V *Puerto Rican* in Gulf of the Farallones

Estimated 10 percent of worldwide humpback whale population remains (only 10,000-12,000 whales)

1985 - 1986

'85 - Small boat *Xantu* begins operations at Channel Islands

'85 - First algae assessment, community metabolism and nutrient flux studies at Gray's Reef

'86 - Restoration of extirpated Common Murre breeding colony following oil spill by Barge *Apex Houston* in Gulf of the Farallones

1987

First published biological assessment of Fagatele Bay

Second recorded large-scale bleaching of corals in the Florida Keys

Gulf of the Farallones hosts its first research symposium

SANCTUARY

Olympic Coast (2008) Water quality in the sanctuary is generally good, possibly reflecting its isolation from major urban and industrial complexes. Benthic habitats have been degraded by bottom-contact fishing gear, and living resource conditions reflect an ecosystem that has been severely altered with respect to historical values. Non-indigenous species such as *Sargassum* seaweed and tunicates are continuing to spread. Principal threats to maritime archaeological resources within the sanctuary come from unauthorized salvage and damage from contact with fishing gear.

Cordell Bank (2009) Due to the offshore nature of Cordell Bank and the distance from urban areas, most water quality parameters suggest relatively good conditions. Benthic habitat quality has been impacted over the years by bottom-contact fishing gear, and many derelict long lines and gill nets remain entangled on rocky areas of the bank. Living resource conditions within the sanctuary are considered to be diminished due to depleted populations of some species.

Gulf of the Farallones (2010) The sanctuary's coastal and offshore resources appear to be in relatively good condition. Water quality parameters are of some concern in the offshore area, primarily due to the pressures from vessel traffic (e.g., noise and discharges) and nearby urban areas. In contrast, conditions are rated lower for resources in the sanctuary's estuaries and lagoons. Introduced species have negatively affected estuarine native biodiversity, and land use pressures have altered sediment and freshwater in-flow.

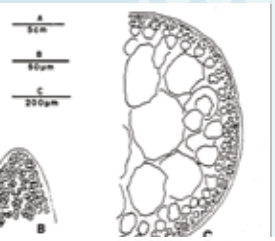
Papahānaumokuākea (2009) Due to the monument's remoteness and regulations limiting access, there are relatively few impacts from local human uses. Habitats are generally in good condition, although some have been altered by past activities. Resources within the monument can also be degraded by problems originating outside the monument, such as marine debris (e.g., litter, fishing gear). Other concerns include climate change and coral bleaching, diseases affecting marine organisms, and non-indigenous species.

Monterey Bay (2009) Offshore and nearshore environments are generally in Good to Fair condition. Populations of habitat-forming organisms such as surfgrass, kelps and sponges are healthy in the nearshore environment. Abundance is reduced for some species such as rockfish, salmon, and some seabird and mammal species. Proximity to dense population centers and agriculture is a stressor on nearshore water quality, and beach water quality issues are observed within the sanctuary. Sanctuary resources in the estuarine environment of Elkhorn Slough are in Fair to Poor condition, highlighting the importance of ongoing multi-agency efforts to restore estuarine habitats and improve water quality and health of living resources.

Hawaiian Islands Humpback Whale (2010) Water quality in the sanctuary is currently not likely to pose a threat to humpback whales. Humpback whale abundance is increasing within the sanctuary. However, reports of entanglement and whale-vessel collisions have also increased and been identified as immediate and pressing issues for the sanctuary. Although humpback whale habitat remains widely available at present, some preferred habitat could be impacted due to offshore development activities.

Channel Islands (2009) Water quality in the sanctuary is generally good due to the sanctuary's offshore location and distance from major urban population centers. Habitat quality and living resource conditions have been degraded by a range of human activities, changing ocean conditions and disease. Principal threats to maritime archaeological resources include looting, natural degradation and potential damage from fishing gear and anchors.

1988



Publication of the first illustrated field and laboratory guide for the seaweeds of Gray's Reef

Long term monitoring program at East and West Flower Garden Banks established

1989

Publication of the first illustrated guide to the fishes of Gray's Reef

First annual aerial survey of canopy kelps in Olympic Coast

1990

NOAA's conducts biological survey of the USS *Monitor*

Third large-scale coral bleaching in the Florida Keys

First mass spawning of Atlantic corals observed at Flower Garden Banks

Water Quality Protection Program established for Florida Keys

Snapshots

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

Thunder Bay (2013) The condition of the sanctuary's maritime archaeological resources is considered to be good. Some human-use pressures, such as anchoring, have been mitigated through effective management and education programs. However, other pressures, such as impacts from non-indigenous species, are more difficult to control. Research conducted by the sanctuary and its partners is producing a better understanding of the state of sanctuary resources and the pressures on them, as well as establishing a baseline for future monitoring. In general, water quality in the sanctuary as it relates to public access to maritime archaeological resources is considered to be Good/Fair.

Stellwagen Bank (2007) Most water quality parameters in the sanctuary appear to suggest relatively good conditions; however, habitat quality has been degraded over many years, primarily as a result of long-term use of bottom-contact fishing gear. Living resource conditions have been declining, and surface-dwelling marine mammals are at risk for vessel strikes and entanglements. The main threat to maritime archaeological resources comes from bottom-contact fishing gear.

Monitor (2008) The sanctuary is in good condition overall, but the *Monitor* is at risk from both human activity and natural deterioration. Prohibited activities such as looting, vessel anchoring and bottom trawling are not major problems, but they are still a cause for concern due to significant diving, boating and fishing activity in the area. The *Monitor* has become a productive habitat; however, limited data are available on living marine resources within the sanctuary, and currently no consistent monitoring is being conducted. Water quality in the sanctuary is generally good, with no evidence of any risks to human health.

American Samoa (2007) Water quality in Fagatele Bay is generally good, but declining. Higher water temperatures in recent years have led to an increase in frequency of coral bleaching events. Resilient coral populations and high biodiversity indicate fairly good habitat conditions, but destructive fishing activities have harmed some areas of the reef. Selective fishing practices have decreased abundance of large predatory fish within the sanctuary, which could have harmful effects on the ecosystem as a whole. *Note: In 2012, NOAA expanded Fagatele Bay National Marine Sanctuary (FBNMS) and renamed it National Marine Sanctuary of American Samoa. The FBNMS Condition Report is specific to Fagatele Bay and does not include the expanded region.*

Gray's Reef (2008; Addendum in 2012) Sanctuary waters show little indication of human-caused degradation, although researchers have detected low levels of human-produced pollutants in the sanctuary's sediments and filter-feeding organisms. Habitats are in good condition despite localized impacts from some human activities. Living marine resources have been impacted by human activities such as anchoring, recreational fishing, and spearfishing. A 2012 addendum to the 2008 condition report found that water quality was still good and not changing. Habitat quality was upgraded to good (generally near-pristine, but with local impacts), and in recent years there were fewer species overfished or undergoing overfishing than in 2008 (upgraded to Fair). There are invasive lionfish in the sanctuary. Significant monitoring gaps remain.

Flower Garden Banks (2008) In general, the condition of most sanctuary resources was found to be relatively good, another sanctuary that benefits from isolation. High levels of benthic cover at the East and West FGB's remain consistent with conditions found in the 1970's; however, bleaching and hurricane events may have led to loss of important benthic components at Stetson Bank. Areas of concern include recent findings of high levels of ciguatoxin and mercury in certain fishes, increases in the level of fishing, and apparent decreases in certain fished species. Lionfish were not present at time of publication of the FGBNMS Condition Report. Consequences of this invasive species on the ecosystem within sanctuary boundaries and the region are of great concern.

Florida Keys (2011) Generally, the status and trends of the resources protected by the sanctuary reflect the inherited condition of a system that has been heavily exploited during the past century; many of the historically abundant species and biogenic habitats had already been severely altered or reduced when the sanctuary was designated. Resource managers are working to conserve pieces of the former ecosystem so that it can be restored to an improved state.

1992

Gulf of the Farallones begins 20-year rocky intertidal monitoring

Aquarius, the world's only operating undersea research laboratory, deployed in Florida Keys

1993

Beach Watch volunteer monitoring program begins in Gulf of the Farallones

Stetson Bank long-term monitoring initiated in Flower Garden Banks

Aerial surveys support earlier findings that inshore waters are preferred habitat for Hawaiian humpbacks

1994

Mass coral bleaching in American Samoa

R/V *Tatoosh* begins service at Olympic Coast

Multibeam sonar used to map bathymetry and characterize benthic sediments at Stellwagen Bank

National Status and Trends
Summaries and Performance

ONMS annually reports to the Office of Management and Budget on three of its program performance measures, which evaluates its goals to maintain or improve the conditions of water quality, habitat and living resources in national marine sanctuaries and monuments. Annually reporting on progress towards these measures is supported by sanctuary condition reports as well as more current information from science staff across the sanctuary system. Looking broadly across the system, sanctuaries tended to rate conditions for water quality higher than habitat and living resources. They also rated habitat quality higher than living resource quality. Most reports discuss the differing qualities of offshore and nearshore areas. For sanctuaries that rated offshore and nearshore environments separately (Monterey Bay and Gulf of the Farallones), degraded conditions, especially with respect to water quality, were highlighted in estuaries. Ratings of habitat and living resource conditions often reflected impacts and degradation from human activities (e.g., coastal development, destructive fishing techniques) that preceded designation of the sanctuary. However, due to the pervasive and severe nature of these impacts, they are still relevant.

WATER

1. Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality and how are they changing?
2. What is the eutrophic condition of sanctuary waters and how is it changing?
3. Do sanctuary waters pose risks to human health and how are they changing?
4. What are the levels of human activities that may influence water quality and how are they changing?

HABITAT

5. What is the abundance and distribution of major habitat types and how is it changing?
6. What is the condition of biologically structured habitats and how is it changing?
7. What are the contaminant concentrations in sanctuary habitats and how are they changing?
8. What are the levels of human activities that may influence habitat quality and how are they changing?

LIVING RESOURCES

9. What is the status of biodiversity and how is it changing?
10. What is the status of environmentally sustainable fishing and how is it changing?
11. What is the status of non-indigenous species and how is it changing?
12. What is the status of key species and how is it changing?
13. What is the condition or health of key species and how is it changing?
14. What are the levels of human activities that may influence living resource quality and how are they changing?

MARITIME ARCHAEOLOGICAL RESOURCES

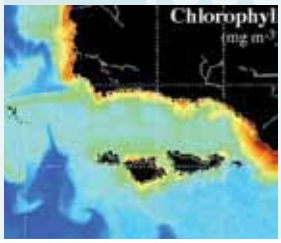
15. What is the integrity of maritime archaeological resources and how is it changing?
16. Do maritime archaeological resources pose an environmental hazard and is this threat changing?
17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

1995

R/V *Ballena* begins service in Channel Islands

Long-term monitoring of seagrass, coral and water quality begins in Florida Keys

1996



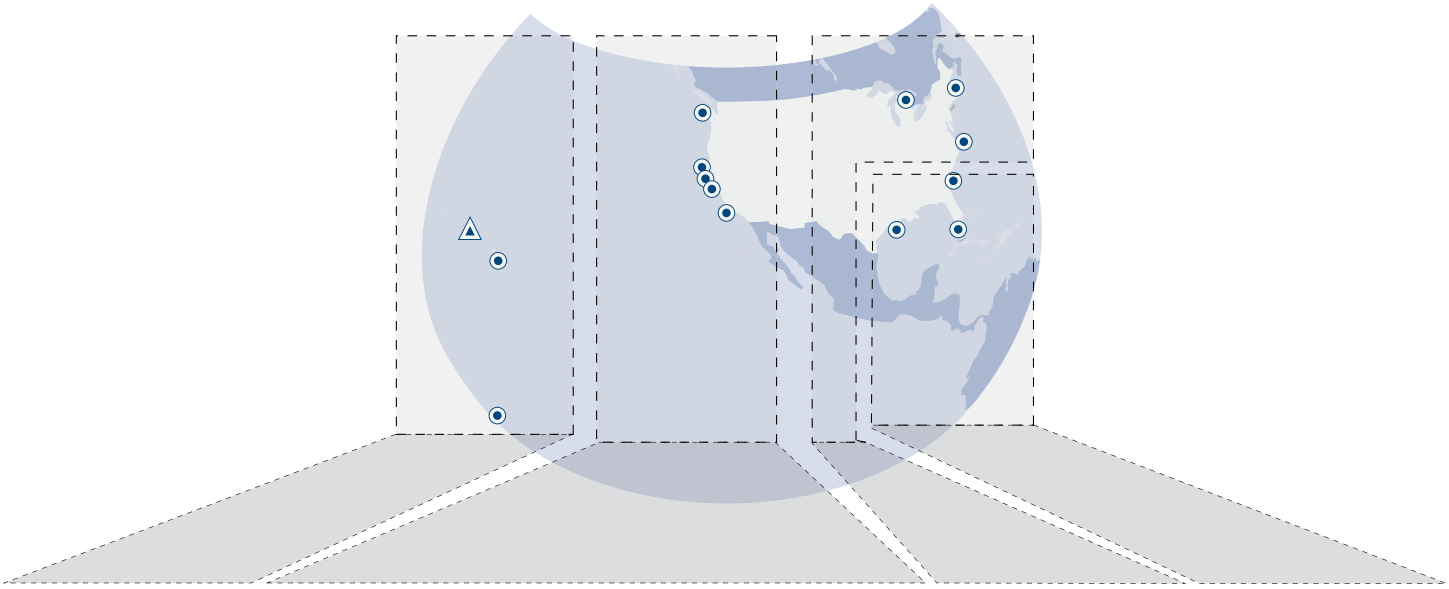
Channel Islands begins supporting University of California Santa Barbara Plumes and Blooms water monitoring project

Florida Keys begins examining biological responses to marine zones

Ten-volume set of site characterization for the Florida Keys released

Sanctuary Ocean Count enables Hawai'i residents and visitors to conduct yearly shore-based census of humpbacks during breeding season

Beach Watch volunteers conduct wildlife and damage assessment surveys following Cape Mohican oil spill



PACIFIC ISLANDS REGION			WEST COAST REGION								NORTHEAST REGION			SOUTHEAST REGION		
Papahanau-mokuakia	Hawaiian Island Humpback Whale	Fagatele Bay	Olympic Coast	Cordell Bank	Gulf of the Farallones: Coastal & Offshore	Gulf of the Farallones: Estuarine & Lagoon	Monterey Bay: Offshore	Monterey Bay: Nearshore	Monterey Bay: Estuarine	Channel Islands	Thunder Bay	Stellwagen Bank	Monitor	Gray's Reef	Florida Keys	Flower Garden Banks
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Status:	Good	Good/Fair	Fair	Fair/Poor	Poor	Undetermined
Trend:	▲ Improving	— Not changing	▼ Declining	? Undetermined trend	N/A Question not applicable	

1997

Channel Islands begins aerial surveys to monitor human use

NOAA and State of Florida implement the nation's first large-scale marine zoning plan in Florida Keys

Significant bleaching event in the Florida Keys

A new species, the Mardi Gras Wrasse (*Halichoeres burekae*) discovered at Flower Garden Banks

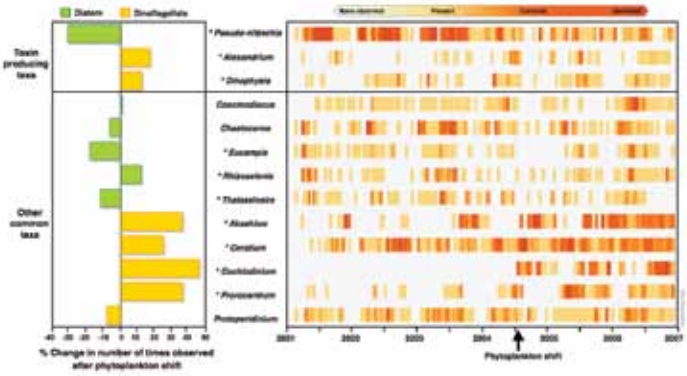
First comparison of fish populations in Gray's Reef to similar habitats off the Southeastern United States

Beach COMBERS initiate monthly volunteer beach surveys in Monterey Bay sanctuary

1998

Socioeconomic research and monitoring begins in Florida Keys in order to document use patterns and impacts on resource value

USS *Monitor* propeller recovered in collaboration with U.S. Navy



Water Quality

Some sanctuaries contain nearshore waters with constrained circulation and are in areas with high levels of human activity (e.g., mangroves in Florida Keys, estuaries in Monterey Bay and Gulf of the Farallones). These tend to have poorer water quality than offshore areas. Nutrient and contaminant loading from runoff and point source pollution related to human activities, particularly in the coastal zone, affect nearshore waters and pose significant challenges to management. Most offshore sanctuaries reported more favorable conditions, especially with respect to eutrophication and potential risks to human health. Two sanctuaries (Fagatele Bay and Florida Keys) and the Papahānaumokuākea Marine National Monument reported increasing water temperatures, potentially attributable to climate change. This is an issue many sanctuaries identified as an emerging concern that would likely influence status ratings in future condition reports.

Sanctuaries generally rated water quality condition higher than habitat and living resources. The factor most influencing water quality is proximity to human development.

Habitat

Commercial and recreational bottom-contact fishing has significantly decreased in many sanctuaries. Nevertheless, historic impacts from bottom-contact fishing gear continue to influence habitat condition and trends in sanctuaries across the system. This is most evident in the west coast sanctuaries and Stellwagen Bank. Sanctuaries where fishing is limited by habitat, resource availability, or regulations reported better conditions; however, trends were often rated as decreasing, and were attributed to other human induced pressures including marine debris, non-indigenous species, disease, coastal development, extraction, poor visitation practices, anchor damage and sedimentation. In several cases, coastal development and urban runoff were identified as leading pressures to habitat resources. This is particularly evident in the Florida Keys.While most sanctuaries made determinations relative to habitat resources, many sites noted a need for improved data, such as high resolution habitat maps documenting classifications and distribution of habitat within their boundaries.

Human activities predating establishment of national marine sanctuaries continue to pose significant challenges to management.

First study of species diversity of benthic invertebrate fauna at Gray's Reef

Seabird Protection Network established by Gulf of the Farallones to reduce disturbance to seabird colonies throughout California

Coral bleaching events at Flower Garden Banks and Florida Keys

2000

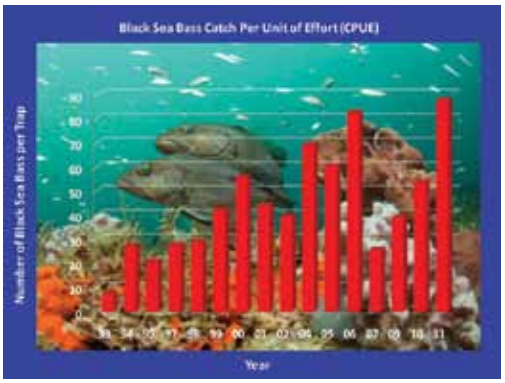
Channel Islands begins supporting Partnership for Interdisciplinary Studies of Coastal Oceans fish monitoring in sanctuary

Olympic Coast begins monitoring program using subs and remotely operated vehicles to document seafloor recovery after trenching for fiber optic cables

2001

Cordell Bank begins four-year benthic habitat and community characterization using Delta submersible

First high-resolution side-scan and multibeam survey collected at Gray's Reef



Living Resources

Conditions of living resources in sanctuaries involved assessment of indicators such as biodiversity, key species and non-indigenous species. Sanctuaries reporting biodiversity loss generally based ratings on reduced abundances of key species (e.g., eelgrass, top level predators), increasing frequency of ship strikes and entanglements of whales, and changing intensity or frequency of harmful algae blooms, coral bleaching and disease. The impacts of non-indigenous species (e.g., certain corals, lionfish, Humboldt squid) on the current status of sanctuary resources was found to be low to moderate across the system; however, a number of sites noted a trend of increasing impacts (e.g., Monterey Bay, Papahānaumokuākea, Florida Keys). Available information and data about these issues vary in quantity and quality across the system. In most cases, ONMS relies heavily on support and information from partnering agencies to address essential monitoring and management actions.

Across the system, status relating to the question of the environmental sustainability of fishing was generally Fair to Poor, in recognition of the cumulative impacts of sometimes long histories of fishing. However, trends were frequently reported as improving (e.g., west coast sanctuaries and Gray's Reef), primarily as a result of more effective management. These trends reflect the importance and efficacy of continuing collaborative efforts with NOAA's National Marine Fisheries Service, regional Fishery Management Councils, and state and territorial fisheries agencies.

Challenges to improve living resource quality are significant. Many ecosystem processes operate at scales beyond sanctuary boundaries: migratory patterns and movement of key species, regional climate variation, and increasing ocean use.

Maritime Archaeological Resources (MAR)

The primary distinction between MAR and the categories above is the non-renewability of these resources. Damage to these resources is permanent. Their protection, therefore, requires a level of vigilance that prevents damage rather than simply limiting it. There were a considerable number of "undetermined" ratings across the system for both status and trends of MAR. For those sanctuaries that did define a rating, most reported a "declining" trend (e.g., Channel Islands, Thunder Bay, Stellwagen Bank, Florida Keys, Papahānaumokuākea, Hawaiian Islands Humpback Whale), for reasons that included looting, damage from anchoring, and corrosion. Most sanctuaries did not consider MAR to pose significant threats to the environment or to human health, particularly where they are known or suspected to lack hazardous materials. For sanctuaries with high uncertainty about MAR integrity and the human activities that affect them, it is clear that more rigorous monitoring and assessment programs are needed.

Because any damage to MARs is permanent, different approaches to protection than those for natural resources may be necessary.

Batten Conservation Laboratory opened at The Mariners' Museum to conserve, preserve and display USS *Monitor* artifacts.

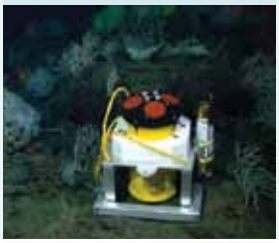
USS *Monitor's* steam engine recovered in cooperation with U.S. Navy

2002

California Fish and Game Commission establishes marine reserve network, including ten percent of sanctuary waters

Invasive species, orange cup coral, *Tubastraea* sp., discovered at Flower Garden Banks

First benthic infauna survey at Gray's Reef



Hawaiian Islands Large Whale Entanglement Response Network, a collaboration between state and federal agencies, local whale researchers, tourism industry, fisherman and citizens, is established

Expedition to Davidson Seamount, just outside Monterey Bay sanctuary

What Concerns Us?

Across the National Marine Sanctuary System, the diversity of pressures and threats to sanctuary resources is notable. The diversity and scope of these issues present significant challenges with regard to resource allocation and staffing. In condition reports, partnerships were identified across the system as fundamental for successful and effective research, monitoring and resource protection programs. Restricted budgets for sanctuaries and many of our partners continue to pose challenges, highlighting the need for enhanced collaborations and the identification of common priorities that can be successfully addressed with limited resources.

Issues addressed in this section represent both challenges and opportunities: challenges to face these seemingly insurmountable issues, and opportunities to capitalize on the collective capabilities and assets of the system, NOAA and committed partners. Some issues are unique to a particular resource type; some are common to multiple sanctuaries. Table 1 presents a summary of this information. For additional information on these issues, or specific pressures/threats and responses at a particular sanctuary, see the condition report for that sanctuary.

> **"Conservation is a *state of harmony* between men and land."**
>
> *— Aldo Leopold*

USS *Monitor*'s gun turret recovered in cooperation with U.S. Navy, along with thousands of artifacts and the remains of two sailors

Olympic Coast works with University of Washington to begin citizen scientist beach monitoring and Reef Environmental Education Foundation to monitor fish and invertebrates

Location of historic shipwreck *Portland* confirmed in Stellwagen Bank sanctuary

First mass-bleaching event hits corals in the Northwestern Hawaiian Islands; 40 scientists, educators, cultural practitioners, and managers participate on Reef Assessment and Monitoring Program cruise

2003

R/V *Shearwater* begins supporting research and education in Channel Islands

First discovery of live Acropora palmata at West Flower Garden Bank (two years later at East Bank)

First survey of vertical distribution of larval and post-larval fishes at Gray's Reef

Pressures \ Sanctuary or Monument	Pacific Islands			West Coast					NE and Great Lakes			SE and Gulf of Mexico			Examples
	Papahānaumokuākea	Hawaiian Islands	American Samoa	Olympic Coast	Cordell Bank	Gulf of Farallones	Monterey Bay	Channel Islands	Thunder Bay	Stellwagen Bank	Monitor	Gray's Reef	Florida Keys	Flower Garden Banks	
Marine Debris	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Entanglement, ghost fishing, ingestion
Changing Abundances of Key Species	•	•	•	•	•	•	•	•		•		•	•	•	Marine mammals, corals, krill, sea urchins
Non-Indigenous Species	•			•	•	•	•	•	•	•	•	•	•	•	Lionfish, zebra mussels, green crabs, *Undaria*, orange cup coral
Fishing Impacts	•		•	•	•	•	•	•		•		•	•	•	Historical practices, bottom contact gear, by-catch
Spills	•	•		•	•	•	•	•		•			•	•	Ships, shore facilities
Tourism and Visitation	•		•	•		•	•	•	•	•	•	•	•	•	Trampling, anchoring, diving, overflight
Coastal Uses		•	•	•		•	•		•	•		•	•		Armoring, urbanization, agriculture
Ship Strikes		•			•		•	•		•			•	•	Injury and mortality to whales, manatees, whale sharks
Archaeological Resource Degradation	•			•		•	•	•	•	•	•		•		Corrosion, salvage, looting
Offshore Industry		•		•				•		•				•	Oil and gas, aquaculture, cables
Degraded Water Quality				•			•		•				•	•	Bacterial loads, runoff, harmful algal blooms
Emerging Threats															
Climate Change	•	•	•	•	•	•	•	•	•	•		•	•	•	Temperature, sea level, and changes in phenology
Ocean Acidification	•			•	•		•	•		•			•	•	Reduced calcification rates, impacts to food webs and ecosystem services
Noise		•		•	•	•	•	•		•				•	Vessels, sonar, air guns, aircraft

Table 1. Pressures across the National Marine Sanctuary System. Dots indicate the pressure was presented in the sanctuary condition report, and pressures are listed from most to least commonly reported at the time of publication. For additional information on these pressures, or sanctuary specific pressures/threats and responses, please see the condition report for that particular sanctuary.

Hawaiian Islands Humpback Whale sanctuary coordinates largest whale research project ever; Structure of Population, Level of Abundance, and Status of Humpbacks

Sanctuary Integrated Monitoring Network web site launched in Monterey Bay sanctuary

Titanic discoverer Robert Ballard films sanctuary's historic shipwrecks in high definition

2004

Cordell Bank and Gulf of the Farallones work with Point Reyes Bird Observatory to study links between ocean processes, zooplankton, and marine birds and mammals as part of Applied California Current Ecosystem Studies program

Marine Debris, Entanglement, Ghost Fishing

Marine debris is defined as any persistent, manufactured, or processed solid material that is directly or indirectly, intentionally or unintentionally, disposed of or abandoned in the marine environment. It can include a wide variety of objects (e.g., construction material, derelict fishing gear, lost vessel cargo, plastics) from multiple sources (e.g. storm water runoff, landfills, rivers, recreational and commercial activities). Collectively, marine debris threatens the marine environment and resources, human health, and safe navigation. Ingestion and entanglement of marine debris may lead to death in animals like turtles, marine mammals, birds, and benthic organisms. Entanglement may result in drowning, starvation, physical trauma, systemic infections, or increased susceptibility to other threats such as ship strikes. Further, marine debris can alter the structure of habitats, and lost or discarded fishing gear continue catching and killing fish ("ghost fishing") for years if left in the ocean.

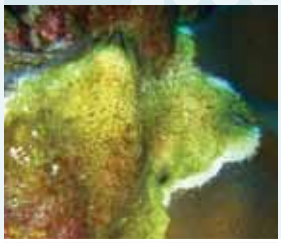
Every national marine sanctuary, including those in isolated locations, faces challenges with respect to managing the impacts from marine debris, and the issue stands as one of the most prevalent across the system. Efforts to address these challenges vary among sanctuaries and can include focused surveys to better understand distribution and abundance of debris, removal and mitigation efforts (e.g., beach clean-ups, "ghost gear" removal) and targeted education and outreach programs to highlight the importance of community involvement and personal action. None of these efforts were presented as comprehensive solutions, but they represent effective steps to mitigate impacts. Developing partnerships with local, state, territorial and federal agencies to leverage resources and create opportunities for volunteers and citizen scientists to contribute time and expertise was uniformly regarded as critically important.

Changing Abundances of Key Species

Key species that influence the health and structure of their ecosystem are often referred to as "keystone" and "foundation" species. "Keystone" species are those on which the vitality of a large number of other species depends; they are pillars of community stability. Their contribution to ecosystem function is disproportionate to their numerical abundance or biomass (e.g. corals, sea otters, top level predators). "Foundation" species such as krill, kelp and forage fish such as anchovies and sardines also control much of the structure of a community and influence the abundance and biomass of many other species. They exhibit similar control over ecosystems as

NOAA ship *Hi'ialakai* commissioned in Honolulu; first project is 35-day Reef Assessment and Monitoring Program cruise

2005



Coral bleaching and coral disease events in Flower Garden Banks sanctuary; Stetson Bank shows decline in important benthic components

Monitoring of ship traffic begins at Stellwagen Bank, using Coast Guard's Automatic Identification System

Historians and natural scientists begin to collaborate on study of historical abundance and diversity at Stellwagen Bank

Non-indigenous Species

Non-indigenous species, also called alien, exotic, non-native, or introduced species, are animals or plants living outside their native distributional range, having arrived there by human activity, either deliberate or accidental (e.g., ballast water exchange, restaurant waste disposal, trade in exotic species for aquaria). Non-indigenous species that have damaging effects on ecosystems are called "invasive" species. These impact the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities in the vicinity.

Problems with non-indigenous species were reported by most marine sanctuaries. Some species have been established for a long time. Others, such as the Indo-Pacific lionfish, have yet to reach their full range or full impact on Atlantic, Gulf of Mexico and Caribbean ecosystems. Gray's Reef and Florida Keys document their presence in condition reports. More recently, they are being found in increasing abundances on the Flower Garden Banks. Sanctuaries with semi-enclosed areas (bays and estuaries) reported significant ecosystem impacts from other non-indigenous species. The invasion of zebra and quagga mussels in the Great Lakes has fundamentally changed not only their ecosystems, but the huge masses of growth have degraded the integrity of many shipwrecks in Thunder Bay. Apparently benign instances of non-indigenous species include the acorn barnacle at Gray's Reef and orange cup coral at Florida Keys.

Regardless of impacts, the topic of non-indigenous species is of concern at most sanctuaries, and specific management actions are needed. In some cases these are underway and include studies to better understand the biology of specific species, develop early warning programs, reduce recruitment potential, and mitigate impacts from established species. Such actions include developing volunteer based monitoring programs, establishing new partnerships for sustained mitigation and removal, implementing new policies to limit contributing activities (e.g., ballast water discharge), and conducting broad-reaching education and outreach efforts to increase public understanding of the issue and the potential impacts.

keystone species, but their high abundance distinguishes them and determines their level of influence. Changes in the condition or abundance of keystone or foundation species can transform ecosystem structure through dramatic increases or decreases in abundance of dependent species.

All twelve sanctuaries with responsibility over natural resources reported on the conditions of keystone and foundation species. Their responses included information on living resources such as krill, forage fish, and mammals that are used by managers as indicators of overall ecosystem health and integrity. While the condition of most of these important species was reported to be relatively stable, some sanctuaries noted historical decreases that have led to broader ecosystem level changes (e.g., cod and river herring at Stellwagen Bank, krill along the west coast, monk seals in the Hawaiian Islands, and *Diadema* in Florida Keys). Other sanctuaries indicated significant successes relative to keystone and foundation species, including increasing populations of humpback whales at Hawaiian Islands Humpback Whale sanctuary, giant sea bass and lobsters at Channel Islands, and predatory fish and corals at Papahānaumokuākea and the Florida Keys.

2006

Biodiversity and derelict fishing gear data at Cordell Bank result in Essential Fish Habitat Conservation Area designation

NOAA's National Marine Fisheries Service Fisheries lists two corals (*Acropora cervicornis* and *A. palmata*) as "Threatened" under the Endangered Species Act.

Discoveries at Flower Gardens include manta rays traveling between banks, mass spawning of sponges, and fossil *Acropora* reefs

Biogeographic comparison of sponge fauna from Gray's Reef and other hardbottom reefs off coastal Georgia

Diamond Shoals Data Buoy installed in Monitor sanctuary, providing real-time water and weather data.

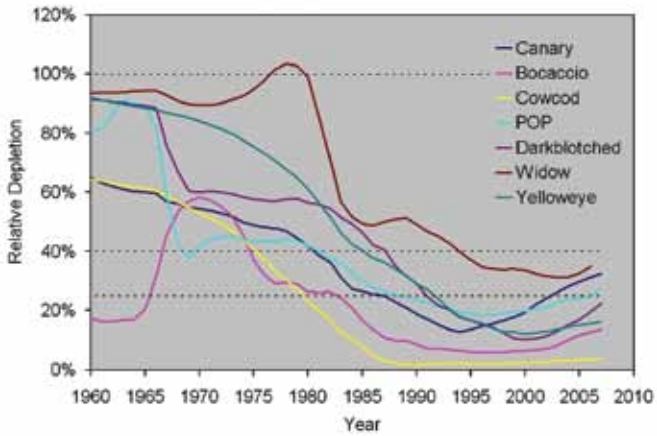
R/V *Fulmar* begins service in West Coast Region

Fishing Impacts

Both historical and current fishing activities pose diverse challenges to the management of sanctuary resources and the protection of biodiversity and ecosystem health. Fishing activities affect sanctuary resources through direct take, by-catch, and habitat damage from the use and loss of fishing gear. The removal of targeted species and coincident mortality of non-target species (by-catch) may result in complex and confounded ecological effects. Because fishing can also be size-selective, concerns exist about ecosystem disruption by removal of ecologically-important age classes and key species of top predators (e.g., groupers, snappers, sharks, jacks).

All sanctuaries with management responsibility for the protection of natural resources reported fishing as a significant pressure. Status ratings related to fishing represent the current understanding of the degree of change that has occurred over time relative to how sanctuary ecosystems functioned in a more pristine state. Many sanctuary ecosystems have been degraded by decades of overfishing and habitat loss and current activity may inhibit full community or ecosystem development and function.

The status ratings themselves should not be confused with assessments of current fishery conditions or fishery management practices. Many sanctuaries noted that recent fishery management actions have started to have positive effects on sanctuary resources. Improving trends appear to be associated with designations of Essential Fish Habitats (EFH) and Habitat Areas of Particular Concern (HAPC), establishment of marine reserves, and area closures (e.g., those found in California marine sanctuaries, Florida Keys). In addition, sanctuaries reported a decrease in secondary impacts resulting from fishing activities (e.g., habitat disturbance and loss, by-catch, and gear loss). In general, positive trends in fishery resources were attributed to fishery management actions aimed at reducing fishing mortality (e.g., size and bag limits, quotas, moratoriums) and increasing use of ecosystem-based management practices, including those required by recent amendments to the Magnuson-Stevens Act. These require that major ecosystem components and services be taken into account in making fisheries management decisions.



Spills

Various types of spills (but primarily petroleum and other chemicals) can pose significant pressures for marine ecosystems. For marine sanctuaries, these are likely to emanate as point sources from ships or shore-side facilities. For Flower Garden Banks and Channel Islands sanctuaries, the sources could also include damaged petroleum pipelines or platforms, either inside or outside sanctuary boundaries. Sanctuaries have experienced hydrocarbon spills from grounded or sunken vessels often originating from locations outside sanctuary boundaries. The effects can be lethal or sublethal and include contamination of shallow habitats and water, physiological impacts to animals and plants and their food sources, smothering of intertidal organisms, and coating of surface dwellers like seabirds and marine mammals. Furthermore, spills sometimes require responses that include mechanical recovery or chemical dispersion, potentially impacting additional resources.

All marine sanctuaries with either shallow habitats or shorelines with nearby ship traffic reported spills as an issue. Sanctuaries in busy waterways and nearby ports and vessel traffic lanes are particularly vulnerable (e.g., Stellwagen Bank, Monterey Bay, Gulf of the Farallones, Florida Keys). Most sites expressed concerns about increasing levels of vessel traffic and the specific risks of oil spills from container ships, oil tankers, barges and liquefied natural gas tankers. Because of these threats, marine sanctuaries are actively involved in regional spill response planning and vessel routing evaluations. Some sanctuaries have volunteer-based beach monitoring programs to provide early warning and impact assessments.

2007

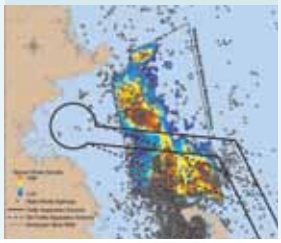
Florida Keys study shows the changing nature of resources through analysis of historical sportfishing trophy pictures

Census of Marine Life cruise to French Frigate Shoals collects numerous new invertebrate species

Channel Islands co-sponsors a five-year review of marine protected areas network within the sanctuary

Three new species described from Davidson Seamount

Cordell Bank and University of California Davis Bodega Marine Laboratory install oceanographic mooring



First monitoring report on ecological conditions and contaminants at Gray's Reef

Using whale distribution data, shipping lanes moved to protect endangered whales at Stellwagen Bank

American Samoa maritime heritage survey published

Tourism and Visitation

While tourism and visitation can result in many impacts (e.g., trash, spills, wildlife disturbance), concerns addressed in this category focused mostly on the physical impacts of visitation (e.g., trampling, anchoring) and wildlife viewing. Education and outreach programs have been put in place throughout the system to promote safe and effective wildlife viewing techniques. Damage to habitat, living resources and maritime archaeological resources was often directly attributed to impacts from anchoring. This common pressure to sanctuary resources was identified by most sanctuaries and is being addressed through zoning efforts, education programs, and installation of mooring buoys at popular locations in several sanctuaries. There were fewer impacts from visitation in the more isolated or inaccessible sanctuaries, including Cordell Bank and Papahānaumokuākea, or where visitation is predominantly run through local tourism operators (e.g., Stellwagen Bank, Hawaiian Islands Humpback Whale, and Flower Garden Banks).

More than half the marine sanctuaries reported problems with wildlife disturbance. There were several different resource types affected, and certain circumstances that make sanctuaries particularly vulnerable. For example, whales in the main Hawaiian Islands and birds in Gulf of the Farallones and Channel Islands are susceptible to disturbance by overzealous sightseers on boats or on foot. Low-flying aircraft can flush seabirds from coastal or island nests or pinnipeds from haulout areas. At many sanctuaries, frequent diving activities directly influence living resources (e.g., coral damage resulting from improper diving techniques at Florida Keys). Large animals like mantas and whale sharks in Flower Garden Banks and large groupers in the Florida Keys are often harassed unintentionally, altering their natural behaviors and potentially putting them in danger. In response, some sanctuaries have changed regulations governing wildlife interactions, or instituted interpretive enforcement or other programs to educate users.

Coastal Development

Coastal development in virtually any form affects adjacent waters and habitat. All marine sanctuaries with populated shorelines reported issues of concern that can be traced to one or more of the following: shoreline protection (e.g., coastal armoring), growing urban populations and infrastructure, or agricultural development. Reported impacts relating to water quality generally included altered physical, sediment, nutrient, or contaminant regimes. Changes to habitat generally included shoreline alterations, biogenic habitat loss, and sedimentation. Typically, multiple point and non-point sources exist, creating multiple stressors. Sorting the specific sources and their various impacts on natural or archaeological resources can be difficult, thus making mitigation decisions challenging. Some sanctuaries (e.g., Monterey Bay, Florida Keys) have been diligent over the years in developing water quality protection programs that engage communities of users (e.g., farmers, harbor and port authorities) to identify mitigation measures and solutions to water quality problems.

2008

New species of tunicate *Aplidium ruzickai*, described from Gray's Reef

Coral bleaching event at Flower Garden Banks; Research Vessel *Manta* begins service

Battle of the Atlantic Project gathers data on historically significant wrecks lost during the WWII Battle of the Atlantic off North Carolina.

Remotely operated vehicle surveys document Olympic Coast deep-sea coral and sponge communities; in four years, seven new corals, two sponges and one nudibranch discovered

Thunder Bay works with the University of Rhode Island and discovers the steamer *Messenger*

Newly discovered schooner *Kyle Spangler* documented in Thunder Bay

Submersible cruise by the Hawai'i Undersea Research Lab discovers six new genera, seven new species of deep water bamboo corals

Ship Strikes

Substantial vessel traffic, particularly by large commercial vessels, creates the possibility of collision with and behavioral modifications of large marine mammals, reptiles, or fish (primarily whale sharks). Ship strikes have been identified as a priority issue at seven national marine sanctuaries, including three of the four sanctuaries off California, Stellwagen Bank, Hawaiian Islands Humpback Whale, Florida Keys, and Flower Garden Banks. Strikes are also considered a threat to endangered blue, right, humpback and fin whales by NOAA's National Marine Fisheries Service. Efforts have been made to analyze the relationship between incidence of whale strikes and ship speeds on the east coast (Stellwagen Bank) in relation to the recovery of the highly endangered North Atlantic right whale. Mitigation techniques that employ observers, radar, sonar and infrared detection, as well as speed reductions in high-density whale areas, could reduce the threat and the probability of a collision. Other activities include establishing or modifying vessel traffic lanes and Areas To Be Avoided in national marine sanctuaries. Effective responses would benefit from improved monitoring of the location, abundance and seasonality of species at highest risk (e.g., within foraging and calving areas), monitoring shipping activity, increased communication with the shipping industry, and education and outreach campaigns regarding sensitive species, (e.g., manatees in the Florida Keys). Future response plans across the system could include improving notification of mariners, additional evaluations of existing traffic lanes, and vessel speed reductions.

Threats to Archaeological Resources

Archaeological resources are material evidence of past human activities and include vessels, aircraft, structures, habitation sites, and objects created or modified by humans. The condition of archaeological resources affects their value for science and education, and the resource's eligibility for listing in the National Register of Historic Places. Impacts to archaeological resources may result from deterioration caused by both human and natural forces. The nonrenewable nature of archaeological resources makes permanent any reduction in integrity, even if caused by natural forces. Pressures such as ice movement, waves, and invasive species are known to cause negative impacts to maritime archaeological resources. Human activities reported to cause detrimental impacts to these resources include anchoring, inadvertent and intentional diving practices that damage resources, and looting.

Two national marine sanctuaries were designated with the sole purpose of protecting archaeological resources (Thunder Bay and Monitor); however, seven other sanctuaries have robust archaeological management programs, including research, education and conservation efforts. Salvage and looting are among the most pressing challenges at many sanctuaries, especially when considering the permanent nature of those impacts. To promote awareness and protection of these resources, ONMS has worked to list several key resources on the National Register of Historic Paces (e.g., USS *Monitor*, Florida Keys shipwreck trail, the *Portland* at Stellwagen Bank). OMNS also looks to partnerships with local community groups to establish volunteer networks of citizen scientists to assist in documenting resources and creating inventories and maps of archaeological sites. Many sanctuaries feature visitor centers and museums (e.g., the Great Lakes Maritime Heritage Center and the Mariner's Museum) that aim to enhance public awareness, understanding and stewardship of sanctuary maritime archaeological resources by allowing visitors to view recovered artifacts, historic documents and replicas.

2009

Whale sharks shown to travel between Mesoamerican reef and Northwest Gulf of Mexico

Plankton blooms off Oregon and Washington kill more than 6,000 seabirds

Study at Gray's Reef describes the connection between mid-water prey fish species and bottom-dwelling predators

Proposed alternative energy project could include wind farms on the islands of Moloka'i and Lana'i and an undersea cable traversing the Hawai'ian Islands Humpback Whale sanctuary.

Monitor sanctuary locates YP-*389*, a U.S. Navy patrol boat sunk during WWII off North Carolina

First lionfish recorded in Florida Keys

World's first passive acoustic, satellite-linked system for near real-time detection of right whales in and near Stellwagen Bank

Papahānaumokuākea conducts its first technical dives to characterize mesophotic coral ecosystems

INDUSTRY

Offshore Industry

Increasingly, industrial activities in offshore waters are posing new threats to sanctuary resources. Oil and gas development, including exploration, production, pipelines, transportation and removal causes persistent noise, infrastructure and traffic issues, as well as occasional chemical inputs. Alternative energy facilities (e.g., wave, wind) add infrastructure that can affect animal safety, distribution and movement. Undersea cables (e.g., fiber optic cables) cause localized impacts to benthic habitats, either during installation or through time, particularly if they are not stable on the bottom.

Two sanctuaries reported potential issues related to oil and gas production (Flower Garden Banks and Channel Islands). Both exist in the vicinity of such operations and could be affected directly by spills, or other production related activities. Production facilities can also influence the dispersal of both native and non-indigenous species. Three sanctuaries have experienced the effects of cables (Olympic Coast, Stellwagen Bank, Monterey Bay) and instituted monitoring programs, funded by the industry, to track impacts. Hawaiian Island Humpback Whale is just beginning to deal with fish aquaculture facilities and offshore renewable energy infrastructure within its boundaries.

WATER

Degraded Water Quality

Contaminants not only affect resource condition and ecosystem integrity, but they can also impact human health. Excessive bacterial loads can result in health impacts, including flu-like symptoms, infections, respiratory illness, and hepatitis. Runoff from rainfall and irrigation can deliver contaminants, sediments, and debris through storm drains, streams and rivers to wetlands, shorelines, bays and coastal waters, impairing the quality of sanctuary resources and posing risks to human health, especially for the nine sanctuaries with coastal boundaries.

Terrestrial runoff and deposition was identified in the condition reports as a leading cause of water pollution in most sanctuaries, particularly those with estuarine and coastal habitats. It can cause impacts that include harmful algal blooms, tissue toxicity, reproductive anomalies, elevated mortality of marine mammals, and transfer of pathogens. These impacts directly interfere with fishing, visitor access (e.g., beach closures in Thunder Bay, swimming advisories in the Florida Keys), and other recreational activities. High bacterial loads in runoff can produce potent biotoxins that can be transferred up the food chain (reported in Monterey Bay), sometimes poisoning seabirds, marine mammals, and commercially harvested species. In some sanctuaries, fishing advisories have been issued when harmful algal blooms or contaminant loads exceeded safe limits (e.g., Olympic Coast, Florida Keys).

2010

Research area implemented at Gray's Reef

Thunder Bay and NOAA's Great Lakes Environmental Research Lab transform U.S. Coast Guard vessel R/V *Storm* into multi-capable, eco-friendly research vessel

First diving expedition at Cordell Bank since 1985

Thunder Bay and University of Texas discover the steamer *Egyptian* in 240 feet of water using forward looking sonar on an autonomous underwater vehicle

2011

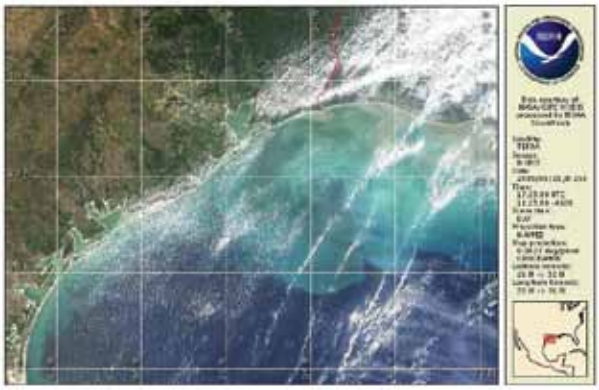
Monterey Bay assesses impacts of lost shipping containers

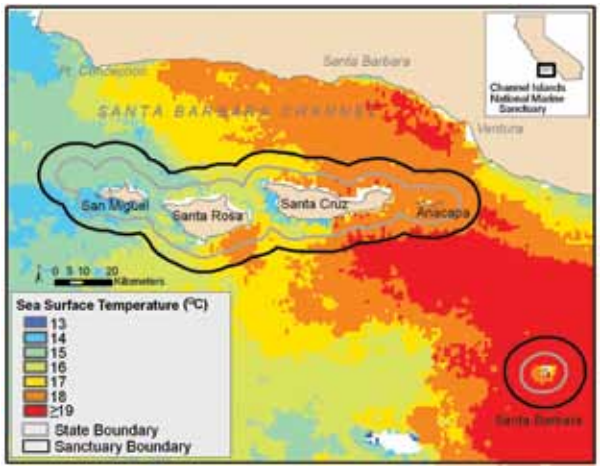
Gulf of the Farallones, U.S. Coast Guard and NOAA's National Centers for Coastal Ocean Science survey rocky reefs at Rittenburg Bank, Cochrane Bank and along the Farallon Escarpment

Climate Change

On global and regional scales, the ocean is changing due to increasing atmospheric carbon dioxide and associated global climate change. Physical changes include sea level rise, coastal erosion and flooding, as well as changes in precipitation and runoff, storm frequency and intensity, ocean-atmosphere circulation, and ocean water properties, including temperature. These changes, in turn, can lead to biotic responses within ocean ecosystems, including changes in physiology, phenology (the timing of events related to life cycles), population connectivity, and species range shifts. Habitats and ecosystems are thus affected by a combination of physical processes and biological responses.

In the last several years, all marine sanctuaries have come to recognize climate change as an emerging threat. Two (Papahānaumokuākea and American Samoa) cited observed increases in water temperature and associated effects as a basis for downgrading resource condition. Other sanctuaries with coral reefs have similar concerns, but no confirmed temperature trends to date. A number of sanctuaries are actively monitoring temperature and sea level to track the impacts of impending change. Concerns over changes in upwelling patterns and increasing levels of hypoxia along the west coast have also generated new, targeted research and monitoring efforts. Currently, there is still much uncertainty about how climate change will manifest across the system and how multiple stressors will interact, creating challenges in assessing appropriate management and conservation actions.





Ocean Acidification

Ocean acidification was identified by numerous sanctuaries (e.g., Florida Keys, Flower Garden Banks, Cordell Bank, Monterey Bay, Channel Islands, Olympic Coast, Papahānaumokuākea) as an emerging threat that is likely to affect living resources and ecosystems, beginning with animals and plants whose structural components contain calcium carbonate. Since humans began releasing immensely greater amounts of carbon dioxide into the atmosphere with the burning of more and more fossil fuels since the late 1800s, the ocean has absorbed it at an increasing rate, changing the water's chemistry and causing it to become more acidic. Seawater acidity has increased 30 percent since the beginning of the Industrial Revolution.

First lionfish recorded at Flower Garden Banks

Thunder Bay's R/V *Storm* outfitted with multibeam sonar from NOAA's Office of Coast Survey

New species of shearwater described from Midway Atoll, the first new bird species in United States since the 1970s

High school students discover the schooner M.F. *Merrick* and steamer *Etruria* during "Project Shiphunt" at Thunder Bay

"Time Zero" data collected in and outside research area at Gray's Reef

2012

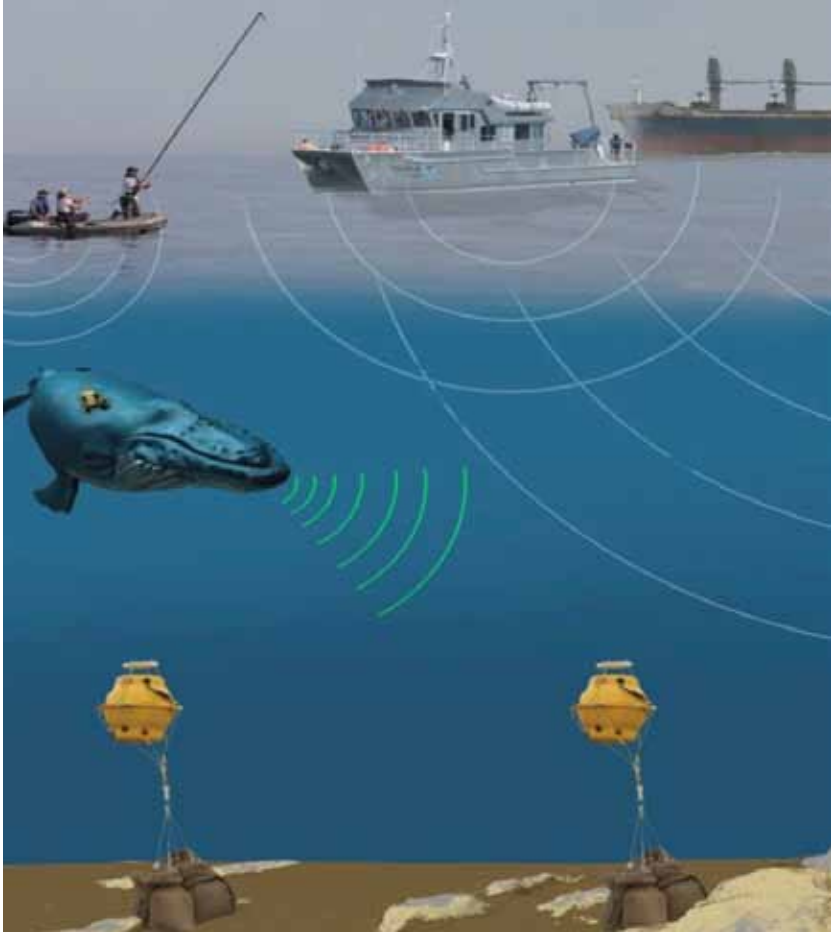
Cordell Bank, California Sea Grant, NOAA's National Marine Fisheries Service, California Department of Fish and Game, and fishermen evaluate rockfish populations in and outside Rockfish Conservation Area

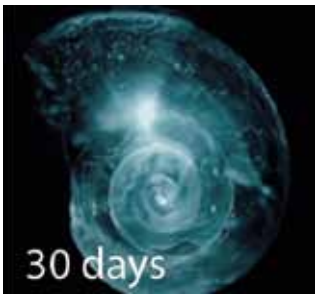
Gray's Reef studies fine-scale movement of acoustically tagged snapper and grouper

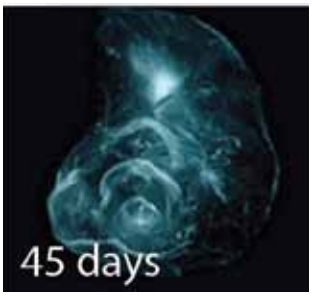
Noise

Major sources of human-generated sound in marine environments include ships and other motorized vessels, military underwater communication, sonar, airguns, and low flying aircraft. Noise can affect living resources both physiologically and behaviorally. It can impact hearing or tissue integrity, or disrupt resting, feeding, courtship, calving, nursing, navigation, communication or other activities. Large ships may create disturbing levels of noise for many kilometers around the vessel.

Noise is already regulated to some extent in sanctuaries that have overflight altitude restrictions. These are intended to limit disturbance that might cause marine mammals or birds to abandon resting or nesting areas. But noise, more generally, was reported by about half of the sanctuaries as an issue of concern, particularly uncertainty about the effects of increasing levels of noise in water. For most of those, though not all, it is considered an emerging issue rather than a proven threat. The nature and likelihood of impacts are also rather poorly understood, and research is currently underway to assess them.







Due to this elevated acidity, many marine animals and plants with calcium carbonate skeletons or shells, such as corals, mussels and many phytoplankton, may experience reduced calcification rates, inhibiting growth and, in many cases, survival. There is concern over the future of coral reef structure and function, which would reduce valuable ecosystem services, including food security, tourism, shoreline protection and biodiversity. For temperate ecosystems, concern is high for cascading effects on marine food webs, initiated by disruptions of critical components, including planktonic communities, larval fish, and shellfish. Most scientists expect the rapid changes caused by ocean acidification to continue, and to exceed the ability of many species and ecosystems to adapt.

First deep coral cruise at Gulf of the Farallones documents 20 species of deep-sea corals and sponges

Governor of Hawai'i supports broadening the sanctuary focus from humpback whales to the ecosystem as a whole, including historic and biocultural resources

Sanctuary Ocean Count in Hawaiian Islands wins Take Pride in America National Award

Monitor sanctuary works with Louisiana State University to reconstruct faces from remains of two USS *Monitor* sailors

Olympic Coast oceanographic mooring data (2000-2011) made available via web site

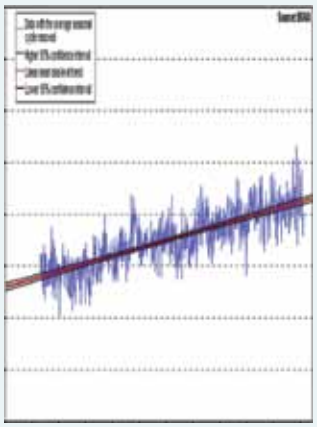
Thunder Bay partners with Alpena Community College to create a Marine Technology Program

First Papahānaumokuākea monument research cruise to use closed-circuit rebreathers

Successes, Lessons Learned

One of the benefits of preparing separate condition reports for all the sanctuaries and the marine national monument and then reviewing them collectively is acquiring an appreciation for issues and solutions that are widespread across the system, as well as identifying response efforts at a local level that have relevance at larger regional or national scales. It is also possible to gain an understanding for some of the common needs across the system and present them in a way that encourages and promotes approaches that will have the broadest impact possible on the needs and challenges facing the system.

It is clear that the sanctuary system faces significant challenges – ones



Baseline Conditions

At the time of designation, sanctuaries inherit existing pressures, management issues, and resource and socioeconomic conditions.

In order to understand an ecosystem and the factors controlling it, sanctuaries have found it useful to investigate historical data on resource qualities. Though these "baselines" are often difficult to determine accurately, they help management identify research and monitoring priorities, develop education and outreach programs, and set realistic targets for restoration actions.

Beyond the Boundaries

One of the best ways to protect a marine sanctuary is to influence actions outside its boundaries.

Condition reports often relied on the expertise of individuals who work on issues operating at scales considerably larger than the sanctuaries themselves. Condition reports affirmed that many problems with sanctuary resources are the result of influences beyond sanctuary boundaries and authorities and will need to be addressed as such. Sanctuaries must continue to engage relevant individuals and organizations when their support in large-scale solutions is required to resolve local problems.

Monitoring Gaps

A shortage of monitoring programs and data uniformly impedes management actions and reporting.

Even with the combined efforts of many partners and volunteers in sanctuary monitoring efforts, the lack of comprehensive monitoring programs makes it difficult not only to track the impacts of existing pressures and the effectiveness of management actions, but also to identify and characterize emerging threats (e.g., noise and climate change). Priority areas of concern for monitoring include contaminants, noise, climate change, ocean acidification, biodiversity loss, habitat degradation and the deterioration of maritime archaeological resources.

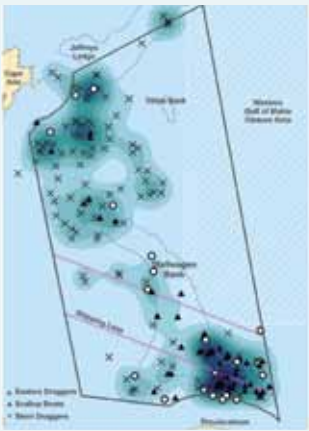
Collaborations Solve Problems

Single problems seldom have a single solution.

The diversity of demands on sanctuary ecosystems, particularly by humans, necessitates multidisciplinary solutions. In addressing complex issues like vessel traffic, fishing and land-based sources of pollution, sanctuaries reported the most successful outcomes when efforts focused the multidisciplinary tools of science, education, communication, community engagement and policy towards a desired outcome.

& Looking Ahead

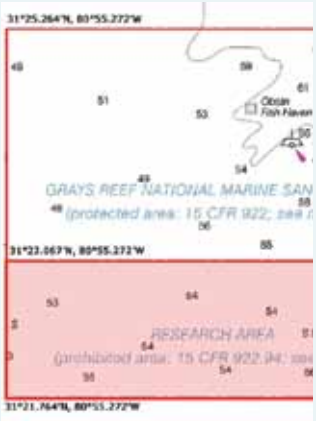
that will continue to grow and change over time. It is also clear that in the face of this growth and change, there will always be gaps in information, insufficient funding and challenging politics. This is the challenge: take what works, use what is available, and apply it to purpose. Below are eight findings that strongly influence resource management decisions and actions at all levels. Each was identified in the course of preparing the sanctuary condition reports, and each has implications for the future of conservation science and other management activities within the sanctuary system.



NMFS Partnerships

ONMS and NOAA's National Marine Fisheries Service must collaborate to manage and restore critical components of sanctuary ecosystems.

Across the system, condition reports identified fishing and associated habitat change as having a strong influence on sanctuary ecosystem condition. Recent improvements in stock assessment and management by NOAA's National Marine Fisheries Service (e.g., EFH, HAPC, area restrictions, closures) are showing positive impacts on managed stocks. This is a favorable and encouraging step towards broader effects on ecosystem services in national marine sanctuaries.



Marine Reserves

Marine reserves work, but they could be used to greater effect.

Several sanctuaries that have established marine reserves (e.g., Channel Islands, Florida Keys) have documented favorable changes in populations, biomass, and community and age class structure. Future improvements in reserve design should include consideration of connectivity between reserves and the inclusion of critical areas, such as spawning aggregation and nursery sites.

Archaeological Resources

For maritime archaeological resources, there is no such thing as resilience; once degraded, they do not recover.

Across the sanctuary system, the condition of maritime archaeological resources can only follow two trajectories: it can either be maintained or allowed to decline. Archaeological resource value cannot be restored by human intervention. While monitoring efforts for these nonrenewable resources needs improvement, overall approaches to the management and protection must be different from those taken for natural resources.

Value of Isolation

Remoteness and limited physical access to sanctuaries have benefits, even if visitation is more difficult.

Isolated and offshore sanctuaries exhibited better resource conditions than nearshore and estuarine locations. Because of greater human activity (both recreational and commercial), near-shore waters, coastal areas, and associated watersheds incur persistent damage from human activities. These influences decrease with distance from shore. Limited pressures in isolated locations may confer added resilience.

Expert Input, Our Action

While drafted by science staff across the system, condition reports are built around the expert knowledge and experience of partners around the country. Through meetings, workshops, and peer review, ideas were shared, information debated, and assessments prepared. Collectively, condition reports speak to many areas of need, opportunity and action. The following items result from a collective review of those recommendations. They are a concise and directed set of actions for the ONMS to consider during annual budget development, as well as long-term planning for the growth and improvement of the national system, the conservation science program and sanctuary resource protection.

- **MONITORING –** Though the judgment of experts was valuable in helping determine sanctuary resource conditions, by itself, expert opinion is not an acceptable alternative to monitoring. **Greatly improved long-term monitoring programs are needed in sanctuaries to track a variety of resources.** Most sanctuaries identified a lack of data as the reason for difficulty in making confident statements about status and/or trends for key resources. Prioritization of and investment in targeted, long-term monitoring programs is critical. Efforts to establish monitoring programs will be most successful if approached through collaborations with local academic institutions and community organizations interested in studying their local resources.

- **CHARACTERIZATION – Across the system, further efforts to establish baseline characterizations are required.** These data are critical to accurate assessments of both natural and archaeological resources and to providing sound guidance for future management actions. ONMS intends to foster collaborations with NOAA programs (e.g., NOAA's National Centers for Coastal Ocean Science) and local partners in sanctuary communities to address this need.

- **TARGETED RESEARCH –** During the development of each sanctuary condition report, information needs were identified pertaining to the quality of information available, knowledge gaps (see gray boxes and question marks in the national summary table, Figure 4), new trends in resource condition (e.g., ocean acidification, non-indigenous species), or newly discovered resources (e.g., spawning aggregations, nursery grounds). **New targeted research is necessary to understand specific pressures and threats to sanctuary system trust resources.** Requirements for these areas of research will be continually added to the sanctuary system Science Needs Assessment, which provides up-to-date information on the priority management issues facing national marine sanctuaries and defines the science and information needs necessary to address the issues.

- **THE HUMAN DIMENSION –** The importance of human interactions in assessing and tracking sanctuary resource condition and associated trends is prominent across the system. **ONMS must increase efforts to understand and respond to use, impacts, and valuation (both use and non-use) of sanctuary resources.** Current efforts to address the human dimension of resource management and protection were found to be insufficient in the condition reports, leading to uncertainty that could delay important management actions. Requirements for this line of study are being added to the sanctuary system Science Needs Assessment. For some units, particular consideration of influential cultural relationships, such as those with Native Hawaiians and coastal tribes, in the context of tracking short- and long-term change, would contribute greatly to resource protection efforts.

Currently, ONMS is considering a moderate expansion of Condition Reports to incorporate a model that more fully reflects human interactions with ecosystems. Using the Drivers-Pressures-State-Ecosystem Services-Response model would broaden the conversation from one focused solely on the benefits to ecosystems of improving resource conditions to one including the human benefits derived from these investments.

- **PARTNERSHIPS** – Key to the success of any effort to protect and manage sanctuary resources has been and will continue to be the role of partnerships. Across the board, from education to enforcement, science to regulatory implementations, success relies on partnerships with federal agencies, state and territorial governments, tribes, local academic and research organizations, and individual community leaders and volunteers. **ONMS must continue to foster these partnerships, promote their importance, and ensure their success.**

> **"When we…treat scientific advice...as just another special-interest opinion, *we jeopardize* not only the opportunity to make good policy decisions, but also our health, environment, and quality of life."**
>
> *— Andy Rosenberg*

- **NEW PERFORMANCE MEASURES** – Current performance measures for the sanctuary system were developed during a 2002 Program Review by the White House Office of Management and Budget. While these measures have become mechanisms for reporting to NOAA and the Administration, **new performance measures are needed to improve our ability to evaluate success of our programs and management actions, including investments in the sanctuary system's Conservation Science Program.** Presently, trend ratings in sanctuary condition reports are used to report on performance relative to system-wide goals regarding resource protection – maintaining or improving water, habitat and living resource quality. One shortcoming of this process, however, is that it emphasizes failures that may not reflect the results of sanctuary management. Many declining conditions are caused by sources beyond sanctuary boundaries and for which sanctuaries have no direct management authority. Primary among these are land-based sources of pollution, large-scale changes in oceanic conditions, commercial and recreational uses, and invasion of non-indigenous species. In these cases, the importance of working with partners to influence resource management decisions cannot be overstated. Further, performance measures based on these three general topic areas (water, habitat, living resources) lack the ability to track effectiveness of management efforts designed to address specific issues for specific outcomes. Examples include marine reserves, enhanced fishing regulations, vessel strike mitigation, and disentanglement programs. ONMS will be considering changes to the performance measurement process to enhance our ability to design, implement, and evaluate effective management and resource protection efforts.

- **CONDITION REPORT STRUCTURE AND NEXT ROUND OF REPORTS** – With the completion of all 14 condition reports, a number of changes to the structure of the reports are necessary, including modifications to the 17 questions addressed by each sanctuary, and an expansion to the Pressure-State-Response framework to consider both "drivers" of the pressures found at each sanctuary and the ecosystem and societal benefits derived from resource integrity. **These changes are already underway and will be implemented when the next round of reports begins.** Furthermore, to increase the utility of these reports, each sanctuary will work to schedule the review and update of their condition report in conjunction with their management plan review.

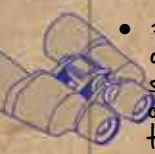
SINCE THE CONDITION REPORTS: NOTES FROM

OLYMPIC COAST (2008)

- ROV surveys (2008-2011) of deep-sea coral and sponge communities result in discovery of new species of deep-sea corals (seven), sponges (two) and nudibranch (one)
- Publication of "Chemical Contaminants, Pathogen Exposure and General Health Status of Live and Beach-Cast Washington Sea Otters" in 2009
- Plankton blooms (*Akashiwo sanguinea*) off Oregon and Washington coast (fall, 2009) resulted in deaths of more than 6,000 seabirds
- Sanctuary oceanographic mooring data (2000-2011) made available via web site
- Marine debris from Japanese tsunami event begin arriving in Olympic Coast in 2012

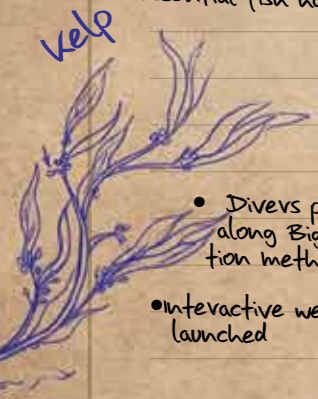
GULF OF THE FARALLONES (2010)

- GFNMS data used in developing Critical Habitat for Steller sea lions around Farallon Islands
- Beach Watch monitoring data supports $52 million settlement for seabird and recreation restoration projects
- Significant range extension of the Christmas tree coral, *Antipathes dendrochristos*, resulting in consideration of new essential fish habitat



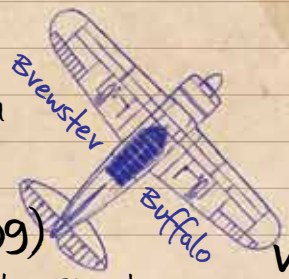
MONTEREY BAY (2009)

- Deep water habitats characterized using camera sled and ROV; images available through online interactive map
- Interactive map developed depicting all monitoring activities in the Sanctuary, including web links and project descriptions
- Historic oil tanker SS *Montebello*, at 900 feet, determined not to contain additional oil and poses no environmental threat
- Sill built at the mouth of Parsons Slough to address tidal erosion problems in Elkhorn Slough Estuary
- Divers provide data from kelp forest community along Big Sur coastline, informing highway construction methods for soil disposal
- Interactive web-based "Historical Ecology Timeline" is launched
- Japanese tsunami debris reaches the west coast of the United States
- Study of lost shipping container illuminates international problem of deep sea habitat modification
- Ten years of data on beach-cast organisms indicate reduction in oiled animals and average of two die-off events (natural or human caused) per year



CHANNEL ISLANDS (2009)

- Channel Islands discontinued participation in key programs assessing MPA effectiveness, ocean acoustics and whale ship strikes, ocean observations, and subtidal and aerial monitoring due to lack of internal and external funding



PAPAHĀNAUMOKUĀKEA (2009)

- Mesopohotic coral reef surveys below 50 meters using technical diving discovered 10 new species of macroalgae and 66 new species of epiphytic algae.
- Historic WWII-era Brewster Buffalo F2A fighter plane wreck discovered and documented at Midway Atoll
- 2012 Reef Assessment and Monitoring Cruise finds no indication of coral bleaching, but discovers two species of non-indigenous invertebrates, likely human-facilitated introductions
- In 2012 and 2013, marine debris with confirmed links to the Japan tsunami washed ashore at Midway Atoll
- Data downloaded from receivers placed by technical divers on deep coral reefs found that tagged Galapagos sharks on shallower reefs (0-30 meters) during the day moved offshore to mesophotic depths (30-80 meters) at night

AMERICAN SAMOA (2007)

- Coral bleaching in shallow areas due to increasing water temperatures
- Decline in water quality around Tutuila due to discharges of sediments, chemicals and sewage from leaky septic tanks and piggeries
- Crown-of-Thorns starfish outbreak on south side of Tutuila
- Manual removal and sodium bisulfate injections to kill Crown-of-Thorns starfish to reduce numbers before breeding season and prevent secondary populations from forming

HAWAIIAN ISLANDS HUMPBACK WHALE (2010)

- New sanctuary vessel Kohola goes into action for research and entanglement response efforts
- Governor of Hawai'i and public indicate support broadening focus of sanctuary from single species to full ecosystem
- Sanctuary citizen science program, Sanctuary Ocean Count, wins Take Pride in America National Award
- Biogeographic assessment of marine resources and habitats around the island of Ni'ihau.

THE FIELD

San Francisco Bay Shipping Lanes

CORDELL BANK (2009)

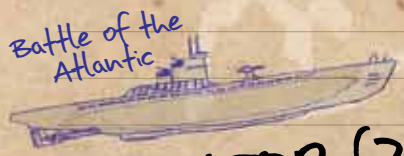
- Harmful algal bloom (fall 2011) causes unprecedented mortality of red abalone and subtidal invertebrates along the Sonoma Coast
- Comparative assessment of 1980 and 2010 imagery indicates no change in invertebrate community of Cordell Bank
- First verified observations of four coral species for Cordell Bank and neighboring Bodega Canyon during surveys for deep-sea corals and sponges
- Rockfish populations continue to rebuild; study initiated to evaluate populations in and outside of Cordell Bank Rockfish Conservation Area
- Whale distribution data informs modifications of San Francisco Bay shipping lanes to reduce the risk of ship strikes

STELLWAGEN BANK (2007)

- "*Whale Alert*" mobile app developed for transmitting conservation information to maritime industry
- Group bottom feeding by humpback whales identified as behavior that makes them vulnerable to entanglement in bottom set fishing gear
- Stellwagen Bank identified as key area for Gulf of Maine cod, and sand lance as a major cod prey resource
- Quantification of right whale communication space loss due to increased shipping noise

THUNDER BAY (2013)

- Thunder Bay's condition report published in 2013; no updates since release



Battle of the Atlantic

MONITOR (2008)

- Remains of *YP-389*, a yard patrol boat lost in WWII, located and identified by NOAA in 2009
- Multiyear Battle of the Atlantic Project to explore and categorize 30-35 shipwrecks lost in WWII off the North Carolina coast.
- Baseline studies of biological communities associated with North Carolina shipwrecks conducted
- Remains of two USS *Monitor* sailors discovered during 2002 turret recovery expedition interred at Arlington National Cemetery on March 8, 2013

GRAY'S REEF (2008 AND ADDENDUM IN 2012)

- Increased sightings of lionfish adjacent to sanctuary
- Six year data record indicates increased levels of atmospheric (0.79 percent per year) and seawater carbon dioxide (2.4 percent per year), comparable to measures from Mauna Loa Observatory in Hawaii
- Sightings of new species, including sturgeon, white shark, bull shark and lemon shark

White Shark

FLOWER GARDEN BANKS (2008)

- Decline in health and cover of major benthic components at Stetson Bank
- No impacts found following Deepwater Horizon spill
- First sighting of lionfish in 2010; abundance continues to increase
- Exploration and characterization activities support proposed boundary expansion
- Colonies of non-indigenous coral *Tubastraea* removed
- Oil platform HIA389A no longer operational; decommissioning and full/partial removal pending

FLORIDA KEYS (2011)

- New research and characterization of spawning aggregations for key species in the sanctuary
- Marine zoning and regulatory review initiated

Conservation Science

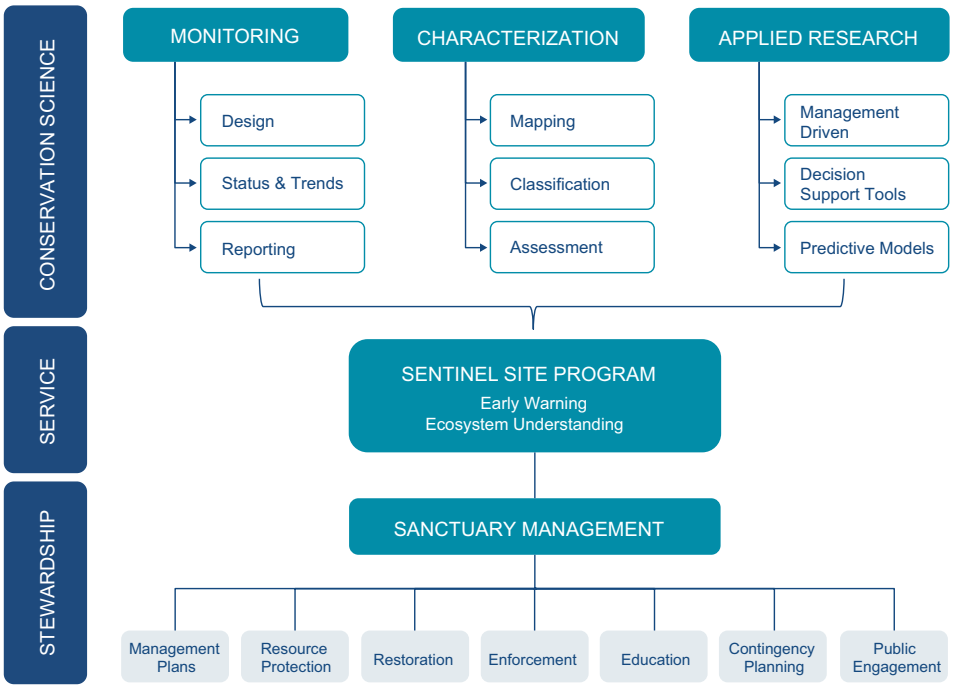
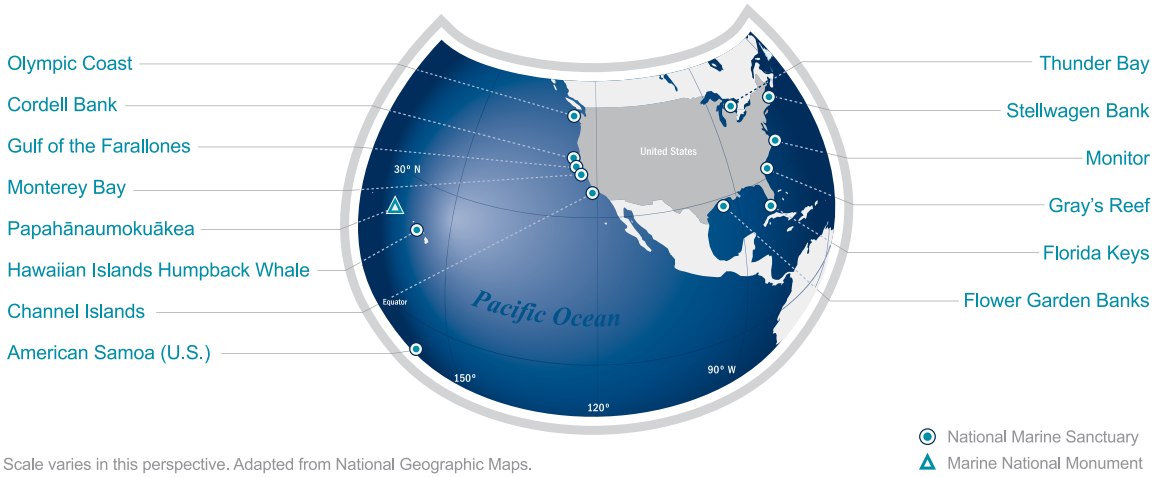


Figure 4: This framework shows the links between selected monitoring, characterization, and research programs in the sanctuary system, its Sentinel Site Program, and sanctuary management activities.

Using science, education, outreach, enforcement and resource protection programs, ONMS delivers on its mission to conserve, protect, and enhance the biodiversity, ecological integrity and cultural legacy of these special places. The Conservation Science Program is a service-based capability that directly supports the management requirements of the system and NOAA, and addresses the needs and interests of local communities invested in the viability of sanctuary resources. ONMS conducts and sponsors natural and social science programs, and facilitates collaborations to better understand ecosystems and cultural resources in marine sanctuaries, their changing condition, and the significance of natural and human-caused threats. It uses conservation science to support policy decisions, develop effective response capabilities, evaluate management practices, and strengthen the role of the sanctuary system to support NOAA's broader science, service and stewardship missions. Sanctuaries work in partnership with universities, public and private research centers, government agencies, international partners and other organizations to characterize, monitor and study the oceans, habitats, and the plants and animals in and around them. Knowledge gained from this work plays an important role in the management of all our national marine sanctuaries.

In implementing sanctuary management plans and responding to findings of sanctuary condition reports, conservation science staff and partners design, implement, and conduct monitoring, characterization, and applied research activities in order to address the priority concerns across the system, locally, regionally and nationally. Collectively, conservation science efforts across the system are the backbone of the sanctuary system Sentinel Site Program, designed to enhance our understanding of sanctuary ecosystems and resources, as well as provide an early warning capability that detects changes to ecosystem processes and conditions. This information plays integral roles in many key program areas of the sanctuary system, including management plan review, permitting, enforcement, education and restoration (Figure 4).

National Marine Sanctuary System



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

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 170,000 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 one square mile to almost 140,000 square miles and serve as natural classrooms, cherished recreational spots, and are home to valuable commercial industries.

Photo Descriptions and Credits

Brief descriptions and credit information for the images found in this report:

COVER: TeamOCEAN kayaker (NOAA/MBNMS); coral reef (Coral Reef Targeted Research and Capacity Building for Management Program); *Monohansett* (NOAA/TBNMS); cruise ship (C. King); derelict fishing gear at Midway Atoll (S. Holst); lionfish (REEF); entangled humpback whale (HIHWNMS/NOAA MMHSRP permit #932-1489); planet Earth (NASA); PAGE 1: marine debris removal (NOAA/FKNMS); whale watching (NOAA); event in Alpena, MI (NOAA/TBNMS); researchers with lionfish (F. Nivens/Ocean Imaging); shipwreck (T. Casserley); children in intertidal zone (R. Lozano-Knowlton); ships in sunset (J. Augustino/FEMA); PAGES 6 – 7: USS *Monitor* (NOAA/Monitor Collection); diver: (R. Schwemmer); filming birds on NWHI (NOAA); sea otters (E. Bowlby); manta (G.P. Schmahl); Delta sub (R. Schwemmer); intertidal monitoring (E. Ueber); PAGES 8 – 9: OCNMS seafloor map (NOAA/OCNMS); CBNMS anemone (NOAA/CBNMS); GFNMS intertidal visitors (J. Roletto); PMNM coral reef (J. Watt); HIHWNMS entangled humpback whale (HIHWNMS/NOAA MMHSRP permit #932-1489); MBNMS P/B Sharkcat (NOAA/MBNMS); CINMS purple sea urchins (A. Crawley); TBNMS diver (NOAA/TBNMS); SBNMS vessel (NOAA/NMFS permit #981-1707-00); MNMS remote technology (NOAA/Monitor Collection); NMSAS crown of thorns (R. Eckert); GRNMS fouled fishing line (M. Kendall); FGBNMS manta ray (E. Hickerson); FKNMS fly-fishing (NOAA/FKNMS); PAGE 10: water/corals (Coral Reef Targeted Research and Capacity Building for Management Program); habitat/kelp (R. Schwemmer); living resources/turtle (E. Hickerson); maritime archaeological resources/shipwreck (J. Watt); PAGES 12 – 13: water quality/relative abundance of diatoms and dinoflagellates common to Monterey Bay (Jester, R.J. 2008. An investigation into the prevalence of *Alexandrium* derived toxins in marine food webs. Ph.D. Dissertation, University of California. Santa Cruz, CA. 116pp.); habitat/healthy coral in Fagatele Bay (R. Murphy) and damaged and dead coral in Fagatele Bay (E. Lyman); living resources/black sea bass catch in GRNMS (NOAA/GRNMS); maritime archaeological resources/*F.T. Barney* (NOAA/TBNMS); PAGES 16 – 17: marine debris/TeamOCEAN kayaker (NOAA/MBNMS),derelict fishing gear at Midway Atoll (S. Holst/NOAA); changing abundances of key species/spiny lobster (R.A. Clevenger), cod under *Paul Palmer* shipwreck (T. Casserely), diver and coral nursery (K. Nedimyer); non-indigenous species/lionfish (REEF), *Kyle Spangler* before and after quagga mussel invasion on (NOAA/TBNMS); PAGES 18 – 19: fishing impacts/ship in the Strait of Juan de Fuca (NOAA/OCNMS), trend in the relative depletion of overfished rockfish species that are managed by the PFMC (S. Ralston and J. Field, NOAA/NMFS/SWFSC); spills/*Cosco Busan* oil spill (D. Howard); tourism and visitation; cruise ship (C. King), trash from cleanup event in MBNMS(Save Our Shores), kayakers in CINMS (R. Schwemmer); coastal development/power plant in Moss Landing (California Coastal Records Project); PAGES 20 – 21: ship strikes/injured humpback whale (HIHWNMS/NOAA MMHSRP permit #923-1489); threats to archaeological resources/shipwreck *Defiance* (NOAA/TBNMS); offshore industry/oil platform near CINMS (R. Schwemmer); degraded water quality/instruments (NOAA/OCNMS); PAGES 22 – 23: climate change/satellite imagery of discolored water in GoM resulting from Hurricane Rita (NASA/MODIS/NOAA Coast Watch), temperature gradients in CINMS (NOAA/CINMS); ocean acidification/time series of coral (Coral Reef Targeted Research and Capacity Building for Management Program), time series of shell dissolution (D. Liittschwager/National Geographic Stock); noise/noise graphic (NOAA/SBNMS); PAGES 24 – 25: baseline conditions/mean tide measurements in FKNMS (NOAA Coral Reef Watch); beyond the boundaries/OCNMS map (NOAA); monitoring gaps/rocky intertidal monitoring in GFNMS (J. Roletto); collaborations solve problems/NR-1(FGBNMS); NMFS partnerships/distribution & density of bottom-tending trawler fishing effort in SBNMS (Wiley, D. N., J.C. Moller, and K.A. Zilinskas. 2003. The distribution and density of commercial fisheries and baleen whales within the Stellwagen Bank National Marine Sanctuary: July 2001-June 2002. Marine Technology Society Journal 37:1 35-53); marine reserves/GRNMS research area (GRNMS);archaeological resources/sonar image of *Frank A. Palmer* and *Louise B. Crary* (NURC and SBNMS); value of isolation/Kure Atoll Wildlife Refuge (P. Maurin); PAGE 27: diver at GRNMS (G. McFall), NOAA ship *Hi'ialakai* (NOAA), Aquarius (NOAA), sidescan sonar at GRNMS (GRNMS)

Brief descriptions and credit information for the images found in the timeline section of this report:

1760: Gulf of Florida chart (image courtesy of the United Kingdom Hydrographic Office); 1778: Captain James Cook (Courtesy of WDSU); 1840: humpback whale breaching (NOAA); 1844: dead loggerhead sponge (M. Butler); 1853: George Davidson (courtesy of Wikimedia); 1857: King Kamehameha IV (courtesy of Wikimedia); 1885: Princess Lydia Lili'uokalani (courtesy of amazingwomeninhistory.com); 1902: Laysan Rail (U.S. Fish & Wildlife Commission); 1905: whaling (V.B. Scheffer); 1911: otter hunting (E.C. "Paddy" Apling); 1922: monk seal drawing (courtesy of NOAA); 1940: sponge diver (State Archives of Florida, *Florida Memory*); 1961: Milton "Sam" Gray (Georgia Marine Institute); 1970: Ozette archaeological site (Maka Cultural and Research Museum); 1976: brine seep in East Flower Garden Bank (Institute for Exploration, URI); 1977: crown of thorns (R. Eckert); 1979: bleached corals in FKNMS (NOAA/FKNMS); 1981: volunteers with CINMS (NOAA/CINMS); 1983: *Diadema* (E. Hickerson); 1984: TV *Peurto Rican* (NOAA/GFNMS);1986: Common Murre restoration (J. Roletto); 1987: diver at FBNMS (W. Cover); 1988: seaweed drawing from GRNMS (NOAA/GRNMS); 1989: kelp in OCNMS (S. Fisher); 1990: spawning coral at FGBNMS (E. Hickerson); 1992: Aquarius (NOAA); 1993: Beach Watch at GFNMS (J. Hall); 1994: T/V *Tatoosh* (K. Brenkman); 1995: seagrass in FKNMS (NOAA/FKNMS); 1996: Plumes and Blooms data (ERI UCSB); 1996: Sanctuary Ocean Count (NOAA/NOS); 1997: aerial survey at CINMS (NOAA); 1997: mardi grass wrasse (Frank and Joyce Burek); 1998: USS *Monitor* propeller (NOAA/MNMS); 1998: Brandt's Cormorant in breeding plumage (R. LeValley); 2000: ROV at OCNMS (NOAA/OCNMS); 2001: Delta sub at CBNMS (R. Starr); 2001: USS *Monitor* engine (Mariners Museum); 2002: orange cup coral (E. Hickerson); 2002: Davidson seamount survey (NOAA/MBNMS); 2002: USS Monitor gun turret (NOAA/ MNMS); 2002: *Portland* sidescan sonar (Klein Sonar Associates); 2003: *Acropora palmate* (G.P. Schmahl); 2003: humpback whale breaching (D. Perrine; HWRF/Seapics.com/NOAA Fisheries Permit #882); 2003: filming sanctuary resources (NOAA/TBNMS); 2004: zooplankton (S. Webb); 2004: NOAA ship *Hi'ialakai* (NOAA); 2005: bleached coral at FGBNMS (B. Altmerier); 2005: Discharging cod fish from vessel Gloucester, MA circa 1882 (National Archives collection, LICON. RG 22-C. Records of the U.S. Fish and Wildlife Service. U.S. Commissioner of Fish and Fisheries. Cyanotypes: Commercial Fishing Activity in the United States, 1882-1891. Courtesy of Gulf of Maine Cod Project, NOAA National Marine Sanctuaries; Courtesy of National Archives); 2006: endangered coral (B. Altmerier); 2006: manta (E. Hickerson); 2006: data buoy (NOAA/NDBC); 2006: child with grouper (Monroe County Public Library, Key West, Florida); 2007: golden coral (NOAA/MBARI); 2005: ship traffic schematic (NOAA/SBNMS); 2008: *Aplidium ruzickai* (G. McFall); 2008: *Oopsacas* sponge (NOAA/OCNMS); 2008: *Kyle Spangler* (NOAA/TBNMS); 2009: whale shark (R. Eckert); 2009: YP-389 (NOAA); 2009: diver in PMNM (G. McFall); 2010: black seabass in GRNMS (K. Roeder); 2010: diver in CBNMS (J. Hoyt); 2011: lost shipping container (MBARI/NOAA/MBNMS); 2011: shearwater (R. David); 2011: *M.F. Merrick* (J. Janzen); 2012: rockfish (D. Roberts); 2012: GFNMS benthic community (NOAA); 2012: USS *Monitor* sailor (Louisiana State University); 2012: Thunder Bay Marine Technology Program (Alpena CC)

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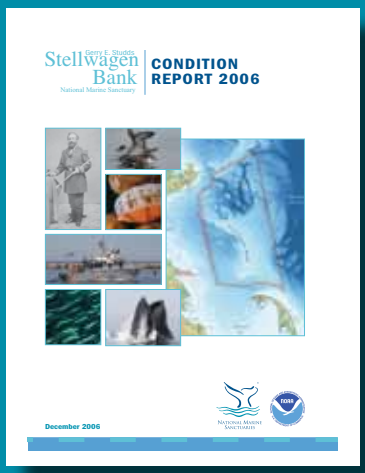

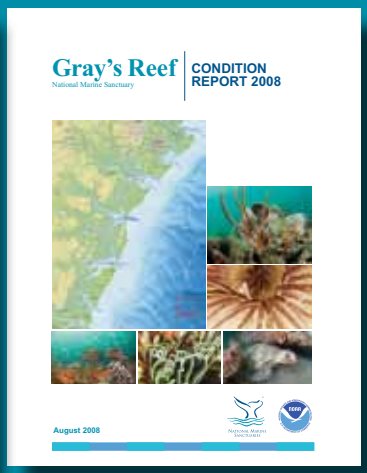

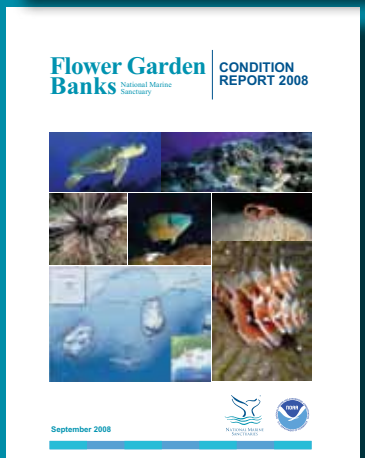

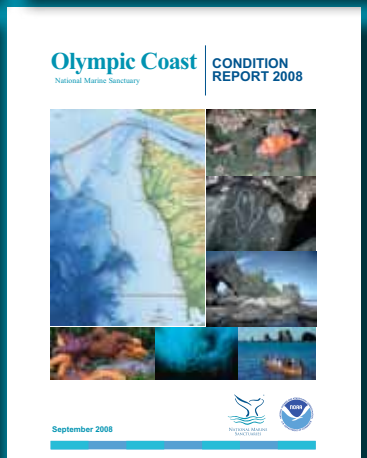

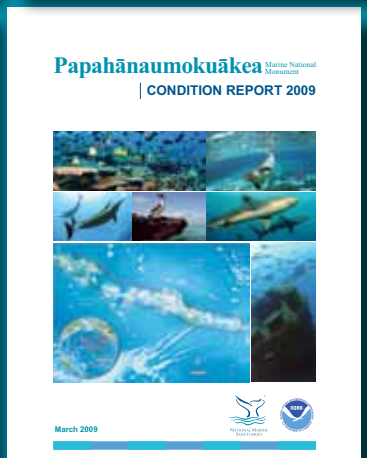

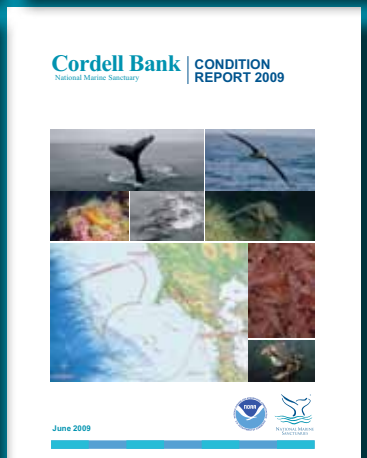

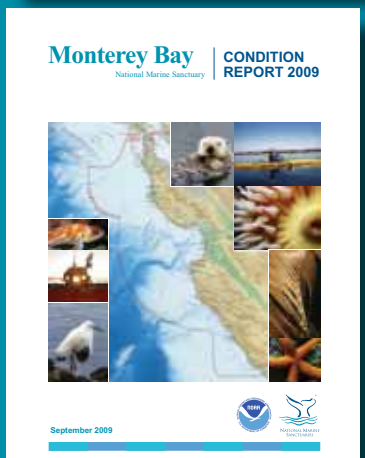

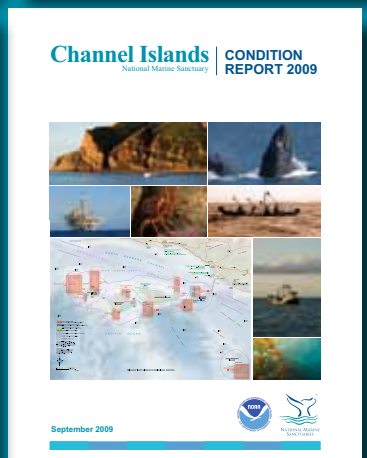

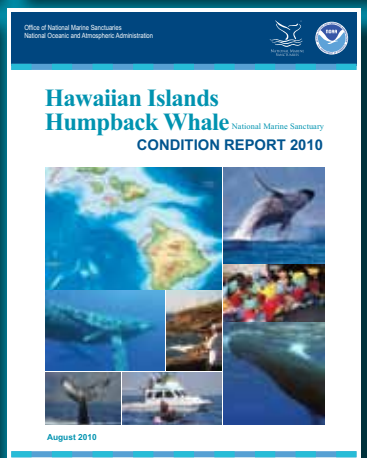

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